SWAKOPPOORT –VON BACH- NAVACHAB WATER SUPPLY SCHEME

UPDATED ENVIRONMENTAL MANAGEMENT PLAN

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
CoC	Code of Conduct
DEA	Directorate of Environmental Affairs
EMA	Environmental Management Act
EMP	Environmental Management Plan
HIV	Human Immunodeficiency Virus
I&AP	Interested and Affected Parties
MET	Ministry of Environment and Tourism
NEM	NamWater Environmental Manager
MSDS	Material Safety Data Sheet
NWQG	Namibian Water Quality Guidelines
NWQS	Namibian Water Quality Standards
STI's	Sexually Transmitted Infections

1. PURPOSE OF THE EMP

This Environmental Management Plan (EMP) has been compiled and updated for the management of potential environmental impacts during the operation, and decommissioning phases of the existing Swakoppoort-Von Bach-Navachab Canal Water Supply Scheme. Best practice is proposed for the generic issues of construction management and supervision as well as the on-going management and operation of the water supply scheme.

In terms of the Environmental Assessment Policy of 1994 and the Environmental Management (Act No 7 of 2007) (EMA), the activities required for the construction of the proposed project requires authorization from the Directorate of Environmental Affairs at the Ministry of Environmental and Tourism (MET: DEA).

An Environmental Clearance Certificate (ECC) was originally issued on the 6th June 2017 and this EMP serves as an application for the renewal of the ECC. The EMP is for an existing scheme and it is therefore only for the operation and maintenance of the scheme.

2. INTRODUCTION

The Swakoppoort-Von Bach-Navachab scheme consists of seven smaller schemes that can be operated individually or together to supply water to the various end-users and consumers along the pipeline routes.

2.1 The scheme is divided into the following components:

I. **Swakoppoort Dam**: Water abstracted from the dam can either be pumped into the Swakoppoort-Okongava pipeline or Swakoppoort-Von Bach pipeline.

II. **Swakoppoort-Okongava**: A pipeline scheme conveying raw-water from Swakoppoort Dam to the Okongava Reservoir, from where water is transferred to the Karibib Treatment Plant and to the Navachab Mine.

III. **Swakoppoort-Von Bach**: A pipeline scheme conveying raw-water from Swakoppoort Dam to Von Bach Dam and vice versa. The pipeline from Swakoppoort base pump station to the Von Bach Dam runs via a booster pump station at Gross Barmen. The system is equipped with three pump stations: the abstraction tower pumps which feed a base station at Swakoppoort Dam and a booster station at Gross Barmen en route to the Von Bach Dam.

IV. **Okongava-Karibib**: A pipeline scheme supplying raw-water to the Karibib Purification Plant.

V. **Karibib Purification**: A water treatment plant supplying potable water to the town of Karibib. Raw water is supplied from the Swakoppoort Dam.

VI. **Navachab Mine**: A piped water scheme supplying raw-water to the Navachab mine. The scheme receives water from the Swakoppoort Dam.

2.2 Swakoppoort Dam

The Swakoppoort Dam is one of the three Central Area dams and located some 70 km northwest of Windhoek and 50 km southwest of Okahandja. The Swakoppoort dam is the main storage dam for water supply to the town of Karibib and the Navachab Gold Mine. It also acts as an important source for augmenting the water supply to Windhoek and supplies a group of consumers along the water supply routes to the Von Bach Dam and Okongava Reservoir.

The dam's concrete arch structure, extraction tower and access bridge are in excellent condition. Water can be abstracted from various levels in the dam and this is controlled by means of valves located in the extraction tower.

Raw water from the Swakoppoort dam is supplied from the extraction tower to the Swakoppoort Base Pump Station via a set of submersible pumps in the Tower pump station. The Base pump station is located on the northern bank of the dam, approximately 690 m from the dam wall. Raw water first passes through an intermediate reservoir before it is fed to the Base pump station.

Two sets of pumps are housed at the Swakoppoort Base pump station, namely the Swakoppoort - Von Bach pumps and Swakoppoort - Okongava pumps.

2.3 Okongava – Karibib/Navachab Scheme

Karibib town is located in the central eastern part of the Erongo Region and is administered by the Karibib Municipality. The town comprises two distinct townships: Karibib and Usab, while there is also an informal settlement area near Usab. There are approximately 765 erven (not all developed) in Karibib and approximately 150 informal houses in the settlement near Usab. The current population is estimated at 5 100 residents with approximately 1 200 households in total (including settlers). There are approximately 696 consumer meters which are not read regularly. The figures exclude the NDF base near the Karibib Airport on the road to Omaruru.

The Navachab Gold Mine is located on the farm Navachab, 6 km south of the B2 main road between Okahandja and Swakopmund. The deposit contains very fine-grained gold, is situated within the southern central zone of the Damaran Orogenic belt and was originally discovered as a result of a geochemical exploration program in October 1984. It was originally anticipated that the life of mine would be in the region of 13 years.

The main ore body at Navachab is some 35 m thick and it is mined by open-cast method to a depth of over 200 metres. The ore body is estimated to contain 10.4 million tonnes of ore with average grade of 2.3 grams of gold per ton. More than 85% of the gold occurs as native gold and the remainder as maldonite (Au2Bi).

Navachab Gold Mine has the capacity to treat 1.32 million metric tonnes of ore per year. In 2004, gold production was 647 kg, compared with 2,331 kg in (2003) and 2,653 kg in (2002). The drastic decrease during 2004 was attributed to a suspension of open-pit mining, due to the installation of new mining equipment. The Navachab Mine has recently delineated additional ore reserves, and was granted an additional 15-year mining license from the Ministry of Mines and Energy.

The mine is wholly owned by Anglo Ashanti Gold (Pty) Ltd, who recently announced their intention to expand mining operations at the Navachab Gold Mine. Since the envisaged expansion depends on the availability of sufficient amounts of raw water from the Swakoppoort-Navachab bulk supply scheme, the mine requested NamWater to investigate the possibility of increasing the current supply capacity from 250 m3/h to 420 m3/h from 2012 onwards. The results of the feasibility study are contained in the NamWater Report Number NWC-IP-NAVAC02-01, Situation Assessment to Increase Water Supply to Navachab Gold Mine.

2.4 Karibib Purification

This treatment works supplies potable water to the town of Karibib. . There are two 200 mm diam. mechanical bulk sales meters serving the town, which are located at the outlet of the Karibib terminal reservoir. In 2008/09, 301 513 m^3 were sold from this scheme.

The Karibib Water Treatment Plant (KWTP) has a total capacity of 216 m^3/hour or 4 700 m^3/d at 22 hour operation (60 l/s) and was completed in 1989. The Swakoppoort dam supplies raw water to the plant via a 65 km pumping main to the Okongava reservoir, from where the water is fed via a gravity pipeline to the KWTP over a distance of approximately 21.7 km. The plant was inspected on 25 June 2010. During the site visit the plant was not in operation.

The EMP is for existing schemes namely Swakoppoort-Von Bach, Okongava-Karibib/Navachab Scheme, and the Swakoppoort-Okongava and it is therefore only for the operation and maintenance of the schemes.

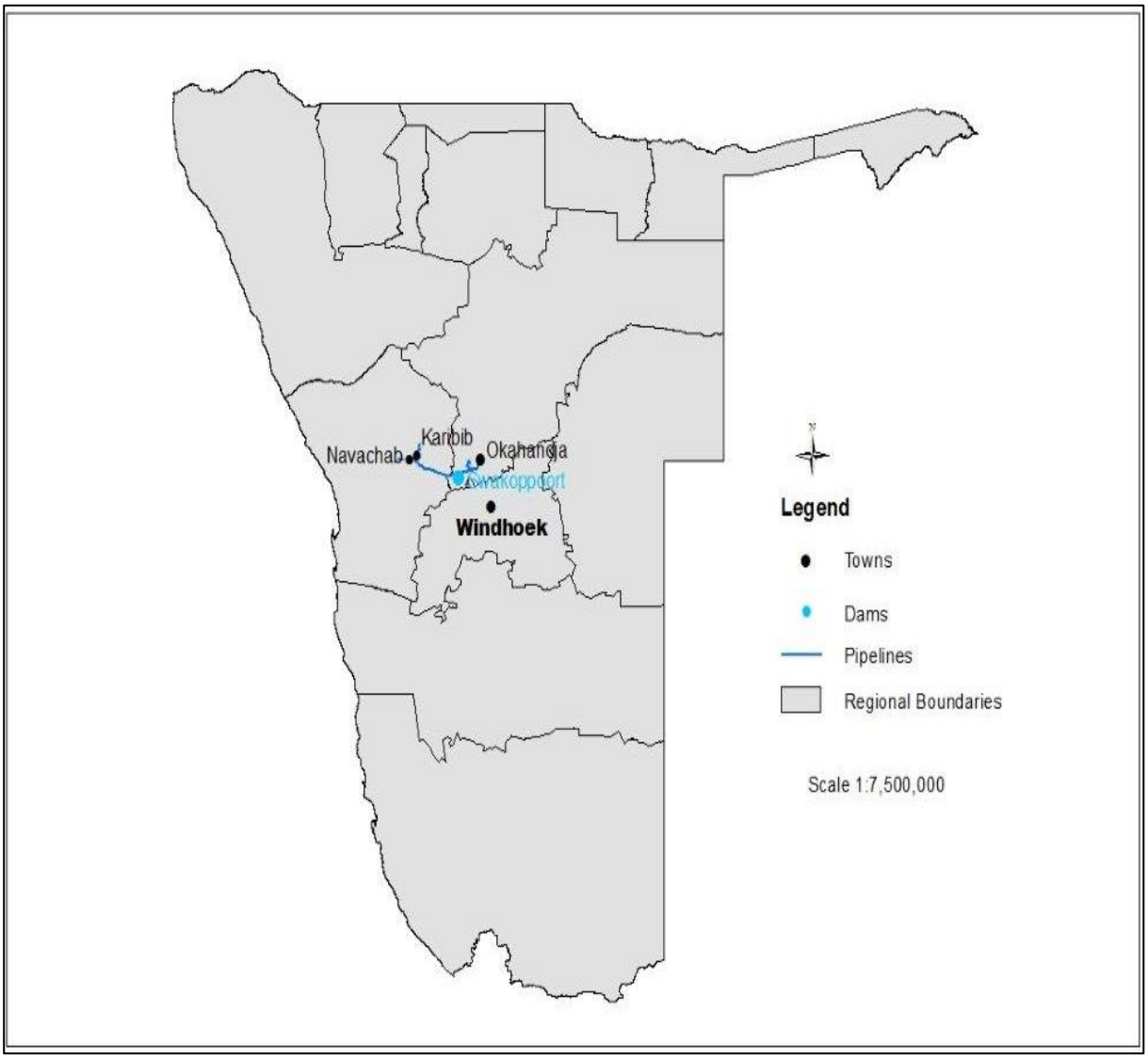

Figure 1: Swakoppoort- Navachab Location Map

3 SWAKOPPOORT-VON BACH-NAVACHAB INFRASTRUCTURE

3.1 Water Source

3.1.1. Swakoppoort-Von Bach Scheme

This scheme is supplied from the Swakoppoort Dam. Although the dam's capacity of 63.5 Mm^3 is more than that of the Von Bach Dam, its surface area to water volume relationship is less favourable than Von Bach. After the rainy season, water that is impounded in the Swakoppoort Dam is transferred to the Von Bach Dam to counteract the higher evaporation losses at the Swakoppoort dam.

The Swakoppoort - Von Bach pumping main has been designed in such a way that water from the Von Bach dam can also be fed to the Swakoppoort dam under reverse gravity flow. In this way the Von Bach dam can be used to augment the water supply to the town of Karibib, the Navachab Gold Mine and other water supply points, if the need arises.

The Swakoppoort Dam is located on the Swakop River, downstream of the Von Bach Dam. The dam has a catchment area of roughly 5 480 km^2 and is fed from the Swakop River, Otjihavera River from the Windhoek area and various tributaries from the Khomas Hochland area. It is a double curvature concrete arch dam and the yield of the dam at 95% assurance is 4.5 Mm^3/annum.

3.1.2. Swakoppoort – Okongava Scheme

The Swakoppoort – Okongava pipeline scheme supplies raw-water from Swakoppoort Dam to the Okongava Reservoir, from where water is transferred to both Karibib town and the Navachab Gold Mine.

As described in Section 26.1, raw water is initially pumped from the Swakoppoort extraction tower to the Swakoppoort Base Pump Station via a set of submersible pumps in the Tower pump station. Raw water first passes through an intermediate reservoir before it is fed to the Base pump station.

The Swakoppoort - Okongava pumping main consists of the Okongava pump set in the Swakoppoort Base pump station, the Okongava storage reservoir and a 65 km long pipeline connecting the two components. From the Okongava reservoir water gravitates to Karibib town and Navachab Mine.

3.1.3. Okongava – Karibib/Navachab Scheme

This system supplies raw water from the Okongava reservoir to the town of Karibib and the Navachab Gold Mine and all components are located in the Erongo Region. The Swakoppoort dam is the main water source for both of these schemes. This is a raw water scheme and therefore no water treatment is provided.

The schematic layouts of the existing infrastructure are indicated in **Figure 2-6** below.

3.2 Process Units

The treatment process at the KWTP can be summarised as follows:

- Coagulant dosing at hydraulic jump at the inlet works;
- Powder Activated Carbon Dosage (10 mg/L) at the inlet works;
- Dosing of lime to stabilise water;

- Flocculation canals;
- Settler;
- Intermediate chlorination before the sand filters;
- Rapid sand filtration;
- Clear water well ;
- Chlorination.

3.3 Water Quality

3.3.1 Swakoppoort-Von Bach

The water at Okahitwa meets the Group B limits for conductivity and total dissolved salts, as well as for all inorganic determinants.

Chlorine dosing is at the Okahitwa reservoir is currently done by means of a floating chlorine dispenser, which uses chlorine tablets, placed in the elevated reservoir.

3.3.2 Swakoppoort – Okongava Scheme

Chlorination is done with Cl2 gas installations at Booster 2, Otjihase reservoirs and Windhoek airport ground level reservoir. The chlorination systems are reported to be in good working condition and should be maintained properly at recommended intervals.

3.3.3 Okongava – Karibib/Navachab Scheme

Additional chlorination of the Rüdenau Nord supply is done at the Gross Barmen pump house. The chlorination is undertaken by means of injecting a concentrated Sodium Hypochlorite solution into the pump line at a position downstream of the base pumps.

A single Grundfos/Alldos diaphragm type dosing pump, BMI 1.0-10 B, is installed with a maximum capacity of 1.0 L/h at 10 Bar pressure. The dosing pump is equipped with an adjustable dial to vary the dosing rate. The Sodium Hypochlorite solution is fed to the dosing pump from a 500L GRP make-up tank, which is also housed inside the pump house.

3.4 Pipe Work

3.4.1 Swakoppoort-Von Bach Scheme

In the 1970's a 600 mm diameter steel pipeline was constructed from the Swakoppoort Dam to the Von Bach Dam. Raw water from Von Bach Dam is supplied to the Von Bach Water Treatment Plant where it is purified before being pumped to Windhoek. The pipe work for the Swakoppoort-Von Bach scheme consists of the three sections, Swakoppoort extraction tower to Base pump station, Base station to Booster pump station and finally Booster station to Von Bach Water Treatment Plant.

A short pipeline conveys raw-water from the Swakoppoort abstraction Tower to the intermediate reservoir at the Swakoppoort Base pump station. The pipeline from Swakoppoort base pump station to the Booster pump station at Gross Barmen consists of a diam. 600 steel pipe line with cathodic protection. The pipeline from Booster Station to Von Bach consists of approximately ±51 km diam. 600 steel pipe also with cathodic protection.

3.4.2 Swakoppoort-Okongava

The pipeline from the Swakoppoort Base pump station to the 15 000 m3 Okongava reservoir is approximately 65 km long and is a 620 mm diam. and constructed from pre-stressed concrete pipe. The design capacity of the 620 mm diam. pipeline is 734 m³/hour.

3.4.3 Okongava – Karibib/Navachab Scheme

Both schemes are supplied from the Okongava reservoir, which transfers the raw water under gravity to the Karibib/Navachab junction. At this junction the feed bifurcates to supply the Navachab Gold Mine and Karibib Water Treatment Plant via two separate gravity pipelines.

Okongava reservoir – Karibib/Navachab junction

From the Okongava reservoir water is transported over 13 km to the Karibib/Navachab junction. For the first 8.6 km the pipeline is constructed from 600 mm diam. AC pipe of unconfirmed class, where after it reduces to 450 mm diam. AC class 12 CID pipe for 3.2 km and the last 2.2 km is a 400 mm diam. AC class 12 CID and class 18 CID pipe for 1.2 km and 1 km, respectively.

The design capacity of the 620/450/400 mm diam. gravity pipeline is 734 m³/h. This flow rate (204 L/s) equates to velocities of between 1.6 m/s and 0.75 m/s through the various pipe sizes.

Karibib/Navachab junction - Karibib Water Treatment Plant

From the Karibib/Navachab junction, raw water is fed to the Karibib Water Treatment Plant via a 9 km long gravity pipeline constructed from a 350 mm diam. AC class 18 CID for 3.7 km and a 350 mm diam. AC class 24 for the remaining section of pipeline. The design capacity of the pipeline is 482 m³/h and 1.52 m/s.

Karibib/Navachab junction – Navachab Mine

From the Karibib/Navachab junction water is transported over 7 km to the connection point at the Navachab Terminal Reservoir. For the first 1.8 km the pipeline is constructed from 350 mm diam. AC class 18 CID, then reduce to a 250 mm diam. AC class 18 CID pipe for 600 m. The pipe class then changes to a 250 mm diam. AC class 24 CID pipe for 2.6 km from where the pipeline class increases to a 250 mm diam. AC class 30 for the last 1.8 km.

Although the original design capacity was determined as 360 m³/h, the feasible capacity of the 350/250 mm diam. gravity pipeline is set at 320 m³/h. This flow rate (89 L/s) equates to velocities of between 2.0 m/s and 1.0 m/s through the two pipe sizes.

3.5 Reservoirs

3.5.1 Swakoppoort-Von Bach

The storage facilities consist of the following two reservoirs:

- The Intermediate reservoir at the Base pump station, situated on the northern bank of the dam, approximately 500 m from the dam wall. It is an open concrete reservoir inside the fence of the base pump station. The reservoir has a design capacity of 1000 m³ and acts as a sump for the Base Station pumps.
- A 500 m³ closed concrete ground reservoir at Booster pump station, which acts as a sump for the Booster pump station. The reservoir has a design capacity of 500 m³. The reservoir appears to be in a general good condition with minor leakage observed around the base.

3.5.2 Swakoppoort-Okongava

The storage facilities consist of the following reservoirs:

- The Okongava reservoir is a PVC lined, open earth bank reservoir with a capacity of 15 000 m^3. The reservoir is divided in two compartments, each with a capacity of approximately 7 500 m^3. The full supply level is at 1 289.43 mAMSL and the lowest abstraction level is at 1 286.36 mAMSL. From these reservoirs the water is gravity fed to Karibib and Navachab Mine. A fence on the banks of the reservoirs prevents animals and people staying in the area from damaging the lining. The inlet structure and split between the two reservoirs is outside the fenced area.

3.5.3 Okongava-Karibib/Navachab Scheme

The storage facilities consist of the following:

- The 500 m^3 concrete raw water reservoir at the Navachab Mine, located on a hill at the eastern side of the mine premises. The concrete reservoir has a cylindrical shape and is covered with a corrugated IBR roof and steel support structure.

  Inlet and outlet pipes to the reservoir are constructed above ground and appear to be in reasonable condition. Although the reservoir is owned by Navachab Mine and not the responsibility of NamWater, it can be reported that the concrete appears to be in good condition and no leaks were visible on the joints in the walls. The corrugated IBR roof and steel support structure showed signs of advanced corrosion.
- The Karibib terminal reservoir is a 1 250 m^3 potable water reservoir, located downstream of the Treatment Plant and used to store treated water for Karibib town. The reservoir is situated close to the treatment works and is located on the highest point in town. The concrete reservoir has a cylindrical shape and is covered with a dome type concrete roof.

Treated water is pumped by means of the Clearwater Pumps to the reservoir inlet pipes, which pass through the base of the reservoir walls. The outlet pipes are below ground and discharge into the town's water reticulation. The inlet and outlet pipes and fittings appear to be in reasonable condition where visible above ground and in the manholes. Although the concrete appears to be in good condition and no leaks were visible on the joints in the walls, there is evidence of concrete spalling at the top of the reservoir walls.

3.6 Power Supply and Control System

3.6.1 Swakoppoort-Von Bach-Scheme

Pump control for the Swakoppoort Tower and Base pump stations is by telemetry and operation is controlled from the Von Bach NamWater station.

The telemetry control panels were locked at the time of the inspection and no notes could be made about the condition and functionality of the system. However, NamWater staff confirmed that the system is fully functional.

The Tower pumps have variable speed drives which allow for accurate control during start and stopping of the individual pumps to reduce pipeline surge effects.

The Base station and booster station is connected via telemetry to the Von Bach NamWater station. Normal operation depends on level sensors, the level of the reservoirs at the different booster stations determine start-up and shutdown.

Swakoppoort Dam Power Supply

The power supply for the Swakoppoort Dam is a NamPower 22kV overhead power line fed from the Osona sub-station. NamPower supplies power for the dam area installation as 11kV from a 22/11kV 5 MVA transformer to the main Base Station 11kV pumps, as 400V from 2MVA 22kV/400V substation located adjacent to the Base Station, for the Okongava pumps, and as 400V from a 22kV/400V substation for the Abstraction Tower pumps. The maximum demand authorised for the pump station is 2 500 kVA (2000 kW). The substation was constructed for the scheme in 1984 and is underrated for the new 11kV pumps. When these pumps are started, the supply voltage drops to 6 000 V which places high stresses on the infrastructure and the pump motors. This matter must be investigated by Nampower and the power supply should be upgraded for the demand. NamWater buys power metered at 11 kV for the Von Bach Dam pumps and at 400V for the Okongava and the tower pumps from NamPower.

Swakoppoort Base Pump Station Power Supply

Power from the NamPower substation is taken to the main HT switchgear located in a high tension room inside the Base Pump Station building. Switchgear consists of five cubicles consisting of Incomer, feeds to Pump Motors 1A, 1B, 2A and 2B. The make of the HT switchgear is ABB and it is in good condition, dated from 2003.

The four pumps are driven by 11kV motors, with 11kV Motor Control Consoles. All panels and switchgear are in good working condition. The motors start direct online.

Booster Pump Station Power Supply

Power from the NamPower substation is taken to the main HT switchgear located in a high tension room inside the Booster Pump Station building. Switchgear consists of five cubicles consisting of Incomer, feeds to Pump Motors 1A, 1B, 2A and 2B. The make of the HT switchgear is ABB and it is in good condition, dated from 2003.

The four pumps are driven by 11kV motors, with 11kV Motor Control Consoles. All panels and switchgear are in good working condition. The motors start direct online.

3.6.2 Swakoppoort – Okongava Scheme

Power from the NamPower substation is taken to the main HT switchgear located in a high tension room inside the Base Pump Station building. Switchgear consists of five cubicles consisting of Incomer, feeds to Pump Motors 1A, 1B, 2A and 2B. The make of the HT switchgear is ABB and it is in good condition, dated from 2003.

The four KSB pumps and two Grundfos pressure pumps which pump water to the Okongava Reservoir are supplied with 400V power from the 2 MVA NamPower transformer.

The transformer feeds the motor control centre main board for the six Base pumps, which also supplies the building power. The pump MCC is new and in a good condition. The make of the switchgear is ABB, and the MCC complies with safety signage regulations. Each of the pumps is controlled via a WEG soft starter, linked to the telemetry control system.

Pump control at the Base pump station is by telemetry and operation is controlled from the Von Bach NamWater station.

The telemetry control panels were locked at the time of the inspection and the condition and functionality of the system could not be assessed in detail. However, NamWater staff confirmed that the system is fully functional.

The Okongava pumps have soft starters, which allow for accurate control during start and stopping of the individual pumps to reduce pipeline surge effects. The water level at Okongava reservoir is monitored by means of level transducers connected to the telemetry control panels.

3.6.3 Okongava – Karibib/Navachab Scheme

The water supply system from the Okongava reservoir to the Navachab Mine Reservoir, and to the Karibib reservoir, is fully telemetry controlled from the NamWater Von Bach station. At the Okongava Reservoir, the telemetry control panel is powered by solar PV electricity from a few solar panels. The installation is fenced in with an electric fence.

The Operation Manual for the Karibib Purification Works (1995) indicates that the amount of raw water inflow to the plant is regulated by a pressure reducing valve in series with a flow control valve, which are operated via a PLC installed in the control room switchboard. Since the panels of control boards were locked or empty, it could not be determined for certain if the inlet control system is still functioning automatically or operated manually.

The inflow to the reservoir is also regulated by means of automated flow control valves with Rotork actuators, which are mounted in a vertical configuration to the two inlet pipes. The water level at the Navachab terminal reservoir is monitored by means of a float switch that opens and closes the Rotork actuators on the inlet pipes. The control panels are located in a small brick building constructed in close vicinity of the reservoir. Only one of the flow control valves has been provided with a protective cage.

3.6.4 Karibib Purification Plant

The power supply for the Karibib Water Treatment Plant is a municipal 100kVA 11kV/400V transformer located near the entrance gate to the NamWater property. The transformer is connected to the Karibib HT town reticulation by underground 11kV cable and is protected by an HT breaker at the gate house. The maximum demand authorised for the plant is 60 kVA (3x80A). The transformer and power supply that was constructed for the scheme, is old, but in good condition. NamWater buys power metered at 400V from ErongoRed, the regional utility.

Power from the ErongoRed meter board located near the entrance gate is taken to a NamWater MDB located just inside the premises. It is equipped with a 125A TP circuit breaker, and the purification plant is fed via a 4 core 70mm2 LV underground cable. The meter board is old but in a good condition. However, the incomer voltage measured at the 200A TP main circuit breaker terminals was 330V P-P, and 180V P-N, which is much lower than the acceptable limits. The board voltage selector switch on the voltmeter was faulty. The reason for the under voltage situation is most likely the wrong tap setting on the transformer.
The Plant Operation DB main circuit breaker is a Merlin Gerin 250A unit, which feeds the electric motors of the plant.

The Karibib Water Treatment Plant is operated manually and is not connected to the central telemetry system. The dosing equipment, including the Alum and Lime feeder motors, is controlled by variable frequency motor controllers. The model of controller is Commander VC 55 from Control Techniques.

3.7 Scheme Processes/Operation

There is a fulltime NamWater scheme operator, who does checks on a daily basis whether all the systems are functional. The scheme has been electrified and automated with timer switches.

3.8 Maintenance

Maintenance is done by a permanent NamWater team.

3.9 Pumps

All motors bearings should be lubricated with a high-temperature lithium-based grease after 3000 hours.

If a pump/s were out of operation for six months, lubrication is required before service commence on all motor bearings.

3.10 Air Valves

The valves must be opened monthly to be descaled and cleaned to ensure effective operation. The service intervals will depend on the severity of the conditions.

3.11 Pressure Gauges and Transducers

The gauge cocks must be turned monthly to bleed-off air and ensure accurate readings. Turning prevents scale accumulation which prevents the gauge cock from functioning. The operational or service intervals will depend on the severity of the conditions.

3.12 Reservoirs

The reservoirs should be checked for leaks and other damages on a monthly basis. If leaks are detected, it should be fixed immediately.

3.13 Pipe Breaks/leaks

Monthly monitor of pipes should be done to avoid wastage of water in an event a major pipe break. The pipeline corridor for maintenance work is 10 m by 5 m.

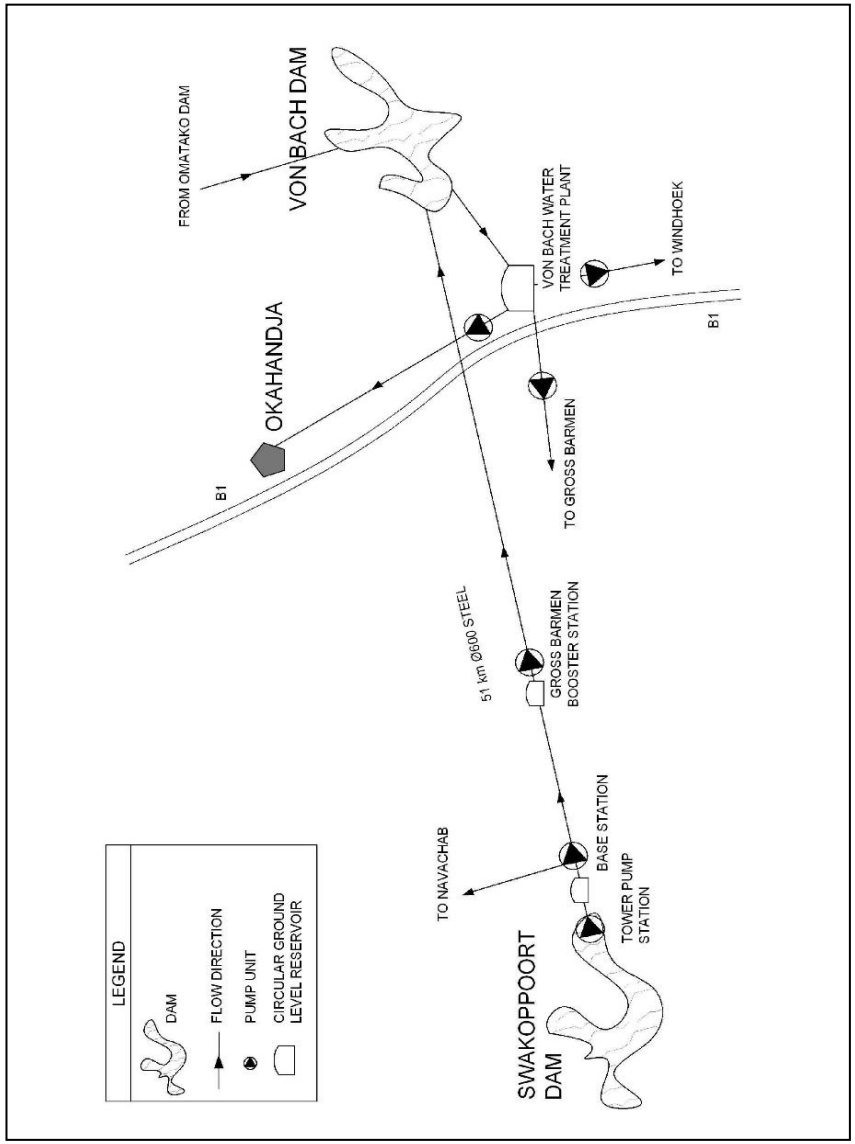

Figure 2: Schematic Layout of the Swakoppoort-Von Bach Scheme

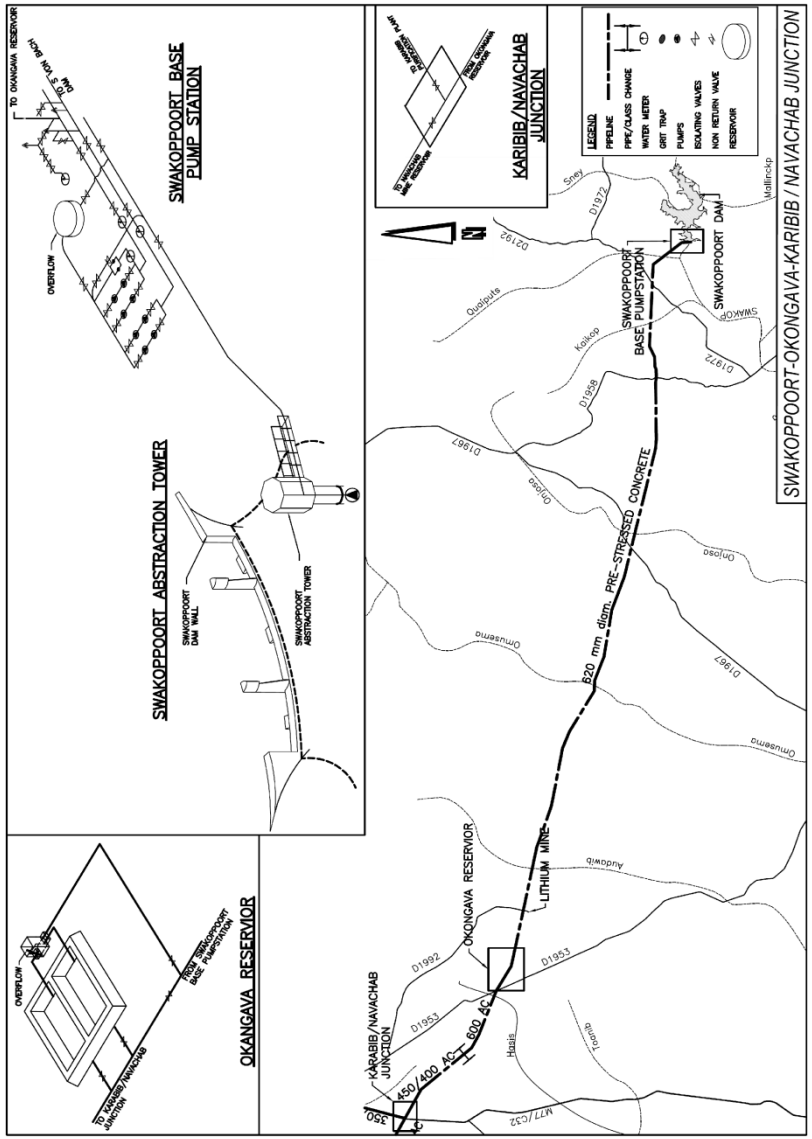

Figure 3: Schematic Layout of Swakoppoort-Okongava Scheme

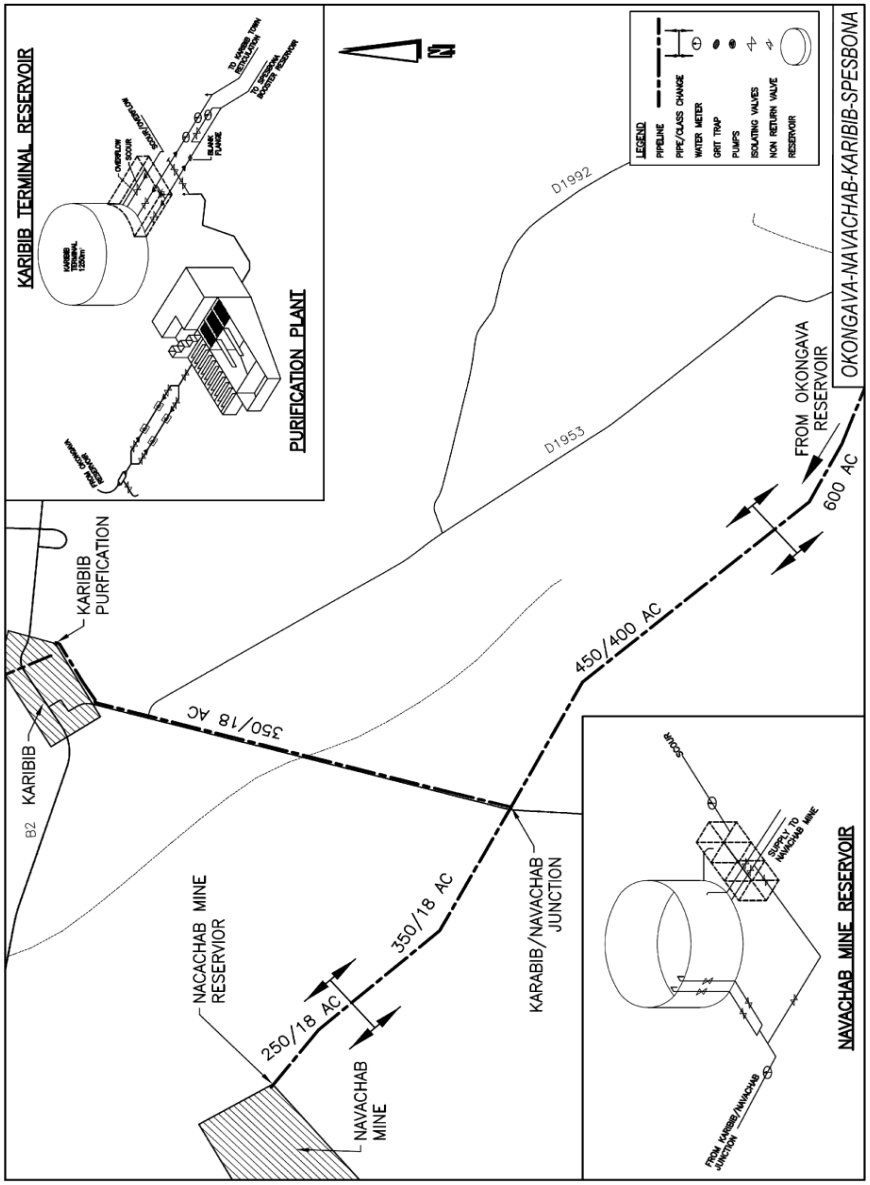

Figure 4: Schematic Layout of the Okongava-Karibib/Navachab Scheme

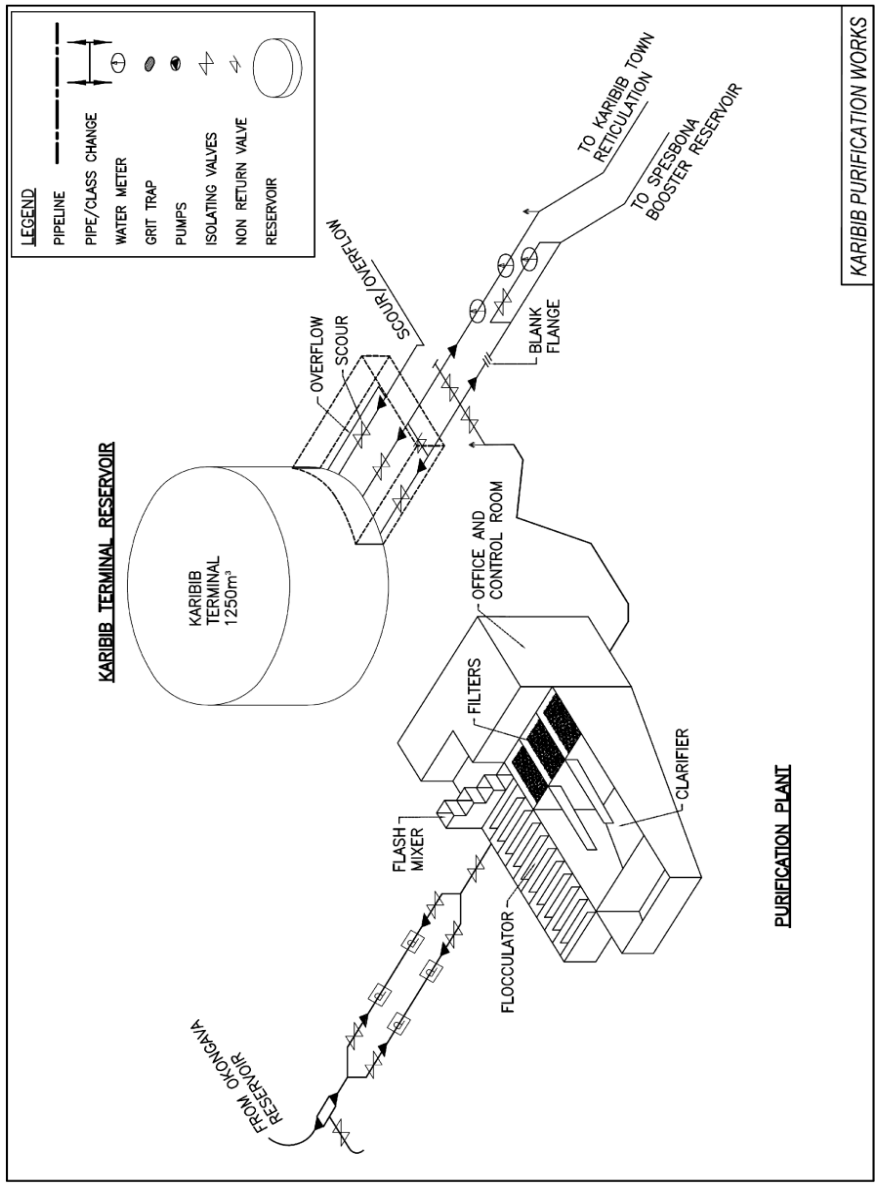

Figure 5: Schematic Layout of Karibib Purification Works

4 BRIEF DESCRIPTION OF THE RECEIVING ENVIRONMENT

The baseline description provided below focuses on the receiving environment:

4.1 Climate

The study area has an extreme climate most times of the year with high temperatures especially during the rainy season and low temperature during the dry winter season.

4.1.1 Precipitation

The study area has according to Mendelsohn *et al.,* (2009) a semi-desert climate, characterised by a large range of temperatures, low rainfall, and high evaporation. Hot summers and mild winters are typical in the area. The prevailing wind direction is south-west and the minimum speeds recorded are 15 km/hour.

4.1.2 Temperature

The area has hot summers and mild winters, maximum summer temperature rising to as high as 32 ºC, while minimum temperatures drop as low as 8 ºC (Enviro Dynamics, 2015). Extreme daily and seasonal variations are the norm for the central part of the country.

4.2 Physical Geography

The Karibib Formation consists of an interbedded succession of dark grey marble, ribbon marble that is made up of thin alternating layers of light and dark grey marble, sedimentary marble breccias, grey phyllitic dolomite and laminae of calc-silicate rock (Steven et al.,1994).

The area is underlain by meta-sediments and granites of the Damara Sequence that have a low groundwater potential. The marble and schist aquifers around Karibib have moderate yields, and are insufficient to maintain the water supply to the Karibib and the Navachab gold mine, hence the augmentation of supply to the town by the Swakoppoort Dam.

4.3 Natural Flora

The study area is situated on the edge of the Central-Western Plains stretching from the coast to about 450 km to the east which connects the Escarpment. The escarpment divides most of the country into two general landscapes: the low lying coastal plain, and the higher inland plateau (Khomas Hochland to the east of Karibib) (Enviro Dynamics, 2015).

Among the marble ridges, and magnificent specimens of the protected *Sterculia africana* can be found. Although this tree species is widely distributed throughout the country, its range is largely restricted to rocky outcrops and hill slopes. In addition, a number of Commiphora species were observed among the same marble ridges. *Commiphora glaucescens* is the more dominant species on the slopes while *Commiphora saxicola* is observed on top of the marble ridge (Enviro Dynamics, 2015).

4.4 Fauna

According to Mendelsohn *et al*., (2002) a total of 658 species of birds are recorded in Namibia, with nearly 200 of these are reported in the study area. The bird species recorded in the area, include the yellow-billed hornbill (*Tockus leucomelas*), the colourful lilac breasted roller (*Coracias caudatus*) and the crimson bou bou (*Laniarius atrococcineus*)

The following type of mammalian species can be found in the Karibib surrounds are: kudu (*Tragelaphus strepsiceros*), blesbok (*Damaliscus pygargus*), springbok (*Antidorcas marsupialis*),

steenbok (*Raphicerus campestris*), mountain zebra (*Equus zebra*), and warthog (*Phacochoerus africanus*).

5 RESPONSIBLE PARTIES

NamWater's Environmental Manager is primarily responsible for the implementation of the EMP during the operational and maintenance phases.

5.1 NamWater

NamWater, as the implementing agency, is responsible for:

- Ensuring that the objects of the EMP are being obtained;
- Ensuring that all environmental impacts are managed according to the environmental principles of avoiding, minimizing, mitigating and rehabilitation. This will be achieved by successful implementation of the EMP;
- Ensuring that appropriate monitoring and compliance auditing are executed;
- Ensuring that the environment is rehabilitated to its natural state as far as possible.

NamWater shall ensure that all employees attend an Environmental, Awareness Training Course. This course shall be structured to ensure that attendees:

- Become familiar with the environmental controls contained in the EMP;
- Are made aware of the need to conserve water and minimise waste;
- Are made aware of NamWater's Code of Conduct;
- Are aware that a copy of the EMP is readily available at the plant and that all staff are aware of the location and have access to the document;
- Are informed that employee information posters, outlining the environmental "do's" and "don'ts" (as per the environmental awareness training course) will be placed at prominent locations throughout the site.

6 ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plans (EMP) is an important tool focusing on the management actions that are required to ensure environmental compliance of a particular project.

EMP implementation is a cyclical process that converts mitigation measures into actions and through cyclical monitoring, auditing, review and corrective action, ensures conformance with stated EMP aims and objectives. Monitoring and auditing, feedback for continual improvement ensures that environmental performance has been provided and corrective action is taken for an effective EMP.

The main aim of this EMP is to ensure that the project complies with the goals of the Namibian Environmental Management Act (No. 7 of 2007); and, more specifically, to provide a framework for implementing the management actions as described in the EMP for the operational and maintenance phases of the scheme. Best practice is proposed for the operation of the scheme.

There are some environmental impacts that cannot be avoided. These environmental impacts require mitigation, and in order to mitigate against these impacts an EMP is required. The EMP aims to ensure best practises are implemented and environmental degradation is avoided through appropriate environmental protection, adherence to legal requirements and maintaining good community relationships.

MET indicated that EMP is for existing operations are sufficient. The project activities are grouped according to the different operational processes and stages. Most of the impacts can be reduced through good housekeeping.

7 MANAGEMENT ACTIONS

7.1 Operation and Maintenance phase of the SWAKOPPOORT-VON BACH-NAVACHAB Water Pipeline Scheme

7.1.1 Introduction

The Operational Phase Section relates to the management and mitigation measures required to ensure that the continuation of the bulk water supply network and the maintenance of the infrastructure is operated in a manner that demonstrates responsible, precautionary environmental management.

The EMP will address specific areas of concern in terms of the long-term environmental management of the affected environment and is intended to serve as a guide to the on-going management of the water supply scheme site as well as the affected environment. The EMP will therefore aim to provide NamWater with the necessary tools to ensure that the potential impacts on the natural environment of the site during the operation of the water supply scheme are minimised. Moreover, it will aim to ensure that the infrastructure is operated and maintained according to Best Practice, in an environmentally sensitive and sustainable manner, and that the operation of the infrastructure does not result in reasonably avoidable environmental impacts.

Table 2: Operation and Maintenance Phase Management Table

Issue	Objective	Strategy	Actions	Time frame
Maintenance and emergency procedures	To ensure correct procedures are in place to avoid environmental impacts associated with maintenance activities as well as proactive intervention to avoid, and if required, to respond to emergencies	• Establish environmentally sensitive and technically sound maintenance procedures as well as reporting structures. • Compile a staff competency assessment and training programme. • Establish emergency procedures to ensure appropriate response and minimise potential risk to the biophysical and social environment.	1. Establish regular reporting procedures on maintenance 2. Undertake regular inspection and maintenance of all infrastructure to ensure in working order and to assess damaged / deficient equipment, as per the O&M Manual. 3. Review, and if necessary, revise maintenance manual. 4. Establish emergency procedures guidelines for the blockage/failure, flooding, contaminant removal and disinfection, power failure and fire of the scheme. 5. Implement the response procedures when emergency incident occurs. 6. Complete the incident report checklist in the case of emergency and keep with monitoring records for submission. 7. Undertake annual education course for all operational staff. 8. Review, and if necessary revise emergency manual.	Bi-monthly for the lifespan of infrastructure as per the maintenance manual. Bi-annually for lifespan of works. When emergency incident occurs. Emergency incident Annually for lifespan of operation. Annually for lifespan of operation Annually for lifespan of operation

7.2 Maintenance Procedures

The optimal operation and effective maintenance of all the scheme components is important in protecting the environment and ensuring that resources are not wasted and environmental incidents arising out of equipment or infrastructure failures, are avoided. Operation and Maintenance Manuals are available for the Omatako Dam - Von Bach water pipeline. The manuals provide a detailed guidance on the operation of all machinery and associated systems as well as related maintenance procedures, including maintenance schedules. Implementation of this manuals by NamWater will facilitate the proactive management of potential risks and thus result in impacts on the receiving environment being averted.

The maintenance procedures set out in the manuals, provides specific guidance in terms of the monitoring and maintenance of the scheme components. These procedures will specify the equipment item and specific component of each piece of equipment requiring checking, the scope and nature of the check that is to be carried out including detailed instructions related to the specific check, and the programme for conducting each check.

7.3 Facility Management and Operations

NamWater shall ensure that sufficient budget allocations and provisions are made available to ensure that the infrastructure can be adequately operated and maintained. NamWater must also attend to damage to the scheme components resulting in water loss as a matter of high priority.

7.4 Routine Maintenance and Repairs

The condition of the infrastructure shall be inspected routinely and a maintenance list compiled. Identified, preventative maintenance issues shall be undertaken as soon as possible. Any wastes arising from the repair and maintenance work must be removed and disposed-off at a designated waste deposal site as part of the operation.

7.5 Environmental Awareness

Instilling a sense of environmental awareness and consideration in all employees, but especially those involved with the scheme operations is vital to the overall success of any environmental management plan. It is therefore recommended that a general environmental awareness course for the Scheme Staff Members, who may be required to carry out duties on the scheme, be undertaken.

7.6 Waste and Pollution Management

7.6.1 Waste and Pollution Prevention

To prevent the improper disposal of waste and to prevent pollution, the following management actions shall be enforced:

- All waste will be removed to an appropriate waste dump.
- No waste should be buried.
- General Waste: Includes waste paper, plastic, cardboard, harmless organic (e.g. vegetables) and domestic waste.
- No littering will be allowed. The plant area will be kept free of waste at all times.
- Provide sufficient waste bins at worksites. Make sure that all waste is removed from the worksites.

- Hazardous Substances include sewerage, fuels, lubrication oils, hydraulic and brake fluid, solvents, paints, anticorrosives, insecticides and pesticides, chemicals, acids etc. It should be disposed of at designated hazardous disposal sites.
- Contaminated soil should be stored in drums and taken to the nearest appropriate waste dumpsite.
- Do not change oil on uncovered ground. Drip trays will be used to catch oil when vehicles are repaired in the field.
- Used oil and hydraulic fluids will not be discarded on the soil or buried. It will be removed from site and taken back to an appropriate dump.
- In the event of a hazardous spill:
  - ✓ Immediately implement actions to stop or reduce the spill.
  - ✓ Contain the spill.
  - ✓ Arrange implementation of the necessary clean-up procedures.
  - ✓ Collect contaminated soil, water and other materials and dispose it at an appropriate waste dumpsite.
- Used solvents and grease should be stored in drums or other suitable containers. It should be sealed and recycled or disposed at an appropriate disposal site.
- Hazardous waste should not be burnt.
- Bunding, concrete slabs and/or other protective measures should be installed where hazardous materials are handled.
- Ensure that the staff are informed and have information pertaining to the management of spills or ingestion.

7.6.2 Hazardous Materials

Where hazardous materials are required for repair and maintenance work (including fuels and oils), care will be taken to ensure that a competent individual is appointed to enforce the responsible use of such materials. The operational staff or maintenance teams shall carry a copy of the relevant Material Safety Data Sheet (MSDS) whenever using such materials. The Scheme Supervisor shall ensure that persons working with hazardous materials have been trained in the handling of such substances, as well as in emergency procedures to be followed in the event of an accidental spillage or medical emergency. Maintenance teams shall also carry a spill kit containing the appropriate neutralizing chemicals, absorbent materials and other relevant equipment required to undertake a clean-up of any spill that may occur.

7.6.3 Noise Management

During maintenance operations, all silencing mechanisms on all equipment must be in a good state of repair. Except for in emergency situations, no amplified sound may be broadcast. All routine maintenance shall be restricted to daylight hours.

7.7 Health and Safety

To minimise the risk of HIV infection and the increase of STI's and the occurrence injuries the following management actions shall be enforced:

- Provide an AIDS awareness programme to all the staff.

- Make sure that all staff are equipped and know how to use safety and protective gear. This includes hard hats, goggles, hearing protectors, dusk masks, steel-toed shoes etc.
- Keep a comprehensive first aid kit at Scheme.
- Establish an emergency rescue system for evacuation of serious injured people.
- Emergency procedures for accidents should be communicated to all employees.
- Dangerous areas must be clearly marked and access to these areas controlled or restricted.
- Good driving and adherence to safety rules will result in a minimum number of road and workplace accidents.
- Fire extinguishers must be available at all refuelling sites. Staff should be trained to handle such equipment.
- Nobody is allowed to dispose a burning or smouldering object in an area where it may cause the ignition of a fire.
- Hazardous substances must be kept in adequately protected areas to avoid soil, air or water pollution.
- Work areas, such as these for the maintenance of equipment, must be on concrete slabs.
- Explosives should be stored according to the prescribed regulations.

8 SITE CLOSURE AND REHABILITATION

Rehabilitation is the process of returning the land in a given area that has been disturbed by construction and earthworks to some degree of its former state, or an otherwise determined state. Many projects, if not all, will result in the land becoming degraded to some extent. However, with proper rehabilitation most impacts associated with the reservoir construction project, could be mitigated and restored to an acceptable level. Poorly rehabilitated construction areas provide a difficult legacy issue for governments, communities and companies, and ultimately tarnish the reputation of operators as a whole.

Objectives of proper site closure and rehabilitation include the following:

- Reduction or elimination of the need for a long-term management program to control and minimise the long-term environmental impacts;
- Clean-up, treatment or restoration of contaminated areas (e.g. soils contaminated by oil or fuel spills, concrete spills, etc.). Excavation of contaminated material and disposal thereof in an acceptable manner.

Rehabilitation measures to implement:

a. A site inspection will be held quarterly by the scheme supervisor after every maintenance work during operation of the scheme. Rehabilitation will be done to the satisfaction of the ENV section and MET.

b. Frequent inspections of the scheme and effective follow-up procedures, to prevent minor defects from becoming major repair jobs.

c. Make sure all soil polluted during maintenance work is properly stored in drums and removed to an appropriate waste dump.

d. Make sure all windblown litter is removed once maintenance has seized.

e. Make sure that all potential hazards (i.e. the sewerage pit) are properly closed and left in a safe and neat position.

Rehabilitation will be completed when the above have be achieved.

9 NAMWATER ENVIRONMENTAL CODE OF CONDUCT

What is an Environmental Code of Conduct?

It is a set of rules that everybody has to follow in order to minimise damage to the environment.

What is the ENVIRONMENT?

The ENVIRONMENT means the surroundings within which people live. The ENVIRONMENT is made up of the **soil, water, plants,** and **animals** and those characteristics of the soil, water, air, and plant and animal life that influence **human health and well-being**. **People** and **all human activities** are also part of the environment and have to be considered during the operation of the Scheme.

Do these ENVIRONMENTAL RULES apply to me?

YES, The Environmental Rules apply to EVERYBODY. This includes all permanent, contract, or temporary workers as well as any other person who visits the Scheme. Every person will be required to adhere to the Environmental Code of Conduct.

ALL PERSONNEL must study and keep to the Environmental Code of Conduct

The SCHEME SUPERVISOR will issue warnings and will discipline ANY PERSON who breaks any of the Environmental Rules. Repeated and continued breaking of the Rules will result in a disciplinary enquiry and which may result in that person being asked to leave the Scheme permanently.

What if I do not understand the ENVIRONMENTAL RULES?

ASK FOR ADVICE, if any member of the WORKFORCE does not understand, or does not know how to keep any of the Environmental Rules, that person must seek advice from the SCHEME SUPERVISOR. The PERSON that does not understand must keep asking until he/she is able to keep to all the Environmental Rules.

Safety and Security

1. Only enter and exit roadways and construction areas at demarcated entrances.
2. Wear protective clothing and equipment as per signboards at the Scheme and according to instructions from your SCHEME SUPERVISOR.
3. Report to your SCHEME SUPERVISOR if you see a stranger or unauthorised person in the construction area.
4. Never enter any area that is out of bounds or that is demarcated as dangerous without permission of your SCHEME SUPERVISOR.
5. Never climb over any fence or enter private property without permission of the landowner or your SCHEME SUPERVISOR.
6. Do not remove any vehicle, machinery, equipment, or any other object from the construction site without the permission of your SCHEME SUPERVISOR.
7. Keep clear of blasting sites. Follow the instructions of your SCHEME SUPERVISOR.
8. Never enter or work in the Scheme while under the influence of alcohol or other intoxicating substances.

9. All staff should know the emergency procedures in case of accidents.

Waste Disposal

10. Learn the difference between different types of waste, namely:
    - general waste, and
    - hazardous waste.

Containers will be provided for different types of wastes.

General Waste includes waste paper, plastic, cardboard, harmless organic (e.g. Vegetables) and domestic waste

Hazardous Waste includes objects, liquids or gases that are potentially dangerous or harmful to any person or the environment. Sewage, fuel, tyres, diesel, oils, hydraulic and brake fluid, paints, solvents, acids, soaps and detergents, resins, old batteries, etc. are all potentially hazardous.

11. Learn how to identify the containers for the different types of wastes. Only throw general waste into containers, bins or drums provided for general waste.
12. Recycle drums, pallets and other containers.
13. Never bury or burn any waste on site, all waste is to be disposed in allocated refuse disposal containers, bins or bags.
14. Never overfill any waste container. Inform your SCHEME SUPERVISOR if you notice a container that is nearly full.
15. Do not litter.
16. Do not bury litter or rubbish in the backfill trench.

Plants and Animals

21. **Do not ever pick any plants, or catch any animal.** People caught with plants or animals in their possession will be handed to the authorities for prosecution.
22. Never feed, tease, play with, or set devices to trap any animal or livestock. Wild animals are not to be domesticated.
23. Keep off the rock outcrops unless given specific permission by the SCHEME SUPERVISOR to be there.
24. Never cut down any tree or branches for firewood.
25. Never leave rubbish or food scraps or bones where it will attract animals, birds, or insects.
26. Rubbish must be thrown into allocated waste disposal bins/bags.
27. Always close the gates behind you.

Preventing Pollution

28. Only work with hazardous materials in bunded areas.
29. Never discard any hazardous substances such as fuel, oil, paint, solvent, etc. into stream channels or onto the ground. Never allow any hazardous substances to soak into the soil.
30. Clean up spills immediately.
31. Immediately report to your SCHEME SUPERVISOR when you spill, or notice any hazardous substance overflow, leak or drip or spill on site, into the streambeds or along the road.
32. Immediately report to your SCHEME SUPERVISOR when you notice any container, which holds hazardous substances overflow, leak or drip. Spillage must be prevented.
33. Only wash vehicles, equipment and machinery, containers and other surfaces at work site areas designated by your SCHEME SUPERVISOR.
34. Do not change oil on uncovered surfaces.
35. If you are not sure how to transport, store, use, or get rid of any hazardous substances ask your SCHEME SUPERVISOR for advice.

Health

36. Drink lots of clean water every day.
37. Use toilets that have been provided.
38. Take the necessary precautions to avoid contracting HIV / AIDS. Condoms are available at most Clinics.
39. Inform your SCHEME SUPERVISOR when you are sick.
40. Do not work with any machinery when you are sick.
41. If you are working in malaria areas, you must take the necessary precautions.

Dust Control

42. Do not make any new roads or clear any vegetation unless instructed to do so by your SCHEME SUPERVISOR.
43. Keep to established tracks and pathways.
44. Keep within demarcated work areas.

Saving Water

47. Always use as little water as possible. Reduce, re-use and recycle water.
48. Never leave taps or hose pipes running. Close all taps after use.

49. Report any dripping or leaking taps and pipes to your SCHEME SUPERVISOR.

Working Hours

50. You may only work on weekends and after hours with the consent of the SCHEME SUPERVISOR.

Archaeological and Cultural Objects

52. If you find any archaeological, cultural, historical or pre-historical object on the construction site you must immediately notify your SCHEME SUPERVISOR.
53. Never remove, destroy, or disturb any cultural, historical, or pre- historical object on site.

<u>Cultural and Historical</u> Objects include old buildings, graves or burial sites, milestones, old coins, beads, pottery and military objects.

<u>Pre-Historical objects</u> include fossils and old bones, old human skeletal remains, pieces of pottery and old tools and implements.

Sensible Driving

54. Tracks and roads should be kept to a minimum. Where possible follow existing roads.
55. No off-road driving is allowed.
56. Never drive any vehicle without a valid licence for that vehicle class and do not drive any vehicle that is not road-worthy.
57. Never drive any vehicle when under the influence of alcohol.
58. **Always** keep your headlights on when driving on dusty roads.
59. Keep to the roads as specified by your SCHEME SUPERVISOR. Vehicles may only be driven on demarcated construction roads. Drivers should always use three point turns, “u-turns” are not allowed. Do not cut corners.
60. Do not drive on rocky outcrops.

Noise

61. Keep noise levels as low as possible.
62. Do not operate noisy equipment outside normal working hours.

Fire Control

63. Do not make open fires, use a drum or tin and do not collect any vegetation to burn.
64. Do not smoke or make fires near refuelling depots or any other area where fuel, oil, solvents, or paints are used or stored. Fireplaces should be at a safe distance from fuel and explosive storage sites as well as vehicle parking sites.
65. Cigarette butts should always be thrown in allocated refuse bins. Make sure that the cigarette butt is out before throwing it into the bin.
66. Immediately notify your SCHEME SUPERVISOR if you see an unsupervised fire at the campsite or construction site.

Dealing with Environmental Complaints

67. If you have any complaint about dangerous working conditions or potential pollution to the environment, talk to your SCHEME SUPERVISOR.

68. If any person complains to you about noise, lights, littering, pollution, or any harmful or dangerous condition, immediately report this to your SCHEME SUPERVISOR.

NP du Plessis
Tell: 061-71 2093
Cell: 081 127 9040

OR

Jolanda Murangi
Tell: 061-71 2105
Cell: 081 144 1528

10 REFERENCES

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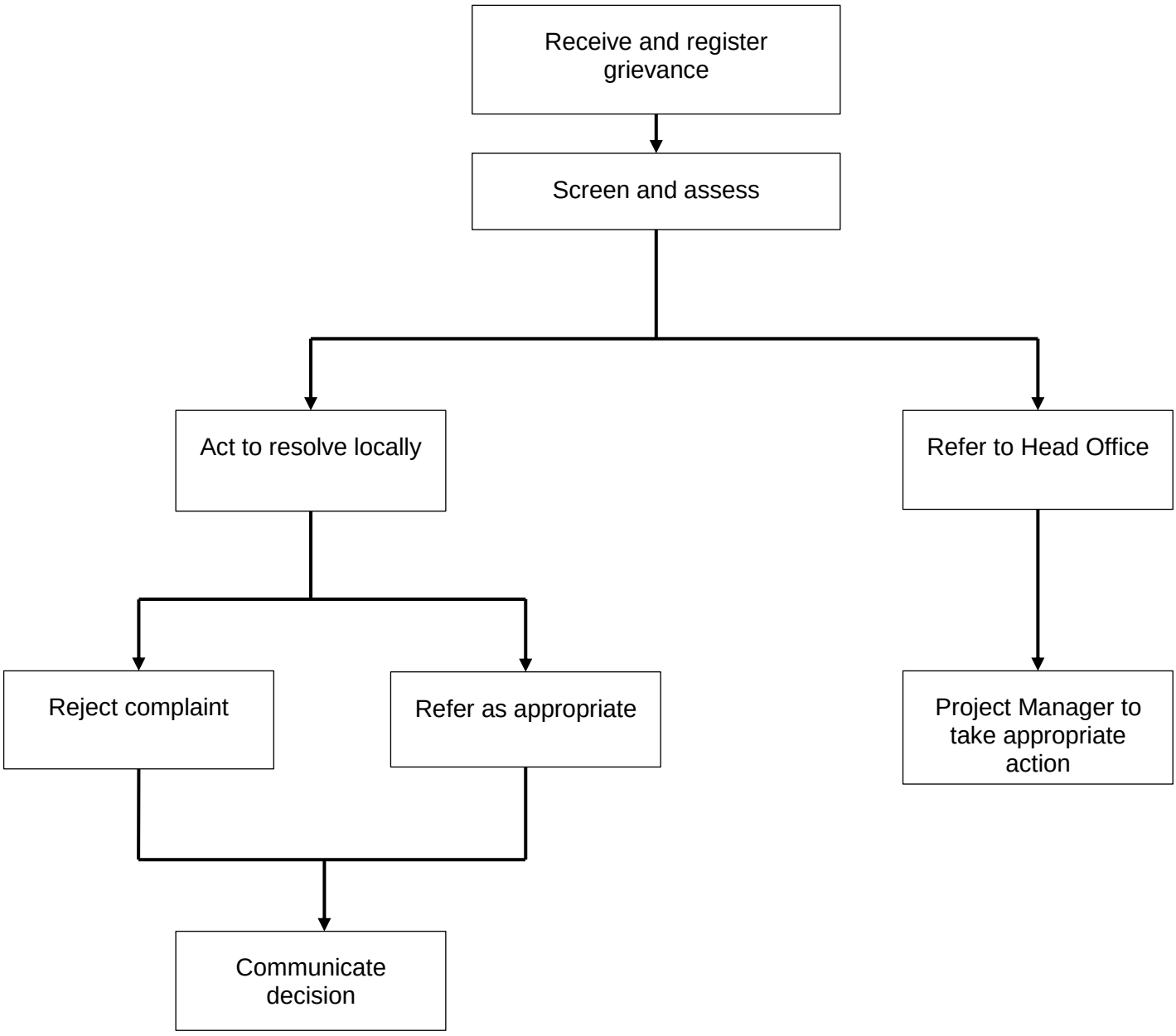
ANNEXURE 1: GRIEVANCE PROCEDURE AND REGISTRATION FORM



Grievance Registration

Grievance Registration	
Case No:	Date:
Name of complainant:	Cell no:
	Email address:
Details of grievance: (Date, location, persons involved, frequency of occurrence, effects of ensuing situation, etc.)	
Name of person recording grievance:	Cell number:
Proposed date of response:	
Signature of recording person:	Signature of complainant:
Date of redress:	
Decision and action:	