# UPDATE OF THE SEWER MASTER PLAN FOR BITOU LOCAL MUNICIPALITY

**JUNE 2020**

# SEWER MASTER PLAN


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**BITOU MUNICIPALITY**

**SEWER MASTER PLAN**

**June 2020**

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# LIST OF ABBREVIATIONS & ACRONYMS

| | | |
|---|---|---|
| AADD | - | Annual average daily demand |
| ADDWF | - | Average daily dry weather flow |
| AMP | - | Asset management plan |
| AR | - | Asset register |
| BM | - | Bitou Municipality |
| CAPEX | - | Capital expenditure |
| CF | - | Consequence of failure |
| CRC | - | Current replacement cost |
| d | - | Day |
| DRC | - | Depreciated replacement cost |
| ECE | - | Element consulting engineers |
| GIS | - | Geographic information system |
| GLS | - | GLS consulting engineers |
| h | - | Hour |
| Ha | - | Hectare |
| IMQS | - | Infrastructure management query station (software package) |
| IPDWF | - | Instantaneous peak dry weather flow |
| IPWWF | - | Instantaneous peak wet weather flow |
| kL | - | Kilolitre |
| kL/d | - | Kilolitre/day |
| km | - | Kilometre |
| kW | - | Kilowatt |
| kWh | - | Kilowatt-hour |
| L | - | Litre |
| L/day/UE | - | Litre/day/unit erf |
| L/min | - | Litre/minute |
| L/min/m pipe/m Ø | - | Litre/minute/meter pipe length/meter pipe diameter |
| L/min/UE | - | Litre/minute/unit erf |
| L/s | - | Litre/second |
| LF | - | Likelihood of failure |
| m | - | Metre |
| m a.s.l. | - | Metres above mean sea level |
| MISA | - | Municipal infrastructure support agent |
| m/s | - | Metres per second |

| | | |
|---|---|---|
| ML | - | Mega litre |
| mm | - | Millimetre |
| | | |
| OPEX | - | Operational expenditure |
| | | |
| P&G | - | Preliminary and general |
| PDDWF | - | Peak daily dry weather flow |
| PRP | - | Pipe replacement potential |
| PS | - | Pumping station |
| | | |
| R | - | Rand |
| | | |
| s | - | Second |
| SEWSAN | - | Sewer system analysis program (software) |
| SG | - | Surveyor general |
| SWIFT | - | Sewer water interface for treasury systems (software) |
| | | |
| TWD | - | Total annual water demand |
| | | |
| UAW | - | Unaccounted-for-water |
| UE | - | Unit erf |
| UH | - | Unit hydrographs |
| UWD | - | Unit water demand (e.g. L/stand/d, or kL/ha/d) |
| | | |
| v | - | Flow velocity (in m/s) |
| VAT | - | Value added tax |
| | | |
| WWTP | - | Wastewater treatment plant (sewage) |

# 1. INTRODUCTION

## 1.1 BRIEF

GLS Consulting Engineers (GLS) was appointed as sub-consultants to Lyners Consulting Engineers & Project Managers to update the master plan of the sewer drainage system for Bitou Municipality (BM).

The project entails the verification of system data, updating of the existing computer model for the sanitation network, the linking of the model to updated land use information, evaluation and master planning of the sewerage networks to include expected future land use and resulting capital expenditure and the posting of all information to the Infrastructure Management Query Station (IMQS).

This master plan report lists the analyses and findings of the study on the sewer reticulation systems for all the towns within the BM.

## 1.2 STUDY AREA

The location of BM within the Western Cape is shown on Figure BMS1.1. The towns within the boundary of the BM are:

- Plettenberg Bay (including Keurboomstrand, Kranshoek, Green Valley and Wittedrift)
- Kurland
- Nature's Valley
- Harkerville (including Forest View)

Figures BMS1.2 show the suburbs with suburb names entered during this investigation for all records in the GIS database. The total area of these suburbs indicates the study area of this investigation.

## 1.3 PREVIOUS MASTER PLANNING

In January 2005 Community Engineering Services consulting engineers (CEs) compiled a report for BM regarding the analysis of the existing sewer system in Plettenberg Bay and Kurland. CEs conducted a comprehensive sewer master plan for BM in September 2008.

No overall master planning had been conducted for the BM prior to these investigations, but various Engineering Consultants have been performing evaluation and planning of portions of the sewer distribution systems in the area over the years.

During 2016 the September 2008 master plan was updated by GLS for BM and documented in a report, dated June 2016. All relevant information from the previous studies was included and the firms consulted as part of the investigation.

These previous master plans have been updated in this study and is documented in this report, dated June 2020.

## 1.4 DEFINITIONS

### 1.4.1 Stand

In this report *stand* is used to denote a piece of ground identified in the database of the surveyor general (SG) as a unique property. A stand could have one or more (or no) metered connections to the water supply system. The words property, site, erf (or erven), and lot are also sometimes used elsewhere to describe a stand.

### 1.4.2 Treasury record

A *treasury record* is a consumer's account that is recorded in the treasury database of the Municipality. Each treasury record normally represents a consumer's connection to the sewer distribution system. Some treasury records might not pertain to a sewer connection (or customer meter).

## 1.5 STRUCTURE AND SCOPE OF REPORT

This report addresses the disposal of sewage within the BM area.

This study is confined to the sewerage networks and therefore the process and sufficiency of the wastewater treatment plants (WWTP's) are beyond the scope of this study.

The contents of each chapter is arranged so that all of the text is grouped together, followed by the tables and then the figures, if applicable to the chapter.

## 1.6 DISCLAIMER

The investigation has been performed and this report has been compiled based on the information made available to GLS. All efforts, within budget constraints, have been made during the gathering of information to ensure the highest degree of data integrity. The information supplied to GLS by the BM and other consultants at the outset of this master planning process is assumed to be the most accurate representation of the existing system up to date hereof.

Subsequent to the completion of the data capturing, the layout plans including the relevant attributes, were handed back to the Municipality so that the information could be verified by the Client. GLS can therefore under no circumstances be held accountable by any party for any direct, indirect, special or consequential damages as a result of inaccurate information received pertaining to the components of the existing system.

The information in this report is intended for use by the BM only.

**Figure BMS1.1 Locality plan - Bitou Municipality**

**Figure BMS1.2a Towns and suburbs per treasury - Plettenberg Bay**

**Figure BMS1.2b Towns and suburbs per treasury - Kurland & Nature's Valley**

# 2. EXISTING SYSTEM

## 2.1 SYSTEM LAYOUT AND OPERATION

The layouts of the BM sewer systems are shown on Figures BMS2.1 with a separate Figure for each area as follows:

- a - Plettenberg Bay
- b - Kurland & Nature's Valley

This notation to distinguish between areas is used throughout this report for all Figures where appropriate.

Each system is operated in a main drainage area with a WWTP, which in turn could be sub-divided into several sub-drainage areas each as shown on Figure BMS2.2.

There are 73 pumping stations in the Plettenberg Bay system and three in Kurland as indicated on Figures BMS2.1 and BMS2.2. Of the 73 pumping stations in the Plettenberg Bay system 41 pumping stations are municipal (owned and operated by BM) and 32 pumping stations are privately owned (part of internal infrastructure of private developments).

Tables BMS2.1a and BMS2.1b provide a summary of all the system components.

Table BMS2.2 lists the actual and potential fully occupied present Peak Day Dry Weather Flows (PDDWF's) of the drainage areas.

### 2.1.1 Plettenberg Bay

The Plettenberg Bay sewer system is operated in 6 main drainage areas with several pumped sub-drainage areas in each main drainage area. The 6 main drainage areas are the Ganse Valley Gravity, Kwanokuthula, Aventura, Goose Valley, Piesang Valley and Town main drainage areas.

<u>Ganse Valley Gravity</u>

The Ganse Valley Gravity main drainage area consist of the Plettenberg Bay Gravity drainage area and 5 smaller sub-drainage areas that is pumped to the gravity system through 4 pumping stations. The gravity system discharges at the Ganse Valley WWTP. The four pumping stations are the Castleton PS, Erf 2073 PS, Erf 2089 PS and the Schoongezicht PS no. 2. Sewage from the Schoongezicht PS no. 1 sub-drainage area is pumped to the Schoongezicht PS no. 2 via the Schoongezicht PS no. 1.

Sewage from the other 5 main drainage areas is pumped to the Ganse Valley main drainage area via the Kwanokuthula PS 1 (for the Kwanokuthula main drainage area), the Aventura PS (for the Aventura main drainage area), the Goose Valley Main PS (for the Goose Valley main drainage area), the Piesang Valley PS 18 (for the Piesang Valley main drainage area) and the Plettenberg Bay PS 1a (for the Town main drainage area).

<u>Kwanokuthula</u>

There are 3 pump stations in the Kwanokuthula system. Two pump stations discharge sewage into the Kwanokuthula main PS drainage area from where sewage is pumped via the Kwanokuthula PS no. 1 to the Ganse Valley gravity system through a 200 mm diameter rising main.

Aventura

There are 19 pump stations in the Aventura system. Sewage is transferred to the Aventura PS from the Wittedrift PS (Wittedrift system), the Matjiesfontein PS (Matjiesfontein system) and from 3 smaller sub-drainage areas (Aventura Resort, Twin Rivers PS no. 1 and Twin Rivers PS no. 2)

There are 2 pump stations in the Wittedrift system. The Green Valley pump station discharges sewage into the Wittedrift PS drainage area from where sewage is pumped via the Wittedrift PS to the Aventura PS through a 125 mm diameter rising main.

There are 13 pump stations in the Matjiesfontein system. Sewage is pumped to the Matjiesfontein PS from 5 upstream pump stations. Sewage from the 5 upstream pump stations is collected from various sub-drainage areas via a number of smaller pump stations. The most significant upstream pump station is the Keurboom Main PS where sewage from the upstream Keurboomstrand area is pumped to the Matjiesfontein PS via a 200 mm diameter rising main.

From the Matjiesfontein PS sewage is pumped to the Aventura PS drainage area through a 200 mm diameter rising main.

Sewage is pumped from the Aventura PS to the Ganse Valley WWTP through a 200 mm diameter ring main.

Goose Valley

Sewage from The Tides PS drainage area is pumped into the Turtle Creek no. 1 PS drainage area. The Turtle Creek no. 1 PS discharges into the Turtle Creek no. 2 PS drainage area.

Sewage from the Turtle Creek no. 2 PS, Goose Valley no.1 PS & Goose Valley no. 2 PS drainage areas are pumped to the Goose Valley Main PS drainage area from where sewage gravitates towards the Goose Valley Main PS. From here sewage is pumped through a 200 mm diameter rising main directly to the Ganse Valley WWTP.

Piesang Valley

There are 31 pump stations in the Piesang Valley system. The Piesang Valley system has a bulk sewer consisting of a pump-stepped main (Piesang Valley pump stations 5, 18, 19 & 20) where sewage is pumped from the Piesang Valley PS 5 from one PS to the next until it delivers into the Ganse Valley gravity system.

Sewage is pumped to the Piesang Valley PS 5 drainage area from 4 large drainage areas where flows from smaller sub-drainage areas are combined before it is pumped to the Piesang Valley PS 5 drainage area, from where sewage gravitates to the Piesang Valley PS 5.

Sewage flows from the 4 larger drainage areas are pumped to the Piesang Valley PS 5 drainage area via the Plettenberg Bay PS 8 (through a 150 mm diameter rising main), the Whale Rock PS 5 (150 mm diameter rising main), Pump Station H3 (160 mm diameter rising main) and the Kranshoek PS 4 (200 mm diameter rising main). Two smaller pump stations (River Club PS and Pump Station 6) also discharge into the Piesang Valley PS 5 drainage area.

Sewage from 3 smaller sub-drainage areas is combined to the PS 8 drainage area through 3 pump stations, from where sewage gravitates to PS 8 and is then pumped to the Piesang Valley PS 5 drainage area.

Sewage from 5 smaller sub-drainage areas is combined to the Whale Rock PS 5 drainage area through 5 pump stations, from where sewage gravitates to the Whale Rock PS 5 and is then pumped to the Piesang Valley PS 5 drainage area.

Sewage from 6 smaller sub-drainage areas is combined to the Pump Station H3 through 6 pump stations, from where sewage is pumped to the Piesang Valley PS 5 drainage area.

In Kranshoek sewage is combined through the Kranshoek pump stations no. 1, no. 2 & no. 3 to the Kranshoek PS no. 4 drainage area where sewage gravitates towards the Kranshoek PS no. 4. From here sewage is pumped to the Piesang Valley PS 5 drainage area.

Sewage from the Plettenberg Bay PS 7 drainage area is pumped to the Plettenberg Bay PS 6 drainage area from where sewage gravitates towards the Plettenberg Bay PS 6 and is then pumped to the Piesang Valley PS 5 drainage area.

From the Piesang Valley PS 5 sewage is pumped through a 350 mm diameter rising main to the Piesang Valley PS 20 drainage area. Sewage from the Brackenridge private development also drains towards the Piesang Valley PS 20 (Brackenridge sewage is combined through 3 pumping stations).

From the Piesang Valley PS 20 sewage is pumped through a 350 mm diameter rising main to the Piesang Valley PS 19, from where sewage is pumped via a 350 mm diameter rising main to the Piesang Valley PS 18 and then via a 350 mm diameter rising main to the Ganse Valley gravity system.

Town

There are 8 pump stations in the Town system. Sewage from 7 smaller sub-drainage areas is combined to the Plettenberg Bay PS1a drainage area through 7 pump stations, from where sewage gravitates towards the Plettenberg Bay PS1a. From here sewage is pumped through a 355 mm diameter rising main directly to the Ganse Valley WWTP.

The Ganse Valley WWTP has a treatment capacity of 9,0 ML/d and is located to the north of the town and to the north west of New Horizon suburb.

### 2.1.2 Kurland

The Kurland sewer system is operated in 3 drainage areas. Sewage from the Kurland PS no. 3 drainage area is pumped into the Kurland PS no. 2 drainage area, from where it gravitates towards the Kurland PS no. 2. Sewage from the Kurland PS no. 1 drainage area gravitates towards the Kurland PS no. 1.

From the Kurland PS no. 1 and Kurland PS no. 2 sewage is pumped directly to the Kurland WWTP through 2 rising mains.

The Kurland WWTP has a treatment capacity of 500 kL/d and is located at the south eastern corner of the town.

### 2.1.3 Nature's Valley

Nature's Valley is serviced with septic tanks. There is no WWTP at Nature's Valley and sewage from the septic tanks are collected through sewage trucks and disposed of at the Kurland WWTP.

### 2.1.4 Harkerville

Harkerville and Forest View are currently serviced through chemical toilets. A new conservancy tank has been installed for the area in order to service the area in future through a full waterborne sanitation system. Sewage will then be collected from the conservancy tank through sewage trucks and disposed of at the Ganse Valley WWTP in Plettenberg Bay.

## 2.2 DATA INTEGRITY

The data captured for the sewer model consists of a blend of as-built plans, design drawings, and GIS information. For some pipes only geographical information was available, and a default diameter of 150 mm Ø was assumed.

It is important that the integrity of the information be kept in mind when considering upgrades to the system. Figure BMS2.3 shows the integrity of the pipes in three categories:

- Pipes for which invert levels were available from the as-built drawings.
- Pipes for which invert levels were calculated based on minimum slopes.
- Pipes for which the slope of the pipes were available from the as-built drawings.

If this report is noted to have any discrepancies compared to alternative information, GLS should be contacted in this regard to ensure that the relevant sections of the system are verified as part of a future ongoing Bureau Service aimed at improving the data integrity in future.

## 2.3 DRAINAGE AREA, WATER DEMAND AND SEWER FLOWS

The total drainage area for each sewer system is shown on Figures BMS2.2.

### 2.3.1 Plettenberg Bay

The present fully occupied Annual Average Daily Demand (AADD), for the existing Plettenberg Bay system that contributes to the domestic sewer flow is ± 12 871 kL/d, which includes non-revenue water (NRW).

The PDDWF for the Plettenberg Bay system is estimated at ± 9 823 kL/d, or roughly 76% of the AADD. Approximately 78% of this is a direct contribution from connections to the sewerage system, and the other 22% is contributed by groundwater infiltration.

### 2.3.2 Kurland

The present fully occupied AADD, for the existing Kurland system that contributes to the domestic sewer flow is ± 541 kL/d, which includes non-revenue water (NRW).

The PDDWF for the Kurland system is estimated at ± 373 kL/d, or roughly 69% of the AADD. Approximately 81% of this is a direct contribution from connections to the sewerage system, and the other 19% is contributed by groundwater infiltration.

### 2.3.3 Nature's Valley

Nature's Valley is not currently serviced by a waterborne sewer system (town is serviced with septic tanks).

### 2.3.4 Harkerville

Harkerville and Forest View are not currently serviced by a waterborne sewer system (area is serviced with chemical toilets).

## 2.4 WASTEWATER TREATMENT PLANTS

All the present PDDWF for each drainage area is treated at each town's WWTP:

| | | | |
|---|---|---|---|
| • | Ganse Valley | - Capacity | 9,00 ML/d |
| • | Kurland | - Capacity | 0,50 ML/d |
| | **Total Capacity** | | **9,50 ML/d** |

The total WWTP capacity for Bitou is roughly equal to 1.14 x the present PDDWF.

The analysis of the capacities of the existing BM WWTP's is however beyond the scope of this study.

## 2.5 SEWER FLOW MEASUREMENTS AND CALIBRATION

Relatively good quality daily sewer flow volumes were obtained from BM for the period of January 2015 to June 2019. These sewer flow measurements were used to calibrate the Bitou sewer system analysis program (Sewsan) model for this study. Useful parameters such as stormwater ingress, typical unit hydrographs and leakage/infiltration could however not be derived from the information provided as no hourly flow measurements where available.

The Sewsan models were populated with unit hydrographs (UH) as described in Figure BMS5.1, Chapter 5, which is based on the analysis of many flow recordings done for similar previous studies as well as the 2016 update of the Plettenberg Bay and Kurland systems.

From this data the dry weather flow was predicted and the Sewsan models adjusted to simulate the PDDWF. The predicted flow volume from the Sewsan model corresponds well with the actual flow volumes of the entire system measured at the various WWTP's (see Figure BMS2.4).

## 2.6 EXISTING OPERATIONAL PROBLEMS

The following operational problems were indicated by the operational staff:

- Contamination of rivers with raw sewage caused by spilling during power outages.

## 2.7 SPECIAL CONSIDERATIONS

### 2.7.1 General

Detailed drawings of the system are included in the plan book. The plan book should be used to indicate (by physical markings on the drawings) any additional information, or amendments, that would improve the quality of the final layout.

### 2.7.2 Information to be clarified

It is recommended that field tests be carried out to verify pump duty points at all the pumping stations. The unknown pipe diameters and invert levels should also be determined in order to improve the confidence levels of the models.

**Table BMS2.1a Existing sewer system summary - WWTP's and pumps**

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**Table BMS2.1b Existing sewer system summary - Pipes**

**Table BMS2.2 Existing sewer drainage areas and PDDWF's**

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**Figure BMS2.1a Existing sewer system layout - Plettenberg Bay**

**Figure BMS2.1b Existing sewer system layout - Kurland & Nature's Valley**

**Figure BMS2.2a Existing drainage areas - Plettenberg Bay**

**Figure BMS2.2b Existing drainage areas - Kurland & Nature's Valley**

**Figure BMS2.3a Existing data integrity - Plettenberg Bay**

**Figure BMS2.3b Existing data integrity - Kurland & Nature's Valley**

**Figure BMS2.4 Sewer flow measurements and calibration**

# 3. PRESENT LAND USE, WATER DEMAND AND SEWAGE FLOW

## 3.1 METHODOLOGY

The SWIFT program is a link between treasury billing data, and water/sewer network models. (The name is derived from "Sewer Water Interface for Treasury systems"). The program was used to analyse the present land use and water demand situation in BM, as well as the projected potential water demand for a fully occupied existing system.

## 3.2 SWIFT ANALYSIS

A SWIFT analysis was conducted as part of this investigation. The BM has a SAMRAS treasury system, with a single treasury system for all the towns in the Municipal area. A data extraction routine for SWIFT was compiled as part of this investigation and will remain a standard part of the SAMRAS software suite in future.

The treasury records for the period November 2018 to October 2019 were used as the base information for the analysis.

## 3.3 LAND USE

With cognizance of the limited land use and zoning codes maintained in the treasury system being operated by the BM, the following land use categories were identified for this study:

- BUS_COMM - Business/Commercial
- CLUSTER - Town houses
- EDU - Educational
- FARM_AH - Farm/Agricultural holding
- FLATS - Flats
- GOVT_INST - Government/Institutional/Municipal
- IND - Industrial
- OTHER - All other categories
- PARKS - Parks
- RES - Residential stands
- UNKNOWN - All stands where the category of the land use code is unclear

In order to account for the effect of stand size on residential water demand, the RES category is further subdivided into five sub-categories, based on stand size, as follows:

- RES 500 - smaller than 500 $m^2$
- RES 1 000 - 500 $m^2$ to 1 000 $m^2$
- RES 1 500 - 1 000 $m^2$ to 1 500 $m^2$
- RES 2 000 - 1 500 $m^2$ to 2 000 $m^2$
- RES > 2 000 - larger than 2 000 $m^2$

The LARGE category is required to remove these special water consumers from their regular land use category, so as to prevent them from skewing the statistics for the specific category and to detach them from any theoretical UWD's that might not be applicable to them. The large water users are discussed later in this Chapter.

Figure BMS3.1 shows all the stands coloured in accordance with their land use.

## 3.4 SWIFT RESULTS AND RESULTING WATER DEMANDS

### 3.4.1 Suburb-by-suburb land use and water use statistics

All available treasury data in BM was analysed with the SWIFT program, in order to determine (for each stand/meter record) the suburb, the land use, whether it is occupied or vacant, its AADD and total annual water demand (TWD) for the base year. This information was then totalised and summarised by SWIFT per suburb, and broken down into the various land use categories. Average unit water demands (L/stand/d) were also determined for each land use category in each suburb. The results are summarised in Table BMS3.1.

Figure BMS3.1 shows all the stands coloured in accordance with their land use according to the Swift analysis.

### 3.4.2 Non-revenue water

The total water inputs for each area were compared with the total water sales, which resulted in a NRW figure of 31,3 % for Plettenberg Bay, 25,1 % for Kurland and 26,5 % for Nature's Valley. The water from unmetered stand pipes at informal settlements could contribute substantially to this high NRW figure. The results are summarised in Table BMW3.3.

The global NRW of 30,9% should be able to be reduced by implementing a Water Demand Management Programme.

It is important to note that these figures are only the difference between the volume of water put into the reticulation system (system input volume) and the volume of water sold (as abstracted through the municipal treasury system). These high NRW figures excludes:

- the volume of free basic water consumed in BM (estimates for basic water used in informal areas not metered),
- unbilled-unmetered consumers,
- unbilled-metered consumers, and
- any unauthorised consumption (water used through illegal connections and water used but not billed for because of inaccurate meters, data transfer errors, low estimate readings or any administrative errors).

This could result in the actual real losses (losses through the reticulation network) to be much lower.

### 3.4.3 Rationalized ("theoretical") unit water demands

The UWD's per land use in each suburb were rationalised into rounded-up "theoretical" values. These values were calibrated by applying them to the total number of occupied stands in each land use category of each suburb, and comparing the resultant "theoretical" total water demand (excluding NRW) for each suburb with the actual water demand (excluding NRW) for the suburb. The results are summarised in Table BMS3.1.

### 3.4.4 Rationalized ("theoretical") NRW

For planning and evaluation purposes, the NRW figures were also rationalised on a regional (wider-area) basis, as allowed by the sensibility of the results. A NRW figure of 30% for the Greater Plettenberg Bay area, 25% for Kurland and 25% for Nature's Valley were applied for modelling purposes of the existing system.

A NRW figure of 20% for the Greater Plettenberg Bay area, 20% for Kurland and 20% for Nature's Valley were applied for modelling of the future system.

### 3.4.5 Potential land use and AADD of existing developments

The Swift program determines the total number of vacant stands in each land use category for each suburb and each distribution zone. These vacant stands do not contribute to the present water demand calculations (actual or theoretical) as described above. However, the Swift program also determines from treasury data what the land use or zoning rights of vacant stands might be.

The rationalised theoretical UWD's and NRW's can therefore also be applied to these vacant stands in order to determine their potential water demand, should they become developed/occupied.

The theoretical present water demand model was therefore extended in Swift to include all vacant stands and a potential fully occupied present water demand (inc. NRW) for each suburb and distribution zone in BM was determined. The results are summarised per suburb in Table BMS3.1.

This potential future water demand so calculated is only for existing developments/ stands that have been proclaimed and exist. Potential future land developments and upgrading/relocation of informal areas were dealt with as described in Chapter 4.

### 3.4.6 Large water users

Table BMS3.2 is a list of all the stands defined as large users in SWIFT for BM. The table shows the large users (AADD > 10 kL/d) sorted per demand. The tabulated information for each user (e.g. owner, consumer, address) is unchanged as recorded in the treasury system.

The water demand for each of the large users recorded in the treasury database is interrogated by SWIFT. The AADD calculated by SWIFT for each large user is used to calculate the peak flow for the relevant consumer. The location of each large user is identified uniquely in view of its demand in the water system model.

The 64 large water users in BM have a total AADD of 2 174 kL/d (excluding NRW), representing ± 32,4 % of all water sold in the BM sewer system.

### 3.4.7 Informal settlements

The treasury data does not contain any information on informal settlements in the study area.

The following informal settlements were reported to be present:

- 1 725 households in the Bossiegif/Qolweni area in the New Horizon zone
- 70 households in Green Valley
- 223 households in the north western part of Kurland

These settlements receive water from a number of unmetered stand pipes and therefore contribute to the NRW figure.

### 3.4.8 Present water demand summary

Table BMS3.4 is a summary of the present actual water demand in the various drainage areas.

## 3.5 PRESENT SEWER FLOW

### 3.5.1 Unit hydrograph types

After careful consideration of the various land uses and their unit water demands as established earlier in the chapter, it was decided to use 14 unit hydrographs for modelling the sewer flow contributions of typical erven. The 14 UH's are described in Figure BMS5.1, Chapter 5, and are based on the analysis of many flow recordings done for previous studies.

Table BMS3.5 is a summary of how the various land uses in BM were mapped to these UH's.

Figure BMS3.1 shows the stands coloured in accordance with their UH allocation.

### 3.5.2 Sewer flow components

Each UH contribution by a typical stand consists of a leakage (base flow) component, and a domestic flow component. The UH can be used as is in the sewer system analysis, or a more accurate approach can be taken where only the shape of the UH is used, and all the ordinates are adjusted so that the volume of the hydrograph represents a certain percentage (typically 50% to 60%) of the AADD for water.

In addition to the domestic flow and leakage component, there is another base flow component due to groundwater infiltration into pipes (typically ± 0,04 L/min/m pipe/m Ø). This component typically increases the sewer flow to somewhere between 60% and 70% of the water AADD.

Stormwater ingress can also result in significant peaks in the sewer flow, even though the systems are ostensibly designed as "closed". For this study, the systems are analysed and designed with a 30% allowance for stormwater ingress. Previous studies proved that accommodation of stormwater ingress in sewer systems is very expensive, and that funds should be applied to solving the problem, rather than treating the symptom and shifting the problem downstream to the WWTP.

### 3.5.3 Present PDDWF

The present PDDWF of the drainage areas in BM are summarised in Table BMS2.2. These PDDWF's are based on the UH's, by applying their shapes to represent certain percentages of the water AADD, with additional groundwater infiltration.

The "Actual" PDDWF scenario varies from 69% to 76% of the actual present AADD for the towns in the Municipal area.

**Table BMS3.1 Treasury water use per suburb and land use**

**Table BMS3.2 Large water users (>10 kL/d AADD)**

(Table 3.2: Page 1 of 2)

(Table 3.2: Page 2 of 2)

**Table BMS3.4 Present water demand summary**

**Table BMS3.5 Mapping of land uses to unit hydrographs**

**Figure BMS3.1a Land use per stand - Plettenberg Bay**

**Figure BMS3.1b Land use per stand - Kurland & Nature's Valley**

# 4. FUTURE LAND USE, WATER DEMAND AND SEWER FLOW

## 4.1 FULL OCCUPATION OF EXISTING DEVELOPMENTS

For the future land use and sewer flow scenario, it was assumed that all existing but vacant stands in the area would become “occupied”, i.e. start using water and discharging sewerage, as summarised in Table BMS2.2.

## 4.2 POTENTIAL FUTURE LAND DEVELOPMENTS

The potential areas for future developments were identified in consultation with the Municipality’s town planning consultants. Each potential area was assigned an anticipated predominant land use, and will be phased in over a 20 to 30 year period.

The potential future land developments in BM are shown on Figure BMS4.1, coloured according to the land use.

## 4.3 WATER DEMANDS OF FUTURE LAND DEVELOPMENTS

Typical UWD’s (per ha or per stand/unit) were assumed for the future development areas, based on the statistics obtained from the analysis of the present water demands and in consultation with the Engineering Services department of BM, to determine their potential water demand.

The estimated water demands for the potential areas for future development are shown in Tables BMS4.1 and BMS6.3

## 4.4 SEWER FLOWS OF FUTURE LAND DEVELOPMENTS

Table BMS4.1 also shows estimates for the PDDWF and Table BMS6.3 the UH allocations for the future land developments.

## 4.5 FUTURE WATER DEMAND

The future AADD (that contributes to the sewer flow) of the Plettenberg Bay and Kurland systems studied for this report is ± 34 409 kL/d. The future AADD represents an increase of ± 157% over the present fully occupied AADD that contributes to the sewer flow. The potential future developments account for ± 61 % of the future AADD.

## 4.6 FUTURE SEWER FLOW

The future PDDWF’s of the drainage areas in Bitou are summarised in Table BMS4.2. The future PDDWF of ± 24 935 kL/d is ± 72 % of the future AADD for the entire Plettenberg Bay and Kurland systems.

**Table BMS4.1 Potential future land developments**

(Table 4.1: Page 1 of 3)

(Table 4.1: Page 2 of 3)

(Table 4.1: Page 3 of 3)

**Table BMS4.2 Present and future potential PDDWF's**

(Table 4.2: Page 1 of 3)

(Table 4.2: Page 2 of 3)

(Table 4.2: Page 3 of 3)

**Figure BMS4.1a Potential future developments - Plettenberg Bay**

**Figure BMS4.1b Potential future developments - Kurland & Nature's Valley**

# 5. EVALUATION AND PLANNING CRITERIA

## 5.1 SEWER FLOW AND PEAK FACTORS

### 5.1.1 Planning

The major objectives pursued in the evaluation and planning of the sewer system in BM as presented in this report can be summarised as follows:

- Establishing a model of the sewer network that accurately reflects the existing system.
- Detailed water demand analysis based on data in the treasury system.
- Conformity with operational requirements and criteria adopted for this study.
- Optimal use of existing facilities with excess capacity.
- Optimisation with regards to capital - maintenance - and operational cost.

The study considered year 2050 (i.e. 30 years) as the horizon for planning purposes. The total PDDWF for the BM system can then potentially be ± 24 935 kL/d.

### 5.1.2 Present and future PDDWF's

Existing systems were evaluated on the basis of their maximum potential present PDDWF, i.e. as though all presently developed stands are occupied based on their land use. For planning of future systems, PDDWF's of all potential future developments were added.

### 5.1.3 Unit sewer flows

SEWSAN uses a UH for each erf linked to the model to simulate the leakage (base flow) and domestic contribution to sewer flow as a percentage of the AADD. The parameters of the unit hydrographs for the different types of erven are summarised in Figure BMS5.1. These are based on the analysis of many flow recordings, as performed for previous studies. In the analysis and planning of the system, the UH ordinates are adjusted to reflect the actual percentages of the AADD.

### 5.1.4 Total base flow (Infiltration and Leakage)

As part of the unit hydrographs, each stand contributes a steady flow to the base sewage flow, in the form of leakage from cisterns and taps. The calibrated base flow rates for each UH type were calculated based on the assumption that domestic base flow accounts for ± 50% of the total base flow in the system. The base flow rates for each UH type is listed in Figure BMS5.1. The other ± 50% of the base flow is assumed to be groundwater infiltration through joints and cracks in the sewer pipe system. Based on flow measurements done for previous sewer system studies, a groundwater infiltration rate of 0,04 L/min/m pipe/m Ø was assumed for the sewer system (see Table BMS5.3). The total base flow in the Bitou Municipality systems is typically ± 54% of the PDDWF.

### 5.1.5 Stormwater Ingress

Based on simultaneous sewer flow and rainfall measurements undertaken for previous sewer system studies, it is estimated that ± 1,0% of all rainfall during heavy storms, which falls within 25 m of either side of a sewer pipe, typically ingresses into the sewer system. Storm and ingress criteria used for wet weather system analysis and planning (where applied) are shown in Table BMS5.3.

## 5.2 OPERATIONAL CRITERIA

### 5.2.1 Minimum gradients

The minimum gradient of gravity mains should be such that a minimum flow velocity of > 0,6 m/s at full flow capacity, can be maintained. Table BMS5.1 shows such minimum gradients for different diameter pipes.

### 5.2.2 Flow velocities - Gravity mains

A minimum of 0,65 m/s should be maintained in all gravity mains to ensure that sufficient scouring of the mains takes place. The maximum flow velocity under full flow conditions should be not more than 2,5 m/s to prevent damage to the pipelines, although a higher flow velocity of up to 4,0 m/s may be acceptable over short pipe lengths and for short periods. Flow velocity criteria are summarised in Table BMS5.2.

### 5.2.3 Flow velocities- Rising mains

Flow velocities must be limited in order to protect pipeline coatings and reduce the effects of water hammer. The preferred maximum allowed is 1,8 m/s, but an absolute maximum of 2,2 m/s is acceptable where only intermittent peak flows occur.

### 5.2.4 Pipe roughness coefficient

The Manning flow formula is used by the SEWSAN program and a Manning-n roughness coefficient of 0,012 was assumed for all the pipes in the model.

### 5.2.5 Hydraulic capacity of sewerage network

There are basically two design philosophies, which could be used for this planning study. These are the instantaneous peak dry weather flow (IPDWF) philosophy, with spare capacity allowed for stormwater ingress, and the instantaneous peak wet weather flow (IPWWF) philosophy, where the system is designed to accommodate stormwater ingress, but with pipes allowed to flow 100% full (see Table BMS5.2). It was found however that the effect of 1% stormwater ingress (see par. 5.1.5) is dramatic, resulting in very high IPWWF, and consequently very large and uneconomical pipes sizes. The IPDWF philosophy, as described below, was therefore used.

Pipe sizes in gravity mains should be such that the PDDWF can be accommodated in the pipeline whilst flowing 70% or less full. The remaining 30% of the flow area is for the accommodation of stormwater ingress. Should stormwater ingress cause this “spare capacity” to be exceeded, resulting in pipeline overflow, certain measures should be taken by the system manager to prevent ingress of stormwater into the sewer system.

The "spare capacity" for a regular gravity pipe which is unaffected by upstream pumps is defined as follows:

$$Spare\ \ capacity\ \ (\%) = \frac{Full\ \ flow\ \ capacity\ \ - IPDWF}{Full\ \ flow\ \ capacity}\ x\ 100\ \%$$

If however there are upstream pump stations affecting the flow in a gravity pipe the "spare capacity" for of the pipe has to be redefined with cognisance of the pump flows, as follows:

$$Spare\ \ capacity\ \ (\%) = \frac{Full\ \ flow\ capacity\ \ - Upstream\ \ \ pump\ \ \ flow\ - IPDWF}{Full\ \ flow\ capacity\ \ - Upstream\ \ \ pump\ \ \ flow}\ x\ 100\ \%$$

### 5.2.6 Pumping stations

The following criteria apply to the design and evaluation of PS:

- Pump configurations should be such that there is always at least one standby pump available for emergency purposes.
- PS capacity should be such that it equals or exceeds the IPWWF which arrives at the PS, or the IPDWF plus an allowance for stormwater ingress. In the case of a 30% allowance, the pump therefore must have a capacity equal to:

$$\frac{IPDWF}{(1-0{,}3)} = \frac{IPDWF}{0{,}7} = 1{,}43\ x\ IPDWF$$

- The sump at the PS should be sized to ensure that the pump does not switch on and off more than six times per hour.

### 5.2.7 Hydraulic influence of pump stations

Although sewer pump stations operate intermittently, their flows can influence the hydraulics of the downstream pipes at any time during the day. Pumps are therefore modelled as “continuous” pumps, which pump at specified capacity for 24 h per day.

## 5.3 OPTIMAL USE OF EXCESS CAPACITIES IN EXISTING FACILITIES

Many existing facilities may have excess capacity when measured in terms of the operational criteria described above. In whatever way it has come about, in the planning done for this study it was strived to utilise the excess capacities in existing facilities to its economically viable maximum.

## 5.4 ECONOMIC OPTIMISATION AND COST FUNCTIONS

All the strategic and technical alternatives studied were compared on mainly economic grounds, with a view to establishing a "master plan" which will result in the lowest present value of capital works, operations and maintenance.

The cost functions for cost estimates, cost comparisons and economic optimisation in general, are presented in Figure BMS5.2.

It should be noted that the proposed pipeline routes are indicated schematically on the master plan and that no detail topographical or geotechnical surveys have been conducted to verify these routes. The detail assessment of the routes are thus beyond the scope of this report and should be performed in the preliminary design stage during implementation. A variance of the cost estimates could therefore be experience typically due to the presence of hard rock in the substrata along the pipeline route, existing services of which the crossings appear to be problematic or for which ever reason the pipeline route has to be lengthened.

**Table BMS5.1 Minimum gradients for ± 0,65 m/s full flow velocity**

**Table BMS5.2 Operating min/max velocities and design spare capacities**

**Table BMS5.3 Infiltration and stormwater ingress parameters**

**Figure BMS5.1 SEWSAN unit hydrographs**

**Figure BMS5.2 Cost functions (with tables)**

# 6. EVALUATION AND MASTER PLAN

## 6.1 EXISTING SYSTEM

### 6.1.1 Replacement value

Table BMS6.1 provides an estimate of the replacement value of the existing BM system, based on the cost functions shown on Figure BMS5.2. It amounts to a total value of R 907,72 million and a PDDWF unit value of ± 88 061 R/kL/d.

### 6.1.2 External contributions to sewer flow

There are currently no external sources contributing to the sewer systems within the BM.

### 6.1.3 Existing drainage areas and sewer flows

Table BMS2.2 provides a summary of the existing PDDWF's for each sub-drainage area in BM.

### 6.1.4 Spare capacities

Figure BMS6.1 shows the relative spare capacities in the existing BM systems under IPDWF. The red and light blue lines indicate pipes where capacity problems (< 30% spare) may be experienced. A number of collector sewer pipes and bulk sewer pipes in Plettenberg town have spare capacities less than 30%. It should however be noted that limited information was available regarding the actual slope of the bulk and collector sewer pipes and that the actual capacities of these pipes could potentially be sufficient.

### 6.1.5 Flow velocities under peak demand

Figure BMS6.2 shows the flow velocities in the existing BM systems under full flow conditions. It can be noted that a minimum slope resulting in a velocity > 0,6 m/s was assumed for a number of pipes in the system, where insufficient information was available. See par. 2.2 and Figure BMS2.3.

### 6.1.6 Flow hydrographs

The present PDDWF hydrographs at each WWTP are shown on Figure BMS6.7.

### 6.1.7 Pumping stations and rising mains

All existing PS's and rising mains have sufficient capacity to accommodate the existing sewer flows, except for the Matjiesfontein and Aventura pumping stations that have limited spare capacity during peak holiday conditions. The capacity of the Aventura pumping station is limited by the diameter of the downstream rising main and the rising main should first be upgraded.

It is recommended that the duty points of all the sewer PS's in BM are verified by field pumping tests.

## 6.2 FUTURE DRAINAGE AREAS AND SEWER FLOWS

### 6.2.1 Extended drainage areas

The proposed extended and new drainage areas for the future systems are shown on Figure BMS6.3.

### 6.2.2 Accommodation of future land developments

The future land developments are accommodated in the extended drainage areas. Table BMS6.3 is a summary of the future land development areas linking to the BM system; their PDDWF, land use and estimated additional pipe lengths. The connections of these future areas and sub-areas to the existing sewer system are indicated on Figure BMS6.4.

### 6.2.3 External contributors to sewer flow

No external sources will contribute to the future sewer systems within the BM.

### 6.2.4 Future sewer flow

Table BMS4.2 provides a summary of the future PDDWF's for each sub-drainage area in BM.

## 6.3 MASTER PLAN

The master planning for each of the towns in BM is discussed separately below. Items are identified to accommodate anticipated full development of each town, as provided by the Municipality's town planners.

The required works for the entire study area are shown on Figure BMS6.4. Details of the required items, cost estimates and phasing are also indicated in Tables BMS6.5a and these proposed master plan items are grouped together in proposed projects which are summarised in Table BMS6.5b. The proposed projects with the highest priority in BM are included in Table BMS6.5c.

Note that the internal network pipes in future developments were treated as schematic and are not included as master plan items. Table BMS6.6 shows the required pumping capacities for the future scenario.

### 6.3.1 Plettenberg Bay

The boundaries of the existing drainage areas in Plettenberg Bay are increased to accommodate proposed future development areas that fall within these drainage areas.

The main outfall sewer that gravitates to Kranshoek PS 1 should be upgraded if overflow problems occur.

A new main outfall sewer (items BPS12.10 - BPS12.14) is proposed for future development areas P4, P6, the northern areas of P7, P10, P12, P13 & P14. This outfall sewer should gravitate to the existing Piesang Valley 5 PS. It is proposed that flow from the Kranshoek PS 4 is in future diverted to this new bulk sewer (through the implementation of master plan item BPS12.18) in order to create additional capacity in the existing bulk sewer between Kranshoek and the Piesang Valley PS 5.

A new internal pump station and rising main should be constructed for the southern portion of future area P10 that cannot gravitate to the proposed Kranshoek bulk sewer.

A new Future PS P2 drainage area is proposed for the future development areas P5, P8, P9 and the southern areas of P7. A new pump station and rising main should be constructed for this drainage area that discharges into the drainage area of the Piesang Valley 5 PS (discharges into the proposed new bulk sewer from Kranshoek through master plan items BPS11.9 & BPS12.17).

A new internal pump station (Future PS P17) and rising main should be constructed for the southern portion of future area P11 that cannot gravitate in a northern direction towards the Piesang Valley PS 20.

The option should be investigated to in future (after the new Kranshoek bulk sewer is constructed) abandon the proposed Future PS P17 and Brackenridge pump stations 1, 2 & 3 and divert flow from the upstream drainage areas to the proposed Kranshoek bulk sewer.

A new Future PS P1 drainage area is proposed for future development area P15. A new pump station and rising main should be constructed for this drainage area that discharges into PS H3. When overflow problems occur at PS H3, the pumps should be upgraded according to the sewer master plan.

The main outfall sewer that gravitates to PS 11 should be upgraded if overflow problems occur.

PS 10 should be downsized to a capacity of 7 L/s if overflow problems occur between PS 9 and PS 10.

If overflow problems occur at the main outfall sewer that drains towards PS 8, this outfall sewer should be upgraded. When overflow problems occur at PS 8, the pumps should be upgraded to a capacity of 35 L/s and the rising main upgraded to a diameter of 200 mm. If overflow problems occur in the main gravity outfall sewer into which the rising main of PS 8 discharges, this outfall sewer should be upgraded according to the master plan.

When the Piesang Valley 5 pumping station reaches capacity the pump station should be upgraded to a capacity of 250 L/s and the existing rising main replaced with a new dedicated 500 mm diameter rising main that discharges into the Piesang Valley 20 PS (alternatively the existing 350 mm rising main can be reinforced with a new 350 mm diameter parallel rising main).

A new Future PS P3 drainage area is proposed for future development area P21. A new pump station and rising main should be constructed for this drainage area that discharges into the drainage area of the Piesang Valley 20 PS.

New main outfall sewers are proposed for future development areas P11 & P22 - P25. These outfall sewers should gravitate to the existing Piesang Valley 20 PS. When the Piesang Valley 20 pumping station reaches capacity the pump station should be upgraded to a capacity of 290 L/s and the existing rising main replaced with a new 500 mm diameter rising main (alternatively the existing 350 mm rising main can be reinforced with a new 355 mm diameter parallel rising main).

A new Future PS P4 drainage area is proposed for future development area P46. A new pump station and rising main should be constructed for this drainage area that discharges into the Piesang Valley 19 PS. When the Piesang Valley 18 pumping station is upgraded, the Piesang Valley 19 and 20 pump stations should be upgraded to a capacity of 300 L/s and their existing rising mains replaced with new 600 mm diameter rising mains (alternatively the existing 350 mm diameter rising mains should be reinforced with new 400 mm diameter parallel rising mains.

New outfall sewers are proposed for future development areas P45 & P47 that gravitates to the Piesang Valley 18 & 19 pump stations.

A new Future PS P20 drainage area is proposed for future development area P51. A new pump station and rising main should be constructed for this drainage area that discharges into the drainage area of PS1a.

New Future PS P5 and P6 drainage areas are proposed for future development areas P19 & P20. New pump stations and rising mains should be constructed for these drainage areas that discharge into the drainage area of PS 4.

If overflow problems occur at the main outfall sewers that drain towards PS 2 & 3, these outfall sewers should be upgraded.

New Future PS P7 and P8 drainage areas are proposed for future development areas P33 & P34. New pump stations and rising mains should be constructed for these drainage areas that discharge into the drainage area of Kwanokuthula PS 1. New outfall sewers and pipe reinforcements are proposed for the Kwanokuthula PS 1 drainage area when future development areas P31 - P34 develops. When the Kwanokuthula PS 1 reaches capacity the pump station should be upgraded to a capacity of 62 L/s and the rising main upgraded to a diameter of 250 mm.

Upgrading is proposed of the existing bulk sewer downstream of the Kwanokuthula PS 1 (master plan items BPS27.4A, B & C). This will be required in order to accommodate additional housing projects in Kwanokuthula as well as the future Ladywood development.

A new Ladywood drainage area is proposed for future development areas P27 - P30. A new Ladywood PS 1 with a capacity of 55 L/s and rising main should be constructed for this drainage area that discharges into the Ganse Valley WWTP Gravity drainage area.

A new so-called “Ebenhaezer” bulk sewer is proposed in order to accommodate future development area P35.

A new Future PS P18 drainage area is proposed for future development areas P91 & P92. A new pump station and rising main should be constructed for this drainage area that discharges into the proposed Ebenhaezer bulk sewer.

A new Future PS P9 drainage area is proposed for future development areas P58 & P60. A new pump station and rising main should be constructed for this drainage area that discharges into the Ganse Valley WWTP.

New Future PS P10, P11 and P12 drainage areas are proposed for future development areas P64 - P68. Future PS P12 should pump to Future PS P11, Future PS P11 to Future PS P10 and Future PS P10 to the existing Goose Valley Main PS.

When the proposed housing development in Green Valley (future area P100) starts to develop it is proposed that the existing sewer infrastructure between the development and the Wittedrift PS is upgraded and that the Wittedrift PS is upgraded to a capacity of 12 L/s.

The proposed capacity of 12 L/s for the Wittedrift PS is at the upper limit of what can be pumped to the Aventura PS through the 7,0 km 125 mm diameter rising main between the Wittedrift and Aventura pump stations.

It is proposed that when the upgraded Wittedrift PS reaches capacity (as additional areas in Wittedrift and Green Valley develops) the rising main to Aventura is abandoned and new bulk infrastructure is constructed in order to pump directly from Wittedrift to the Ganse Valley WWTP (see project BPS-058).

A new Future PS P13 with a capacity of 25 L/s and a rising main that discharges into the Aventura PS is proposed for future development area P70.

The capacity of the Aventura PS is currently limited to 32 L/s due to the capacity of the downstream 5,8 km rising main. It is proposed that the existing 200 mm diameter rising main is upgraded to a 355 mm diameter rising main. This will improve the capacity of the Aventura PS from 32 L/s to 78 L/s.

When the Aventura PS reaches capacity in future as development of upstream developments commence, it is proposed that the pumps in the pump station are upgraded to a capacity of 120 L/s.

When future development area P71 develops the Sanderlings PS and rising main should be upgraded to a capacity of 14 L/s and a diameter of 160 mm.

New Future PS P14 and P15 drainage areas are proposed for future development areas P71 - P77. Future PS P14 should pump to the drainage area of Future PS P15 and Future PS P15 to the existing Matjiesfontein PS. It is proposed that the existing Plettenberg Manor PS is decommission and sewage from the upstream drainage area is diverted to the proposed Future PS P15.

When the Matjiesfontein PS reaches capacity it should be upgraded to a capacity of 70 L/s. The existing 200 mm diameter rising main is in a bad state of repair and should be replaced with a new 315 mm diameter rising main.

New outfall sewers are proposed for future development areas P78 - P80, P83 & P84 in the Keurboomstrand Main drainage area.

The proposed sewer infrastructure projects in Plettenberg Bay with the highest priority are:

- Project BPS-023 (Ebenhaezer bulk sewer: New sewer infrastructure to accommodate the Ebenhaezer housing development (future area P35) in New Horizon).
- Projects BPS-010 & BPS-022 (Upgrading of Kwanokuthula sewer infrastructure - Phases 1 & 2: Required to augment the capacity of the existing Plettenberg bulk sewer to accommodate new housing developments in Kwanokuthula).
- Projects BPS-016 & BPS-006 (Development related infrastructure: Green Valley housing development and Wittedrift & Green Valley bulk sewer upgrades - Phase 1: New internal sewer infrastructure for the proposed Green Valley housing development (future area P100), upgrading of the existing sewer infrastructure between the development and the Wittedrift PS and upgrading of the Wittedrift PS in order to accommodate the first phases of the proposed Green Valley housing development).
- Project BPS-013 (Kranshoek sewer upgrades: Augmentation of the existing Kranshoek bulk sewer draining towards the Kranshoek PS 1 in order to prevent overflow problems).
- Project BPS-020 (Upgrade Aventura PS rising main: Upgrade existing 200 mm diameter rising main to a 355 mm diameter in order to increase the capacity of the Aventura PS from 32 L/s to 78 L/s).
- Project BPS-008 (Upgrade sewer infrastructure from PS 8 to Piesang Valley PS 5: Augmentation of the existing bulk infrastructure between Plettenberg Bay PS 8 and the Piesang Valley PS 5 in order to prevent overflow problems).
- Project BPS-009 (Sewer upgrades from PS 3 to PS 2: Augmentation of the existing bulk infrastructure between Plettenberg Bay PS 3 and PS 2 in order to prevent overflow problems).
- Project BPS-004 (Matjiesfontein PS & rising main upgrades: Upgrade existing 200 mm diameter rising main to a 315 mm diameter and upgrade existing pumps at the pump station in order to accommodate upstream developments).
- Project BPS-058 (Wittedrift & Green Valley bulk sewer upgrades - Phase 2: New bulk sewer infrastructure to pump sewage from Green Valley and Wittedrift directly to the Ganse Valley WWTP (as opposed to pumping via the Aventura PS)).

The PDDWF for the future Plettenberg system is calculated at ± 23,9 ML/d. The capacity of the existing Ganse Valley WWTP is 9,0 ML/d and should be upgraded when the existing WWTP reaches capacity.

### 6.3.2 Kurland

The existing Kurland PS 1 drainage area is increased to accommodate future development area P95 to the north of Kurland that fall within this drainage area.

A new Future PS K1 drainage area is proposed for future development area P96 (± 1 500 erven on a portion of Erf 562 to the south of Kurland). A new pump station and rising main to the Kurland WWTP should be constructed for this purpose.

No layout information was available for future development area P96, but from the topographical information it seems that it will be possible to abandon the existing Kurland pump station 1 in future (after the proposed Future PS K1 is constructed) and re-direct flow from the upstream drainage area to the Future PS K1.

It is therefore proposed that when future area P96 develops Future PS K1 should be constructed on a site downstream of future area P96 and Kurland PS 1 so that the total flow from future area P96 and the existing Kurland PS 1 drainage area can gravitate towards the proposed PS (see project BKS-003).

The option should also be investigated to abandon the Kurland PS 2 and re-direct flow from the upstream drainage area towards the proposed Future PS K1.

The PDDWF for the future Kurland system is calculated at ± 1,0 ML/d.

It is proposed that the capacity of the existing Kurland WWTP is upgraded from the current capacity of 500 kL/d to a future capacity of 1 150 kL/d (see project BKS-001).

### 6.3.3 Nature's Valley

There is currently no sewer network in Nature's Valley and the existing erven are serviced through septic tanks. No provision is made in the sewer master plan to service these erven with a waterborne sanitation system in future. This option should however be investigated.

There is no WWTP at Nature's Valley and sewage from the septic tanks are collected through sewage trucks and disposed of at the Kurland WWTP.

### 6.3.4 Harkerville

There is currently no sewer network in Harkerville and Forest View and the existing erven are serviced through chemical toilets. A new conservancy tank has been installed for the area in order to service the area in future through a waterborne sanitation system.

Sewage will then be collected from the conservancy tank through sewage trucks and disposed of at the Ganse Valley WWTP in Plettenberg Bay.

## 6.4 FUTURE SYSTEM

### 6.4.1 Spare capacities

Figure BMS6.5 shows the relative spare capacities in the future BM systems under IPDWF. All pipes were planned in accordance with the IPDWF philosophy for spare capacity > 30%.

### 6.4.2 Flow velocities under peak flow conditions

All future pipes were planned for a velocity > 0,6 m/s under full flow conditions. A few existing pipes with sufficient capacity but low velocities are however still present as indicated on Figure BMS6.2.

### 6.4.3 Flow hydrographs

The future PDDWF hydrographs are shown on Figure BMS6.6, for each WWTP.

### 6.4.4 Pumping stations and rising mains

Table BMS6.6 shows a summary of all the PS in the future system. The table shows which existing PS have sufficient capacity, which PS requires upgrading, which require downsizing, which should be decommissioned in the future and what new PS are required in future.

The existing PS's where duty points were not available were modelled with assumed scouring velocities in the accompanying rising mains. It is recommended that the duty points of these PS's be verified by field pumping tests.

The telemetry system whereby the PS's are closely monitored should also be upgraded and utilized to its full potential in order to assist with the operation of the systems.

All PS's should always have one standby pump available. Diesel-driven generators should be available for emergency conditions at all larger and strategically located (those which have high pollution risks) PS's.

### 6.4.5 Diversion structures

No new diversion structures are proposed for the BM future system to alleviate high flows in the main sewers.

The proposed diversion structure parameters are shown in Table BMS6.7.

## 6.5 UPDATING AND MAINTENANCE OF THE COMPUTER MODEL AND MASTER PLAN

The calibrated computer model of the sewer distribution system is a handy tool for the day to day management of the system and can also be used as a basis for the calculation of services contributions by developers. The utility value of the model will however be lost if it is not properly maintained. The model should therefore be kept up to date with new developments and extensions to the system, and a link to the treasury water sales data.

Unknown or missing network information should be gathered or else surveyed in order to improve the data integrity of the hydraulic model. It is recommended that a survey programme be implemented at the soonest opportunity, with a view to establishing the correct diameters and invert levels of the uncertain elements of the sewer network components. The survey should be prioritized by commencing with the largest diameters and thus focusing on the main outfall sewers. Field tests should also be performed in order to determine the duty points of the PS that are not known. During this investigation the diameters of the rising mains should also be recorded in order to verify the system data.

## 6.6 MONITORING OF THE SYSTEM

A continuous flow monitoring programme, mainly through an extension of the already established telemetry system, is suggested as it will greatly enhance future calibration and planning studies performed with the model as basis. In addition, its results can be used with a view to identifying those drainage areas where the most stormwater ingress occurs, so that these can be prioritized in terms of the proposed investigation into the causes of the problem.

## 6.7 STORMWATER INGRESS AND GROUNDWATER INFILTRATION

The impact of stormwater ingress and groundwater infiltration on the operation and performance of a sewer network is in many cases hugely underestimated. In other municipalities in the Western Cape stormwater ingress measured at the inlet works of WWTP's has been recorded to be as high as 300% of the dry weather sewer flows while groundwater infiltration due to rising water tables in wet winter months have been recorded to be as high as 50% of the dry weather sewer flows. These high flows clearly have a negative impact on the hydraulic performance of a sewer network and also the functioning of the WWTP downstream of the network.

A programme whereby sewer flows at strategic points in the network (WWTP's and PS) are monitored, via telemetry, is recommended. Results from these loggings could be used to identify the areas which pose the greatest problems in this regard. A strategy to address these problems should be adopted which could inter alia include a house-to-house investigation in order to eliminate illegal stormwater ingress from private properties.

## 6.8 ASSET MANAGEMENT

It is recommended that the current data bases as well as hydraulic analyses and master planning results be extended and applied to support the asset register (AR) and asset management plan (AMP). The following aspects are of importance in this respect:

- The data bases must be revisited to ensure compliance with the AR with respect to componentization and hierarchy. Due to the process followed in compiling the data bases it is not expected that this will be a major task, but the specific rules for componentization, hierarchy and continuous update of the AR within e.g. a unique numbering system were not available at the time.
- Similarly the master plan projects should be aligned with the format stipulated in the AMP.
- The data integrity allocation during the establishment of the data base should be applied to inform the data improvement plan which is a subset of the AMP.
- The results of the hydraulic analyses should be applied to assist in determining important component attributes in the AR, such as criticality, utilization, performance and remaining useful lifetime.
- Attributes that will assist in performing AMP related actions, such as risk based pipe replacement prioritization, should be captured. These would e.g. include geological environment, location with respect to areas or consumers sensitive to spillages or flooding etc.
- The units and unit rates used should be checked and adjusted to be consistent for the determination of asset valuations (current replacement cost - CRC), fair values (depreciated replacement cost - DRC) and budgets which includes maintenance (OPEX), and future works planning (CAPEX).

## 6.9 PIPE REPLACEMENT PRIORITIZATION

The risk associated with replacing infrastructure can be quantified in monetary terms by the product of the probability of failure and the consequence of failure. Intervention to replace infrastructure before failure, reduces risk, but finding useable statistical information to perform such an analysis is difficult.

An analysis based on fundamentally independent factors could be performed to assess the pipe replacement potential (PRP) for any one modelled pipe in the water distribution or sewer reticulation model by combining the two critical factors - likelihood of failure (LF) and consequence of failure (CF).

Various independent variables contribute to each of these factors using a simplified scoring system from 0 to 5. The contributing variables are then summated using different weights to give total LF and CF factors. The total PRP is then calculated for each pipe as the product of these factors:

$$PRP = LF \times CF \text{ (in the range of 1 to 25)}$$

Which is then ranked for all pipes in the model to give the PRP% (in the range of 0 to 100%). In addition the actual replacement cost for every pipe is calculated. The pipes with high PRP% can then be visualized graphically. The pipes can be aggregated in various ways to provide the weighted average, maximum or minimum PRP for various collections, such as per region or supply zone. The analysis is performed as an add-in to the SEWSAN GIS-based hydraulic analysis software. Results are reported in generic GIS format or in a dedicated module of IMQS.

It is recommended that a pipe replacement prioritization analysis be performed for the entire BM sewer network in order to ensure that upgrades and replacements of infrastructure are planned and implemented in an efficient and cost effective manner.

**Table BMS6.1 Sewer system replacement value - Existing system**

**Table BMS6.3 Sewer flows and connections for development areas - Future system**

(Table 6.3: Page 1 of 2)

(Table 6.3: Page 2 of 2)

**Table BMS6.5a Proposed works, cost estimates and phasing**

(Table 6.5a: Page 1 of 6)

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(Table 6.5a: Page 3 of 6)

(Table 6.5a: Page 4 of 6)

(Table 6.5a: Page 5 of 6)

(Table 6.5a: Page 6 of 6)

**Table BMS6.5b Proposed projects, cost estimates and phasing**

(Table 6.5b: Page 1 of 2)

(Table 6.5b: Page 2 of 2)

**Table BMS6.5c Priority sewer project - Bitou Municipality**

**Table BMS6.6 Pumping station parameters - Future system**

(Table 6.6: Page 1 of 4)

(Table 6.6: Page 2 of 4)

(Table 6.6: Page 3 of 4)

(Table 6.6: Page 4 of 4)

**Table BMS6.7 Diversion structure parameters - Future system**

**Figure BMS6.1a Existing spare capacities at IPDWF - Plettenberg Bay**

**Figure BMS6.1b Existing spare capacities at IPDWF - Kurland & Nature's Valley**

**Figure BMS6.2a** **Existing full flow velocities - Plettenberg Bay**

**Figure BMS6.2b Existing full flow velocities - Kurland & Nature's Valley**

**Figure BMS6.3a** **Future drainage areas - Plettenberg Bay**

**Figure BMS6.3b Future drainage areas - Kurland & Nature's Valley**

**Figure BMS6.4a Required works - Plettenberg Bay**

**Figure BMS6.4b Required works - Kurland & Nature's Valley**

**Figure BMS6.5a Future Spare capacities - Plettenberg Bay**

**Figure BMS6.5b Future Spare capacities - Kurland & Nature's Valley**

**Figure BMS6.6 SEWSAN flow hydrographs - Bitou Municipality system**

# 7. SUMMARY

This report describes the study undertaken with respect to the updating of the master plan for the sewer drainage system of the Bitou Municipality (BM). GLS Consulting Engineers (GLS) was appointed as sub-consultants to Lyners Consulting Engineers & Project Managers to update the master plan of the sewer drainage system for BM.

The initial sewer master plan for BM was compiled by Community Engineering Services Consulting Engineers (CEs) and documented in a report, dated September 2008. This master plan was subsequently updated by GLS for BM and documented in a report, dated June 2016.

These previous master plans have been updated in this study and is documented in this report, dated June 2020.

## 7.1 SCOPE OF SEWER MASTER PLAN STUDY

The scope of this update study was briefly defined as the following:

- Verification and updating of existing computer models for the BM sanitation networks.
- The linking of these models to updated land use information.
- Evaluation and master planning of the sewerage networks.
- Present all information electronically in geographic information system (GIS) format.

## 7.2 STUDY AREA

The Engineering Services department of the BM is responsible for the operation and maintenance of the sewer reticulation systems of the towns within the boundary of the BM, which are:

- Plettenberg Bay (including Keurboomstrand, Kranshoek, Green Valley and Wittedrift)
- Kurland
- Nature's Valley
- Harkerville (including Forest View)

Figure BMS1.2 shows the suburbs with suburb names entered during this investigation for all records in the GIS database. The total area of these suburbs indicates the study area of this investigation.

## 7.3 SYSTEM LAYOUT AND OPERATION

The layouts of the BM sewer systems are shown on Figures BMS2.1 with a separate Figure for each area as follows:

- a - Plettenberg Bay
- b - Kurland & Nature's Valley

Each system is operated in a main drainage area with a wastewater treatment plant (WWTP), which in turn could be sub-divided into several sub-drainage areas each as shown on Figure BMS2.2.

### 7.3.1 Pumping stations

There are 73 pumping stations in the Plettenberg Bay system and three in Kurland as indicated on Figures BMS2.1 and BMS2.2. Of the 73 pumping stations in the Plettenberg Bay system 41 pumping stations are municipal (owned and operated by BM) and 32 pumping stations are privately owned (part of internal infrastructure of private developments).

### 7.3.2 Pipe network

The total BM system consists of ± 248,2 km of gravity sewers and ± 61,0 km of rising mains.

## 7.4 WATER DEMAND AND SEWER FLOWS

Plettenberg Bay

The present fully occupied Annual Average Daily Demand (AADD), for the existing Plettenberg Bay system that contributes to the domestic sewer flow is ± 12 871 kL/d, which includes non-revenue water (NRW).

The PDDWF for the Plettenberg Bay system is estimated at ± 9 824 kL/d, or roughly 76% of the AADD.

Kurland

The present fully occupied AADD, for the existing Kurland system that contributes to the domestic sewer flow is ± 541 kL/d, which includes non-revenue water (NRW).

The PDDWF for the Kurland system is estimated at ± 373 kL/d, or roughly 69% of the AADD.

Nature's Valley

Nature's Valley is serviced with septic tanks. There is no WWTP at Nature's Valley and sewage from the septic tanks are collected through sewage trucks and disposed of at the Kurland WWTP.

Harkerville

Harkerville and Forest View are currently serviced through chemical toilets. A new conservancy tank has been installed for the area in order to service the area in future through a full waterborne sanitation system. Sewage will then be collected from the conservancy tank through sewage trucks and disposed of at the Ganse Valley WWTP in Plettenberg Bay

## 7.5 SEWER FLOW MEASUREMENTS AND CALIBRATION

Relatively good quality daily sewer volumes were obtained from BM for the period of January 2015 to June 2019. These sewer flow measurements, were used to calibrate the Bitou sewer system analysis program (Sewsan) model for this study. Useful parameters such as stormwater ingress, typical unit hydrographs and leakage/infiltration could however not be derived from the information provided as no hourly flow measurements where available.

The Sewsan models were populated with unit hydrographs (UH) as described in Figure BMS5.1, Chapter 5, which is based on the analysis of many flow recordings done for similar previous studies as well as the 2016 update of the Plettenberg Bay and Kurland systems.

From this data the dry weather flow was predicted and the Sewsan models adjusted to simulate the PDDWF. The predicted flow volume from the Sewsan model corresponds well with the actual flow volumes of the entire system measured at the various WWTP's (see Figure BMS2.4).

## 7.6 WASTEWATER TREATMENT PLANTS

All the present (PDDWF) for each drainage area is treated at each town's WWTP:

| | | | |
|---|---|---|---|
| • | Ganse Valley | - Capacity | 9,00 ML/d |
| • | Kurland | - Capacity | 0,50 ML/d |
| | **Total Capacity** | | **9,50 ML/d** |

The total WWTP capacity for Bitou is roughly equal to 1.14 x the present PDDWF.

The analysis of the capacities of the existing BM WWTP's is however beyond the scope of this study.

## 7.7 REPLACEMENT VALUE

The year 2019/20 replacement value of the system (including wastewater treatment plants) is estimated as follows:

| | | |
|---|---|---|
| Plettenberg Bay | R | 870,54 m |
| Kurland | R | 37,18 m |
| **Total** | **R** | **907,72 m** |

## 7.8 FUTURE LAND USE, WATER DEMAND AND SEWER FLOW

### 7.8.1 Future Land use

For the future scenario pertaining to land use in BM it was assumed that all presently unoccupied erven will become occupied. In addition, certain areas in BM have been identified for future developments in consultation with the Municipality's town planning consultants. Each potential area was assigned an anticipated predominant land use, and will be phased in over a 20 to 30 year period.

The potential future land developments in BM are shown on Figure BMS4.1, coloured according to the land use.

### 7.8.2 Future water demand

The future AADD (that contributes to the sewer flow) of the Plettenberg Bay and Kurland systems studied for this report is ± 34 409 kL/d. The future AADD represents an increase of ± 157% over the present fully occupied AADD that contributes to the sewer flow. The potential future developments account for ± 61 % of the future AADD.

### 7.8.3 Future sewer flow

The future PDDWF's of the drainage areas in Bitou are summarised in Table BMS4.2. The future PDDWF of ± 24 935 kL/d is ± 72 % of the future AADD for the entire Plettenberg Bay and Kurland systems.

## 7.9 OPERATIONAL CRITERIA

For this planning study the instantaneous peak dry weather flow (IPDWF) philosophy was used, where spare capacities in the pipes were reserved to allow for stormwater ingress.

Pipe sizes in gravity mains should therefore be such that the peak dry weather flow can be accommodated in the pipeline whilst flowing 70% or less full. The remaining 30% of the flow area is for the accommodation of stormwater ingress. Should stormwater ingress cause this "spare capacity" to be exceeded, resulting in pipeline overflow, certain measures should be taken by the system manager to prevent ingress of stormwater into the sewer system.

## 7.10 COMPUTER MODEL ANALYSIS AND EVALUATION OF EXISTING SYSTEM

The existing computer model of the existing sewer system was updated with the latest as-built information and calibrated based on sewer flow readings measured at the WWTP's, using the SEWSAN software. The model is complete, detailed, and geographically accurate, and can therefore also serve as the GIS "as-built" record of the system.

The model was subjected to a typical IPDDWF scenario, and evaluated with respect to:

- Spare capacities in outfall sewers
- Spare capacities at PS
- Flow velocities in outfall sewers
- Flow velocities in rising mains

Presently the sewer systems operates and functions without major problems, and this was reflected in the computer model analysis.

A few outfall sewers in BM are however currently near or at capacity (relative spare capacity is less than 30%) and requires upgrading.

## 7.11 MASTER PLAN FOR SYSTEM EXTENSIONS/AUGMENTATION

A master plan for future extensions to the sewerage system, based on the anticipated future land use in BM was compiled with the use of computer models. The master plan was compiled for a total PDDWF of 24 935 kL/d from the system. Pipeline capacities were planned so as to have 30% spare capacity over and above the IPDWF which may occur in a pipe. Proposed works were determined on an economically optimal basis and should be implemented in phases, firstly to ameliorate problems in the existing system and after that as demanded by an increase in sewer flow and the incorporation of new areas into the system.

The proposed works are discussed in detail in the report and only the most important aspects are mentioned in this summary

### 7.11.1 Drainage areas

The proposed future drainage areas to accommodate future developments within the BM boundaries are, in most cases, extensions of the present drainage areas. Where gravity flow into the existing systems were not possible, PS drainage areas were added.

### 7.11.2 Wastewater treatment plants

The analysis of the capacities of the existing BM WWTP's is beyond the scope of this study.

### 7.11.3 Required works

An extended computer model representing the future scenario was set up to plan and size the components of the future sewer system. The motivation for the works, and a detailed description for each component, is provided in the main body of the report.

The required works to reinforce the system for existing and potential future deficiencies are shown on Figure BMS6.4 and listed with short descriptions in Table BMS6.4a. These proposed master plan items are grouped together in proposed projects which are summarised in Table BMS6.4b.

The major new sewer projects with the highest priorities are summarized below:

| Project no. | Description | **Estimated cost** (R-yr 2019/20 value) |
|---|---|---|
| PRJ-BPS-023 | Ebenhaezer bulk sewer | R 4 238 000 |
| PRJ-BPS-010 | Kwanokuthula sewer upgrades - Phase 1 | R 13 782 000 |
| PRJ-BKS-003 | Implement Future Kurland PS K1 drainage area | R 5 228 000 |
| PRJ-BPS-022 | Kwanokuthula sewer upgrades - Phase 2 | R 5 550 000 |
| PRJ-BKS-001 | Kurland WWTP upgrade | R 17 251 000 |
| PRJ-BPS-006 | Wittedrift & Green Valley bulk sewer upgrades (Phase 1) | R 6 335 000 |
| PRJ-BPS-016 | Development related infrastructure: Green Valley housing development | R 3 481 000 |
| PRJ-BPS-013 | Kranshoek sewer upgrades | R 4 582 000 |
| PRJ-BPS-020 | Upgrade Aventura PS rising main | R 24 343 000 |
| PRJ-BPS-008 | Upgrade sewer infrastructure from Pump Station 8 to Piesang Valley PS 5 | R 10 507 000 |
| PRJ-BPS-009 | Sewer upgrades from PS 3 to PS 2 | R 2 222 000 |
| PRJ-BPS-004 | Matjiesfontein PS & rising main upgrades | R 7 553 000 |
| PRJ-BPS-058 | Wittedrift & Green Valley bulk sewer upgrades (Phase 2) | R 17 005 000 |

### 7.11.4 Cost estimates and phasing in of works

The total cost (year 2019/20 value) for all the required works is estimated at R 245 million (including P&G's, contingencies and fees, excluding VAT).

The capital investment of R 245 million is required over time to increase the system capacity from the present PDDWF of roughly 8,3 ML/d, to the future horizon of 24,9 ML/d PDDWF.

Tables BMS6.4a &BMS6.4b also gives an indication of when the works are required. The required expenditure should be phased to remain in line with the increase in PDDWF.

The proposed projects with the highest priority in the BM system are included in Table BMS6.4c. The estimated cost of items required in the next 5 years is ± R 122 million.

## 7.12 MASTER PLAN UNIT COST

The required capital expenditure for these priority sewer infrastructure projects is as follows:

- R 46,0 million for the 2020/21 financial year
- R 38,7 million for the 2021/22 financial year
- R 37,3 million for the 2022/23 financial year

Table BMS7.1 is a summary of the total costs associated with the proposed master plan for the sewer system for the next 30 to 35 years, which amounts to R 244,86 million.

The master plan implementation at cost of R 244,86 million will increase the BM system capacity from its present PDDWF of 8 314 kL/d to the future PDDWF of 24 935 kL/d. This amounts to an implementation unit cost of R 14 732 R/kL/d.

## 7.13 UPDATING AND MAINTENANCE OF THE COMPUTER MODEL AND MASTER PLAN

The calibrated computer model of the sewer system is a handy tool for the day to day management of the system and can also be used as a basis for the calculation of services contributions by developers. The utility value of the model will however be lost if it is not properly maintained. The model should therefore be kept up to date with new developments and extensions to the system, and a link to the treasury water sales and land use data.

## 7.14 MONITORING OF THE SYSTEM

A continuous flow monitoring programme, mainly through an extension of the already established telemetry system, is suggested as it will greatly enhance future calibration and planning studies performed with the model as basis. In addition, its results can be used with a view to identifying those drainage areas where the most stormwater ingress occurs, so that these can be prioritized in terms of the proposed investigation into the causes of the problem.

## 7.15 STORMWATER INGRESS AND GROUNDWATER INFILTRATION

The impact of stormwater ingress and groundwater infiltration on the operation and performance of a sewer network is in many cases hugely underestimated. A programme whereby sewer flows at strategic points in the network (WWTP's and PS) are monitored, via telemetry, is recommended. Results from these loggings could be used to identify the areas which pose the greatest problems in this regard, after which a strategy to address these problems should be adopted.

## 7.16 ASSET MANAGEMENT

It is recommended that the current databases as well as hydraulic analyses and master planning results be extended and applied to support the asset register (AR) and asset management plan (AMP).

## 7.17 PIPE REPLACEMENT PRIORITIZATION

It is recommended that a pipe replacement prioritization analyses is performed for the entire BM sewer network in order to ensure that upgrades and replacements of infrastructure are planned and implemented in an efficient and cost effective manner.

## 7.18 CONCLUSION

It is recommended that the sewer master plan as described in this report be implemented in order to allow the BM sewer distribution system to keep in step with the anticipated growth and expansion of sewer flow.

**Table BMS7.1 Sewer master plan cost summary**