UPDATE OF THE WATER MASTER PLAN FOR BITOU LOCAL MUNICIPALITY

JUNE 2020

WATER MASTER PLAN

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BITOU MUNICIPALITY

WATER MASTER PLAN

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LIST OF ABBREVIATIONS & ACRONYMS

AADD	-	Annual average daily demand
AMP	-	Asset management plan
AR	-	Asset register
BM	-	Bitou municipality
BPT	-	Break pressure Tank
BWL	-	Bottom Water Level (in m a.s.l.)
CAPEX	-	Current expenditure
CES	-	Community engineering services
CRC	-	Current replacement cost
d	-	Day
DRC	-	Depreciated replacement cost
DTM	-	Digital terrain model
DWAF	-	Department of Water Affairs and Forestry
EGL	-	Energy Grade Line (in m a.s.l.)
FCV	-	Flow Control Valve
GIS	-	Geographic Information System
GLS	-	GLS Consulting
h	-	Hour
ha	-	Hectare
HL	-	High Level
IMQS	-	Infrastructure Management Query Station (software package)
kL	-	Kilolitre
kL/d	-	Kilolitre/day
KM	-	Kilometre
kW	-	Kilowatt
kWh	-	Kilowatt-hour
L	-	Litre
L/day/UE	-	Litre/day/unit erf
L/h/connection	-	Litre/hour/connection
L/min	-	Litre/minute
L/s	-	Litre/second
LL	-	Low Level
m	-	Metre
m a.s.l.	-	Metres above mean sea level
m/s	-	Metres per second

ML	-	Megalitre
mm	-	Millimetre
NRW	-	Non-revenue water
OPEX	-	Operational expenditure
P&G	-	Preliminary and general
PDF	-	Peak day factors
PHD	-	Peak hour demand
PHF	-	Peak hour factors
PRV	-	Pressure Reducing Valve
PS	-	Pumping Station
PSV	-	Pressure Sustaining Valve
PWF	-	Peak week factors
s	-	Second
SG	-	Surveyor General
SWIFT	-	Sewer Water Interface For Treasury systems (software)
TWD	-	Total annual water demand
TWL	-	Top Water Level (in m a.s.l.)
UAW/UFW	-	Unaccounted-for-water
UE	-	Unit erf
UWD	-	Unit Water Demand (e.g. L/stand/d, or kL/ha/d)
VAT	-	Value Added Tax
WADISO	-	Water Distribution System Optimization program (software)
WSDP	-	Water Services Development Plan
WTP	-	Water Treatment Plant (potable water)

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 water distribution system for Bitou Municipality (BM).

The project entails the updating of computer models for the water distribution systems in BM, the linking of these models to the stand and water meter databases of the treasury's financial system, evaluation and master planning of the networks, 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 water distribution system of the towns within BM.

1.2. STUDY AREA

The location of BM within the Western Cape is shown on Figure BMW1.1. The towns within the boundary of the BM are:

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

Figures BMW1.2 show the suburbs with suburb names entered during this investigation for all records in the geographic information system (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 water system in Plettenberg Bay and Kurland. CEs conducted a comprehensive water 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 distribution systems in the area over the years. The most notable in this respect include studies and designs performed by Stewart Scott International.

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. Water supply system

In this report the term water supply system is used to describe the reticulation system downstream of the clean water reservoir and upstream of individual consumer meters; it is also often termed the internal water reticulation system. Capital expenditure (CAPEX) relating to this system is the responsibility of the Municipality.

In order to further distinguish between CAPEX by the Municipality and by other role-players the following terms are defined:

- *Bulk water supply system is used to describe the system upstream of the clean water reservoir, yet belonging to the Municipality, while the term,*
- *External bulk water supply system, is used to describe those parts of the water supply system that are owned by third parties.*

1.4.2. Water management zones

Management zones are often termed bulk zones (as in Swift), distribution zones, or water pressure zones. Following the notation of the Water Demand Cookbook (McKenzie et al, Nov 2003) the following terms are used in this report. A water management zone can be, either a district, a sub-district or a zone, where:

- a district is a unique area with individual bulk supply and boundaries usually fixed by topographical constraints. This would include various consumer categories (typically about 30 000 connections).
- a sub-district is a subdivision of a district and is identified by a reservoir, tower, pump, or pressure reducing valve (PRV) zone (typically 2000 to 10 000 connections). This would include various consumer categories.
- a zone is a subdivision of a district, identified by areas of similar characteristics (typically not larger than 2000 connections).

The set-up (identifying and installing, where necessary, zone valves) and maintenance of zones (training maintenance staff to understand why these zone valves should not be opened) is a particular challenge to many towns in South Africa.

1.4.3. Non-revenue water (NRW)

The acronym NRW is used in literature for the term non-revenue water. Generally speaking NRW is the difference between the volume of water purchased by a water service provider (or bulk supply to the town) and the volume of water sold to consumers (recorded by consumer meters and billed to consumers). However, the definition of NRW and the topic is much more involved - NRW is best described by a table and detailed report such as the one by McKenzie et al (2002), where a detailed table is provided to illustrate the different components of NRW.

In this report the term NRW is used to describe all water use that is not recorded in the treasury system of the Municipality whether it is metered or not. Unless metered unbilled water use is specifically pointed out it is not included in the analysis in this investigation.

1.4.4. 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.

1.4.5. 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 water meter forming a consumer's connection to the water supply system. Some treasury records might not pertain to a water connection (or customer meter).

SABS0306: 1999 provides the following definitions:

- A consumer meter is a device that measures the volume of water leaving a water distribution system and entering a consumer's installation for the purpose of billing and accounting for water.

- Billing volume is the total volume of water actually recorded as having passed through a consumer meter during a specified time interval, for a given area, district, town or selection of stands, for which payment would normally be made.

1.5. STRUCTURE AND SCOPE OF REPORT

This report addresses the distribution of potable water within the Bitou Municipal area. Water quality aspects and the analysis of the bulk water (raw water) pipelines upstream of the water treatment plants (WTP's) and reservoirs are beyond the scope of this report.

The contents of each chapter is arranged so that all of the text is grouped together, followed by the tables and 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 not be held accountable for 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 BMW 1.1 Locality plan - Bitou Municipality

Figure BMW 1.2a Towns and suburbs per treasury - Plettenberg Bay & Harkerville

Figure BMW 1.2b Towns and suburbs per treasury - Kurland & Nature's Valley3

2. EXISTING SYSTEM

2.1. WATER SOURCES

2.1.1. Plettenberg Bay

Plettenberg Bay is supplied with water from four sources, namely the Keurbooms River, the Piesang River, desalination and groundwater abstraction.

Water from the abstraction point in the Keurbooms River is pumped to two raw water reservoirs through a 0,9 km pipeline (500 mm diameter) from where it flows through a 16,4 km long 500 mm diameter pipeline to Plettenberg Bay where it is purified at the Plettenberg Bay WTP. Surplus water from this source can be transferred to the Roodefontein dam.

The Roodefontein dam receives its water from the Piesang River. In the dryer summer months when there is a shortage from the Keurbooms River source water is supplemented from the Roodefontein dam. The water from the Roodefontein dam gravitates through a 1,8 km 350 mm diameter pipeline to the Roodefontein dam raw water reservoir from where it is pumped via a 2,1 km 350 mm diameter pipeline to the Plettenberg WTP where water is purified. The treatment capacity of the Plettenberg Bay WTP is 27,0 ML/d.

During peak demand conditions water supply can be augmented from groundwater abstraction and through desalination. Water from the boreholes is pumped directly to the treatment plant or to the existing reservoirs where water is treated.

The Bitou desalination plant (located next to the Beacon Isle hotel) has a treatment capacity of 2,0 ML/d.

2.1.2. Kurland

The source of bulk water for Kurland is the Wit River where BM has a WARMS registration volume of 600 kL/d. Water abstracted from the Wit River is pumped through a 0,7 km 150 mm diameter pipeline to the Kurland WTP where it is purified. Raw water supply is augmented from 2 boreholes close to the Kurland WTP. The safe yield of the boreholes is 430 kL/d.

The treatment capacity of the Kurland WTP is 0,6 ML/d.

2.1.3. Nature's Valley

Nature's Valley receives raw water from the Groot River. The Nature's Valley WTP has a treatment capacity of 1,0 ML/d and is located next to the abstraction point in the Groot River.

2.1.4. Harkerville

No information with regards to the Harkerville water sources was available at the time when the report was compiled except that there are two boreholes in Harkerville North and one borehole in Harkerville South.

Note:

Investigation of, and comments on the sufficiency of the existing water sources are beyond the scope of this study.

2.2. RAW WATER BULK SUPPLY SYSTEM

The analysis of the raw water bulk supply system, viz. the system upstream of the storage reservoirs or WTPs is beyond the scope of this study.

2.3. SYSTEM LAYOUT AND OPERATION

2.3.1. General Description

The existing Bitou water supply system is discussed in this section.

The water distribution system layouts are shown on Figures BMW2.1, with a separate Figure for each area as follows:

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

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

The water distribution zones are shown in Figures BMW2.2.

Tables BMW2.1(a) - BMW2.1(d) provides a summary of the pipes, WTPs, reservoirs, tanks, towers, pumps and control valves in the existing system.

Table BMW2.2 provides a summary of the existing annual average daily demand (AADD) of each zone in the system.

2.3.2. Plettenberg Bay

The system is operated in 25 zones supplied from 22 reservoirs and 7 towers (on 16 reservoir sites). There are 7 PRVs in the system to control static pressures and 14 pump stations to supply bulk water to the reservoirs and towers or to increase water pressure to higher lying areas. The PRVs feed into discrete sub-zones.

From the Plettenberg Bay WTP two sets of pumps and rising mains supply the adjacent Town A, B and C reservoirs with purified water. One pump set supplies the Town A reservoir with water through a 200 mm Ø pipeline while the other set of pumps supplies the Town B & C reservoirs through a 300 mm Ø pipeline. The combined capacity of the 3 reservoirs is 8,5 ML and supplies the Town reservoir zone. Four PRV zones are implemented at the lower lying erven within the Town reservoir zone in order to manage static pressures. Water is also supplied from the Town reservoirs A and C through a 150 mm Ø and 315 mm Ø pipelines to the Wittedrift, Aventura and Matjiesfontein reservoirs.

The 150 mm Ø and 315 mm Ø pipelines from the Town reservoirs A & C runs parallel to each other from Beacon Way to the N2 National Road (N2) and then parallel to the N2 to opposite the Turtle Creek Golf Estate where the 315 mm Ø pipeline ends. The 150 mm Ø pipeline continue alongside the N2 towards the Matjiesfontein reservoir. From the information received it appears that the 150 mm Ø and 315 mm Ø pipes are not connected to each other where the 315 mm pipe ends, but it should be. BM should verify this.

From this point the 150 mm Ø pipeline continues for 3,6 km alongside the N2 to just before the bridge over the Keurbooms River, where the pipe increases in diameter to a 200 mm Ø pipe. The 200 mm Ø pipe runs for 1,4 km alongside the N2 to the Keurboomstrand exit, and then for another 1,4 km to the Matjiesfontein reservoir. The Wittedrift reservoir is supplied with a connection from the 150 mm Ø pipe (at the Rietvlei Road turn-off from the N2 opposite BUCO) and the Aventura reservoir (private reservoir) is supplied with a connection from the 200 mm Ø pipe (just after the 150 mm Ø pipe increases to 200 mm Ø, before the bridge over the Keurbooms River).

Bulk supply to Matjiesfontein is currently augmented through the network of the Goose Valley reservoir zone through a 250 mm Ø pipe (part of the Goose Valley reservoir network) that runs parallel to the existing 150 mm Ø pipe from the Town reservoirs to the Matjiesfontein reservoir.

The Brakkloof reservoir is supplied with bulk water through a 5,2 km 300 mm Ø and 4,2 km 250 mm Ø dedicated rising mains and pumps from the Plettenberg Bay WTP. The 5,6 ML Brakkloof reservoir supplies the Brakkloof reservoir zone.

From the Brakkloof reservoir water is distributed to the Whale Rock, Quarry and Kranshoek reservoirs.

The 2,0 ML Whale Rock reservoir is supplied under gravity through a 200 mm Ø dedicated pipeline from a connection to the 250 mm Ø network pipe of the Brakkloof reservoir zone in Robberg Road. The Whale Rock reservoir zone is supplied from the Whale Rock reservoir.

The 3,0 ML Quarry reservoir is supplied through a 0,6 km dedicated 200 mm Ø rising main and pumps from the Brakkloof PS. The Quarry reservoir zone is supplied from the Quarry reservoir. Water pressure in the Whale Rock Heights and Whale Rock Ridge developments (both located within the Quarry reservoir zone) can be boosted during high demand conditions through the Whale Rock Heights and Whale Rock Ridge private booster pump stations.

The Whale Rock reservoir zone was in the past also supplied with water from the Quarry BPT, which in turn was supplied with water through the network of the Quarry reservoir zone. The Quarry BPT (located close to the entrance of the Whale Rock Ridge Estate) is however decommissioned. It can be considered in future to augment supply to the Whale Rock reservoir zone with a PRV located at the position of the old Quarry BPT.

The Kranshoek reservoir in Kranshoek is supplied with water through a 6,6 km dedicated 150 mm Ø rising main and pumps from the Brakkloof PS. The 150 mm rising main has recently been augmented with a parallel 400 mm Ø rising main (5,5 km) to the proposed position of the future Roodefontein Lower reservoir (corner of Robberg Road and Trekkers Road). From here the 400 mm Ø rising main decreases in diameter to a 250 mm Ø pipe for 1,7 km along Trekkers Road to the existing Kranshoek reservoir. The volume of the Kranshoek reservoir is 1,36 ML.

The Kranshoek Concrete (628 kL) and Kranshoek Steel (500 kL) towers are filled with water from the Kranshoek reservoir through a 100 mm Ø feeder main from the Kranshoek tower pump station. This feeder main will be upgraded in the near future. The Kranshoek tower zone is supplied from the two towers.

From the Plettenberg Bay WTP a dedicated 4,8 km 300 mm Ø rising main and pump can supply water to the Town towers, the Archiewood reservoir and the New Horizon reservoirs. The Kwanokuthula East reservoirs can also be supplied with water from this rising main through a 1,4 km dedicated 200 mm Ø pipe. Currently the Archiewood reservoir and the Kwanokuthula East reservoirs are supplied through this so-called “Kwanokuthula” pipeline (New Horizon reservoirs are supplied from the so-called “New Horizon” pipeline). The volume of the Archiewood reservoir is 2,0 ML and the combined volume of the Kwanokuthula East reservoirs is 3,0 ML.

From the Plettenberg Bay WTP a dedicated 7,4 km 315 mm Ø rising main (the so-called “New Horizon” pipeline) and High Lift pump supply water to the New Horizon and Kwanokuthula West reservoirs (the last section of this pipeline towards the Kwanokuthula West reservoir is however currently under construction and only the New Horizon reservoir is supplied with water from this pipeline). The volume of the recently constructed Kwanokuthula West reservoir is 3,5 ML and the combined volume of the New Horizon reservoirs is 6,5 ML.

The Town Towers reservoir is supplied with water through a 0,7 km 200 mm Ø dedicated pipeline and pump from the Plettenberg Bay WTP. In periods of high demand the

Brackenridge reservoir (4,0 ML) can be supplied with water from the supply pipeline to the Town Tower reservoir through a 1,0 km 250 mm Ø pipe between the Town Tower reservoir and the Brackenridge reservoir.

The Town Upper tower and Town Lower tower are filled with water from the Town Tower reservoir through the Town Tower reservoir pumps or alternatively from the connection to the so-called “Kwanokuthula” pipeline. The Upper tower supplies the Upper tower zone and the Lower tower supplies the Lower tower zone. The volume of the Town Lower and Town Upper towers is 500 kL and 250 kL respectively.

The Archiewood reservoir zone is supplied from the Archiewood and Brackenridge reservoirs and the Brackenridge zone is supplied from the Archiewood reservoir.

The New Horizon reservoir zone is supplied from the New Horizon reservoirs. The lower lying Schoongezight PRV and New Horizon PRV zones are supplied through the New Horizon reservoir zone where water pressure is regulated through two PRV’s.

From the Kwanokuthula East reservoirs the Kwanokuthula New and Old towers were filled through dedicated rising mains and 2 sets of pumps at the Kwanokuthula East pump station. The Kwanokuthula tower zone is supplied from the towers. The Kwanokuthula Old tower (volume of 430 kL) is currently not in operation (the tower had a leak that was only recently repaired). The motors of the set op pumps pumping to the Old tower through the dedicated 300 mm Ø feeder main have also been removed. The second set of pumps currently pumps through a dedicated 2,0 km 160 mm Ø rising main directly to the Kwanokuthula West reservoir (this pipe used to pump directly to the 500 kL New tower).

The New tower is now filled from the Kwanokuthula West reservoir through the Kwanokuthula West PS and accompanying 200 mm Ø feeder main.

A dedicated 4,1 km 200 mm Ø rising main and pumps at the Plettenberg Bay WTP supplies the Goose Valley reservoir with water. From here the Goose Valley zone is supplied with water. The volume of the Goose Valley reservoir is 3,5 ML.

Dedicated gravity mains (150 mm Ø and 315 mm Ø) from the Town reservoirs A & C (a small portion of the Town reservoir zone is however supplied from a connection to the 150 mm Ø pipe) supply water to the Wittedrift, Aventura and Matjiesfontein reservoirs as described above. The Wittedrift reservoir is supplied with a connection from the 150 mm Ø pipe at the Rietvlei Road turn-off from the N2 (opposite BUCO) through a 5,3 km long 90 mm Ø pipe. The volume of the Wittedrift reservoir is 0,5 ML.

From the Wittedrift reservoir water is pumped to the Green Valley reservoirs (2x 0,5 ML) and the Green Valley elevated tank (11 kL) through a 63 mm Ø supply pipe.

The Wittedrift reservoir zone is supplied from the Wittedrift reservoir, the Green Valley reservoir zone from the Green Valley reservoirs and the Green Valley tower zone from the Green Valley elevated tank.

The Aventura reservoir (private reservoir) is supplied through a 75 mm Ø pipe from a connection to the 200 mm Ø pipe towards the Matjiesfontein reservoir (before the bridge over the Keurbooms River).

The Aventura zone is supplied from the Aventura reservoir and the Matjiesfontein zone from the Matjiesfontein reservoir. The volume of the Matjiesfontein reservoir is 3,0 ML.

From the Matjiesfontein reservoir water gravitates through the network of the Matjiesfontein reservoir zone to the Keurboomstrand PS, from where water is pumped to the Keurboomstrand reservoir. The sump before the Keurboomstrand PS (Keurboomstrand BPT) is decommissioned and water is currently boosted from the Matjiesfontein reservoir zone to the Keurboomstrand reservoir through a dedicated 100 mm Ø pipeline. The volume of the Keurboomstrand reservoir is 1,0 ML.

From here water is pumped through the network of the Keurview reservoir zone to the Keurview reservoir (volume of 115 kL). The Keurboomstrand reservoir zone is supplied from the Keurboomstrand reservoir and the Keurview reservoir zone from the Keurview reservoir.

2.3.3. Kurland

The system is operated as a single zone, supplied from the Kurland reservoirs. The combined volume of the Kurland reservoirs is 1,5 ML.

2.3.4. Nature's Valley

The system is operated in two zones, supplied from a single reservoir. There is one PRV in the system to control static pressures. The PRV feeds into a discrete sub-zone.

2.3.5. Harkerville

Minimal information was available at the time when the report was compiled. From the available information it is believed that the system is operated in two zones (Forest View Tanks and Harkerville Reservoir).

2.4. EXISTING OPERATIONAL PROBLEMS

The operational staff indicated the following operational problems:

- High static water pressures in parts of the Town reservoir zone.
- Low residual water pressures in the Kwanokuthula tower zone.
- Low static and residual water pressures at the higher lying erven in the New Horizon reservoir zone.
- Low static and residual water pressures at the higher lying erven in the Kranshoek tower zone.

2.5. SPECIAL CONSIDERATIONS

2.5.1. 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 product.

2.5.2. Information to be clarified

Detail information regarding pump duty points and top water levels of reservoirs in Plettenberg Bay (pump information and raw water reservoir information), Harkerville (pump station and reservoir information) and Nature's Valley (pump information) should be clarified. No detail information was available regarding the network layout and operation of the bulk water system in Harkerville and Forest View. This information should be sourced by BM and used to in future update the integrity of the data set.

2.5.3. Data integrity

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 in an attempt to continuously improve the data integrity.

Table BMW 2.1a Existing water system summary - Pipes

Table BMW 2.1b Existing water system summary - WTP's, reservoirs and water towers

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Figure BMW 2.1b Existing water system layout - Kurland & Nature's Valley5

Figure BMW 2.2a Existing distribution zones - Plettenberg Bay & Harkerville6

Figure BMW 2.2b Existing distribution zones - Kurland & Nature's Valley7

3. PRESENT LAND USE AND WATER DEMAND

3.1. METHODOLOGY

The SWIFT program is a link between treasury billing data, and water/sewer network models. (The name is derived from "***S****ewer* ***W****ater* ***I****nterface* ***F****or* ***T****reasury 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 a previous 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 various 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 unit water demand's (UWD's) that might not be applicable to them. The large water users are discussed later in this Chapter.

3.4. DISTRIBUTION ZONES AND ZONAL METER READINGS

3.4.1. General Description

Distribution zones are defined in Section 1.4 of this report.

Sufficient zonal water meter readings were not obtained from the Bitou Municipality due to records either being unavailable or not measured over a sufficient time period or other related inaccuracies. Table BMW3.1 lists the total bulk water meter readings as obtained from the Municipality which represents the water supplied to the entire Bitou Municipality.

3.5. 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.

3.6. SWIFT RESULTS AND RESULTING WATER DEMANDS

3.6.1. Suburb-by-suburb land use and water use statistics

All available treasury data in Bitou 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 BMW3.2.

Figure BMW3.1 shows all the stands coloured in accordance with their land use according to the SWIFT analysis.

3.6.2. Distribution zone land use and water use statistics

Each stand/record was linked or associated via GIS to its specific distribution zone(s) and the same totals and summaries as above were produced per distribution zone and were also broken down into the various land use categories. In this way the TWD per distribution zone was determined. The results are summarised and available in a table in IMQS.

3.6.3. 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.

3.6.4. 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 BMW3.4.

3.6.5. 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.

3.6.6. Theoretical present water demand

The rationalised UWD's and NRW's were applied to all the stands in each land use category of each suburb, as a "theoretical" model of the present water demand situation. For calibration, the resultant "theoretical" total water demand (inc. NRW) for each suburb was compared with the actual water demand (inc. NRW) for the suburb. The results for the formal areas are summarised in Table BMW3.4.

3.6.7. 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 distribution zone in Table BMW2.2 and per suburb in Table BMW3.4.

3.7. LARGE WATER USERS

Table BMW3.5 is a list of the stands defined as large users in SWIFT for BM. The table shows the large water users (> 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 water system.

3.8. WATER DEMAND USED FOR SYSTEM MODELLING

The SWIFT results presented in Section 3.6 were further analysed before populating the water models. The Swift results provide valuable insight into the monthly water use patterns of each individual consumer - information that could be used to accurately estimate the unit water demand for the (fully occupied) existing system water model.

The reasons for further analysing the SWIFT results to obtain input parameters for the water models (in additional to use the SWIFT programme directly) include:

- All treasury records are not linked to the cadastral data (GIS) and neither have the existing links been verified, implying that a portion of the water demand calculated by Swift would be lost if populating the water models directly with the SWIFT result. These records, and especially the large users, were then linked by hand according to their addresses obtained from the treasury data.
- Many of the private developments in the BM have a bulk meter reading for the total development and not for each individual erf in the development. The individual erf is however in the treasury data and SWIFT treated these erven as vacant stands and determines for each erf its potential fully occupied present water demand (inc. NRW). SWIFT then also treats the private development as a large user if the existing AADD is more than 10 kℓ/d. In these cases the potential fully occupied present water demand for the development was calculated by hand and applied to the models.

Table BMW 3.1 Bulk water input6

Table BMW 3.2 Actual water use per suburb and land use (Swift result)7

Table BMW 3.3 NRW analysis summary8

Table BMW 3.4 Theoretical water use per suburb and land use (Swift result)9

Table BMW 3.5 Large water users (>10 kL/d AADD)

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Figure BMW 3.1a Land use per stand - Plettenberg Bay & Harkerville8

Figure BMW 3.1b Land use per stand - Kurland & Nature's Valley9

Figure BMW 3.2a Location of large water users - Plettenberg Bay & Harkerville10

Figure BMW 3.2b Location of large water users - Kurland & Nature's Valley11

4. FUTURE LAND USE AND WATER DEMAND

4.1. FULL OCCUPATION OF EXISTING DEVELOPMENTS

For the future land use and water demand scenario the potential future developments for the area were taken into account (these areas are information supplied by the Planning Directorate of BM).

It was thus not only assumed that all existing but vacant stands in the treasury data would become "occupied", i.e. start using water (as for the existing system), but also that these potential future developments would materialise and start using water.

4.2. POTENTIAL FUTURE LAND DEVELOPMENTS AND WATER DEMAND

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 a development phasing for the following years:

- Next 5 years
- 5 - 10 years
- 10 - 15 years
- After 15 years

The potential future land developments are shown on Figure BMW4.1, coloured according to the land use.

Typical UWD's (per ha or per stand/unit) were estimated for the potential future areas based on previous experience and statistics obtained from the SWIFT analysis of the present water demands.

4.3. FUTURE WATER DEMAND

The future AADD of the BM system is summarised in Table BMW4.2. The future AADD of 34 814 kL/d (modelled as the future system) represents an increase of ± 232 % over the actual present AADD of 10 485 kL/d, and an increase of ± 152 % over the potential fully occupied present AADD of 13 815 kL/d.

Table BMW 4.1 Potential future land developments11

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Table BMW 4.2 Present and future water demand summary12

Figure BMW 4.1a Potential future developments - Plettenberg Bay & Harkerville12

Figure BMW 4.1b Potential future developments - Kurland & Nature's Valley13

5. EVALUATION AND PLANNING CRITERIA

5.1. WATER DEMANDS AND PEAK FACTORS

5.1.1. Planning

The major objectives pursued in the evaluation and planning of the water supply system as presented in this report can be summarised as follows

- Establishing a model of the water 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 of the system with regards to capital -, maintenance - and operational cost.

The future system planning was done so as to satisfy the future water demands. The future AADD of the study area is anticipated to be 34 814 kL/d. This AADD will be realised in the year ± 2050 if the demand increases at a compounded growth rate of ± 4% per year (30 - 35 year planning horizon).

At a lower growth rate of 2,0 to 2.5% this AADD will be realized in the year 2070 to 2080 (50 to 60 years planning horizon).

5.1.2. Present and future AADD's

Existing systems were evaluated on the basis of the existing AADD as documented, including NRW.

For planning of future systems it was accepted that all existing vacant stands are occupied and are using water in accordance with the assumed UWD's, and AADD's of all potential future developments were added.

5.1.3. Peak factors

The peak factors used for this study are dependent on type of land use in the area under consideration, and the magnitude of water demand in the area, and are summarised in Table BMW5.1.

These peak factors are based on factors measured and obtained from other previous studies in South Africa.

5.2. OPERATIONAL CRITERIA

5.2.1. Maximum and minimum pressures

The pressure criteria used for the evaluation and planning of the reticulation networks are listed in Table BMW5.2.

5.2.2. Fire fighting flows

Fire fighting flow and pressure criteria are listed in Table BMW5.2. The requirements are more or less in conformity with those prescribed by the latest version of the so-called "Red Book" (The Neighbourhood Planning and Design Guide - Dept. of Human Settlements, July 2019).

5.2.3. Flow velocities

Flow velocities must be limited in order to protect pipeline coatings and reduce the effects of water hammer. The preferred maximum allowed is 1,5 m/s, but velocities of up to 2,0 m/s may be acceptable if only intermittent peak flows occur.

5.2.4. Pump stations

Pump stations (PS) should always have one standby pump available. An electrically driven standby pump should suffice except in the case of high-risk areas, where the standby pump should be diesel-driven.

5.2.5. Redundancy

Within distribution networks to end-users, branched systems should be avoided as far as possible, i.e. there must be at least two directions of flow to a consumer. For bulk supply systems branched portions may be acceptable, due to the role of reservoirs, and redundancy refers more to the level of integration in the system.

5.3. RESERVOIR SUPPLY RATES AND STORAGE CAPACITIES

Reservoirs in the system serve two main functions:

- Emergency storage, including that required for fire fighting, to provide sufficient water when a supply failure occurs.
- Balancing storage, required to balance out peaks in the demand.

For initial assessment of reservoir size these two functions are viewed integrally. The criteria for total reservoir volume used in this study for evaluation and planning is 48 hours of the AADD (of the reservoir supply zone) for all the towns in the BM for gravity and pumped supply to the reservoir. It is noted that this could represent as little as 8 to 12 hours' storage of the peak day demand for high-peak consumers such as small coastal holiday areas.

The volume required for the balancing function is dependent on the supply rate to the reservoir and is therefore closely related to the capacity of the feeder main to the reservoir.

In some cases where capacity appears to be a problem the relationship between balancing storage in a reservoir and the supply to the reservoir is dealt with as follows in order to optimise the system by means of time simulation:

- For new reservoirs, the optimum combination of supply rate and balancing volume was determined.
- For existing reservoirs, any excess capacity was utilised as balancing storage, in order to minimise the required supply rate and thus also the load on the system supplying the reservoir.
- For existing reservoirs with limited capacity for balancing, an economic analysis was done in order to determine whether to increase the supply rate to the reservoir so that the balancing load is minimised, or whether to increase the storage capacity.

Balancing storage is an analytical exercise based on time simulation, but in contrast the emergency storage is a matter of perception and subjective assessment of the risk of non-supply of water. It is often not necessary to provide more than 30 h x AADD emergency storage in a reservoir (in addition to balancing storage), unless there are specific conditions or risks to justify a larger storage.

These criteria are summarized in Table BMW5.3.

The risk of interruption of bulk water supply to Kranshoek, Wittedrift, Green Valley and Keurboomstrand is relatively high due to the fact that it is supplied mainly from one source and that it has a relatively long pipeline between that source and the town. The 30 h x AADD that was provided as emergency storage in the reservoirs for these areas should however be sufficient.

5.4. WATER TOWER SUPPLY RATES AND STORAGE CAPACITIES

Seven water towers are present in the existing system of Plettenberg Bay viz. Kranshoek Steel and Concrete water towers, Kwanokuthula New and Old water towers, Town Upper and Lower water towers and the Green Valley elevated tank.

Water towers serve merely to sustain pressure in a network, and should not be regarded as facilities for balancing peaks and for emergency supply. Because of their relatively small volumes, the supply rates to towers must be such that they can be kept full at all times. On the other hand, volumes must be large enough to allow room for operation of pumps filling the tower (where applicable) such that the number of pump cycles per day is limited. The following guidelines as summarised in Table BMW5.3 were used for evaluation and planning of water towers:

- Supply rate into tower - 1,0 to 1,1 x PHF x AADD
- Tower storage - 2 h to 6h x AADD

5.5. 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 the planning done for this study it was strived to utilise the excess capacities in existing facilities to its economically viable maximum.

5.6. 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 Table BMW5.4.

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 BMW 5.1 Design and evaluation criteria - Peak factors for water demand13

Table BMW 5.2 Design and evaluation criteria - Flow and pressure14

Table BMW 5.3 Design and evaluation criteria - Reservoirs and bulk supply15

Table BMW 5.4 Cost functions (Year 2019/20 Rand value, excluding P&G, contingencies, fees and VAT)16

6. EVALUATION AND MASTER PLAN

6.1. EXISTING SYSTEM

6.1.1. Overview

The results of the existing system analysis are presented in the following figures:

- Figure BMW6.1 shows the static pressures in each system, thus the maximum pressure that could be expected in the system at any time.
- Figure BMW6.2 shows the residual pressures in each system under peak hour demand conditions.
- Figure BMW6.3 shows the flow velocity in each system under peak hour demand conditions.

The results of the existing system water network analysis and the evaluation of these results are discussed separately for each system in the following sections.

6.1.2. Discussion

Plettenberg Bay

The static analysis indicates areas in the network where pressures are below 24 m and above 90 m. The most significant areas where the static pressures are below 24 m are the northern areas of Kranshoek, the higher lying areas of the Quarry reservoir zone, the areas closest to the Town reservoir in the Town reservoir zone, the western part of New Horizon, the higher lying areas in the Kwanokuthula tower zone and the higher lying areas of the Green Valley tower zone. These low static pressures are due to the topography of the area. There are however 2 booster pump stations in private developments in the Quarry reservoir zone to improve the low static pressure in this zone.

The most significant areas where the static pressures are above 90 m is the lower lying areas adjacent to the Piesang River in the Town reservoir, New Horizon reservoir and Schoongezicht PRV zones. The eastern area of the Whale Rock reservoir zone experience static pressure of between 60 m and 90 m.

The residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 90m range, except for the areas that already do not have sufficient static pressures.

There are a few pipes in the Town reservoir zone which have a velocity under peak hour demand conditions which exceeds 1,5 m/s. These high flow velocities are due to the relative small diameters of the supply pipelines in the area. A 75 mm Ø reticulation pipe in the Keurview reservoir zone experiences a flow velocity of more than 1,5 m/s if water is pumped through the network towards the Keurview reservoir.

The following bulk supply pipes have flow velocities which exceeds 1.5 m/s:

- The flow velocity in the 300 mm Ø so-called Kwanokuthula supply from the Plettenberg Bay WTP to the Archiewood and New Horizon & Kwanokuthula reservoirs is above 1,8 m/s between the Plettenberg Bay WTP and Archiewood reservoir when the inflow into the reservoirs are not controlled.
- The 200 mm Ø section of the Kwanokuthula supply pipeline from the New Horizon reservoirs to the Kwanokuthula East reservoirs experience a flow velocity of more than 2,0 m/s.
- The flow velocity in the 315 mm Ø so-called New Horizon supply from the Plettenberg Bay WTP to the New Horizon reservoirs is marginally above 1,5 m/s. The flow velocity in this pipeline will however decrease to 1,2 m/s when water is pumped through this pipeline to the Kwanokuthula West reservoir (after construction of the 315 mm Ø

pipeline from New Horizon towards the Kwanokuthula West reservoir is completed and the pipeline is commissioned).

- The flow velocity in the 200 mm Ø supply pipe between the Brakkloof reservoir and Whale Rock reservoir is above 2,0 m/s when the inflow into the Whale Rock reservoir is not controlled.
- The 250 mm Ø portion of the newly constructed supply pipeline from Brakkloof reservoir to Kranshoek reservoir currently experiences a flow velocity of more than 2,2 m/s. This is however only a temporarily supply to Kranshoek and this pipeline will in future form part of the reticulation system (after the proposed Roodefontein Upper reservoir is constructed and commissioned).
- The flow velocity in the 100 mm Ø feeder main between the Kranshoek Towers PS and the Kranshoek towers is more than 2,2 m/s. BM has however indicated that upgrading of this pipeline is in progress.
- The flow velocity in the 200 mm Ø feeder main between the Kwanokuthula West PS and the Kwanokuthula Upper tower is more than 2,2 m/s.
- The 400 mm Ø raw water pipeline from the Roodefontein dam towards the Roodefontein raw water reservoir and PS can experience a flow velocity of more than 1,8 m/s if flow to the reservoir is not controlled.
- The 500 mm Ø raw water pipeline from the Keurbooms River raw water reservoirs towards the Plettenberg Bay WTP can experience a flow velocity of more than 1,8 m/s if flow to the WTP is not controlled.

Kurland

The static analysis indicates no areas where pressures exceed 90 m.

The residual pressures in the existing system under peak hour demand conditions are marginally below 24m for the biggest part of Kurland.

The only pipe with a flow velocity exceeding 1,5 m/s in the system is the 100 mm Ø supply pipe where the 200 mm Ø bulk main from the Kurland reservoirs reduces to a 100 mm Ø pipe before it reaches the Kurland distribution zone. The velocity in this pipe exceeds 2.0 m/s.

Nature's Valley

The static analysis indicates no areas where pressures exceed 90 m.

The residual pressures in the existing system under peak hour demand conditions are in the 24m to 90 m range, which is in the range of the adopted design criteria.

There are no pipes with velocities exceeding 1,5 m/s in the system.

Harkerville

No information with regards to Harkerville reticulation system was available when the report was compiled.

6.1.3. Replacement value

Table BMW6.1 gives an estimate of the replacement value of the existing Bitou system, based on the cost functions shown on Table BMW5.4. This amounts to a total of R 1 351,4 million for the entire BM.

6.2. EXISTING BULK SUPPLY SYSTEM

Table BMW6.2 is a summary of the reservoir and feeder evaluation of the existing system. For each reservoir it shows:

- The present AADD of the zone(s) served by the reservoir, which might include a PRV or booster zone.
- The volume of the reservoir, in relation to the AADD served by the reservoir (expressed as h x AADD). The available balancing volume is the total volume minus the required 30 h x AADD emergency volume. If this is more than 18 h x AADD, the surplus is regarded as "spare" capacity.
- The feeder mains to the reservoir, and their capacities expressed as a ratio of the AADD served by the reservoir. Feeder main capacities have been estimated based on a maximum flow velocity of 1,8 m/s, and not on the actual hydraulic capacity. The required flow of feeder mains is also listed, based on the amount of balancing storage available, and the peak factors and pattern of demand in the reservoir zone. Where the feeder capacity exceeds the required flow, a "spare" capacity is indicated. Feeder mains with a negative "spare" capacity are deficient.

6.2.1 Reservoirs

Evaluated on a town-for-town basis, Plettenberg Bay, Kurland and Nature's Valley have sufficient reservoir storage in all of its zones and requires no additional storage. The total reservoir storage capacity for Plettenberg Bay is 129 h x AADD supplied, for Kurland it is 67 h x AADD supplied and for Nature's Valley it is 84 h x AADD supplied.

In the larger Plettenberg Bay system the Kranshoek reservoir has only 33 h x AADD supplied reservoir storage capacity. This is however not a concern as Kranshoek is supplied from the 2x towers (supplied from the reservoir) which have sufficient spare storage capacity available.

The existing 430 kL Kwanokuthula Lower tower had a leak and is currently not in use. The leak was however recently repaired and the tower should now be re-commissioned.

The condition of the existing 600 kL reservoir in Nature's Valley is in a bad state of repair and should be replaced.

Minimal information was available regarding the Harkerville system to evaluate the reservoir storage capacity, but from the information available it appears that the existing 500 kL Harkerville reservoir has more than sufficient storage capacity available.

6.2.1. Feeder mains

In the Plettenberg Bay system there are a few feeder mains with flow velocities above 1,8 m/s as described in paragraph 6.1.2. Of these feeder mains only the 100 mm Ø pipe to the Kranshoek towers has insufficient capacity and should be upgraded (upgrading of this pipeline is however in progress).

Other pipes in the Plettenberg bulk system with insufficient capacity is the existing 160 mm Ø feeder main between the Kwanokuthula East PS and the Kwanokuthula West reservoir for a scenario where the total bulk water of Kranshoek is supplied from the Kwanokuthula East reservoir to the Kwanokuthula West reservoir and Upper tower through this pipeline. A second supply to the Kwanokuthula West reservoir and Upper tower is however currently under construction which will alleviate pressure on this pipeline.

The following feeder mains are near capacity and should be upgraded in the near future:

- The 150 mm Ø section of the bulk supply from the Town reservoirs A & C to Matjiesfontein reservoir. Bulk supply to Matjiesfontein is however currently augmented through the network of the Goose Valley reservoir zone through a 250 mm Ø pipe (part of the Goose Valley reservoir network) that runs parallel to the existing 150 mm Ø pipe).

- The 90 mm Ø bulk supply pipe towards Wittedrift and Green Valley.
- The 63 mm Ø bulk supply pipe from the Wittedrift to Green Valley.

All the other feeder mains in BM have sufficient capacity.

6.2.2. Pumping stations

Kwanokuthula is currently supplied through only the Kwanokuthula Upper (New) tower as the Lower (Old) tower was out of operation due to the has a leak. In the case where the entire supply to Kwanokuthula is from the Kwanokuthula West pump station, the capacity of the pump station is insufficient to supply peak hour demand to the tower.

The Green Valley PS has insufficient capacity. This is mainly due to insufficient conveyance capacity in the bulk pipeline between Wiittedift and Green Valley.

The existing Kranshoek reservoir to Kranshoek tower pumps have sufficient capacity only when both pumps run simultaneously (no stand-by pump). It is recommended that pump stations should always have one stand-by pump available. The new pumps at Kranshoek reservoir has been sized for the future scenario, where a portion of the Kranshoek tower zone will rezoned into the Roodefontein Upper reservoir, subsequently lowering the pumping capacity required at Kranshoek reservoir. Therefore, no additional pumps will be proposed at Kranshoek reservoir, as they would become redundant in the future. However, the implementation of the master plan should be prioritised to ensure stand-by pump capacity is secured for the Kranshoek tower zone.

The capacities of the pumps at the Tower reservoir to the Upper and Lower towers, the pumps at Kwanokuthula East PS, the pumps in Keurboomstrand as well as the pumps in Nature's Valley is unknown and may possibly require upgrading.

6.3. MASTER PLAN - PLETTENBERG BAY

6.3.1. Proposed distribution zones

The proposed distribution zones are indicated on Figure BMW6.4a.

The changes to the existing distribution zones are the following:

- The boundaries between the existing Brakkloof reservoir zone and the Town PRV 4 zone are adjusted in order to improve network conveyance and redundancy.
- The Town PRV 4 zone, supplied with water from the Town Reservoirs, is increased to include future development areas P18 to P24.
- The boundaries between the existing Brakkloof reservoir zone and the Whale Rock reservoir zone are adjusted. It is proposed that the existing Whale Rock reservoir zone is augmented with water from the Quarry reservoir zone through a PRV (at the position of the old decommissioned Quarry BPT). Future development areas P16 & P17 are accommodated within the existing Whale Rock reservoir zone.
- The Brakkloof reservoir zone is increased to include the lower lying areas of future development area P14.
- The Quarry reservoir zone is increased to include future development areas P13 & P15 as well as the higher lying areas of future area P14.
- Two new zones are proposed for the future development areas between Kranshoek and the Quarry reservoir, viz. the new Roodefontein Upper and Lower reservoir zones. It is proposed that the Roodefontein Upper reservoir zone supplies the future development areas P4 - P6, P97, P98 and the higher lying areas of future area P7, while the Roodefontein Lower reservoir zone supplies the lower lying areas of future development area P7 as well as future areas P8, P10 and P12.
- The boundary of the Kranshoek tower zone is adjusted so that the higher lying area to the north of the zone is incorporated in the proposed Roodefontein Upper reservoir zone.
- The boundary of the Town Upper tower zone is increased to accommodate future development area P51.

- The boundary of the Archiewood and Brackenridge reservoir zone is increased to accommodate future development areas P25, P40, P52, P53, P101, P102 and the lower lying erven of area P94.
- A new Archiewood PRV 2 zone is proposed for when future development area P43 develops, supplied with water from the Archiewood reservoir through a new PRV.
- A new Piesang Valley PRV zone is proposed for when future development area P46 develops, supplied with water from the Archiewood reservoir through a new PRV.
- It is proposed that the existing Kwanokuthula tower zone (which is currently supplied with water only from the Upper tower because the Lower tower was taken out of operation due to a leak) is supplied in future from only the Upper tower. An emergency valve (to be closed) is proposed between the supply from the Lower tower and the existing Kwanokuthula network. The zone boundary of the Kwanokuthula Upper tower zone is increased to accommodate future areas P31 - P35 & P90.
- A new Kwanokuthula reservoir zone (supplied from the existing Kwanokuthula East (Lower) reservoirs) is proposed for the lower lying areas of future development areas P27 & P28 as well as future area P26.
- A new Kwanokuthula Lower tower zone (supplied from the existing Kwanokuthula East (Lower) tower) is proposed for the higher lying areas of future development areas P27 & P28 as well as future areas P29 & P30.
- A new tower (proposed New Horizon tower) is proposed next to the existing New Horizon reservoirs in order to accommodate future development areas P35 & P91. It is proposed that the higher lying erven in New Horizon (that is currently accommodated within the New Horizon reservoir zone) is incorporated in the proposed New Horizon tower zone. This will improve the low static pressure that exists currently within the higher lying erven in New Horizon.
- The boundary of the New Horizon reservoir zone is increased to accommodate future development areas P36, P44, P45 and P47 - P50, P92 and the higher lying erven of area P94.
- A new Goose Valley booster zone is proposed for the higher lying areas of future development area P60.
- The boundary of the Goose Valley reservoir zone is increased to accommodate future development areas P56, P58, the lower lying areas of P60 as well as future areas P64 - P69.
- The boundary of the Matjiesfontein reservoir zone is increased to accommodate future development areas P71 - P82 & P104.
- A new Keurboomstrand Upper reservoir zone (supplied from the existing Keurboomstrand reservoir) is proposed for future development areas P85 - P87.
- A new Keurboomstrand Upper booster zone (supplied from the proposed Keurboomstrand Upper reservoir) is proposed for future development areas P83 & P84.
- Three new distribution zones are proposed for the Hanglip, Roodefontein and Ganse Valley Estates.
- The boundary of the Wittedrift reservoir zone is increased to accommodate future development areas P61 - P63 & P99.
- A new Green Valley booster zone is proposed for when the higher lying future area P100 develops in Green Valley. It is proposed that this booster zone is supplied with water from a new Green Valley reservoir.
- It is proposed that the existing Green Valley reservoirs and elevated tank are decommissioned and that the existing Green Valley reservoir and tower zones are supplied from the new Green Valley reservoir when it is commissioned. Two new PRV's are proposed to reduce static pressures at the lower lying erven when these erven are incorporated within the proposed new Green Valley reservoir zone.
- Future area P54 should be accommodated within the existing Town Reservoir zone and future area P55 within the existing Town PRV 1 zone.

6.3.2. Proposed future system and required works

The existing Bitou water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure BMW6.5a.

The most significant upgrades of the existing distribution system is the alteration of the existing zone boundaries between the Town PRV 4, Brakkloof reservoir and Whale Rock reservoir zones and the implementation of the New Horizon tower zone together with the alteration of the zone boundary of the New Horizon reservoir zone in order to improve operation of the existing system.

The alteration of the existing zone boundaries between the Town PRV 4, Brakkloof reservoir and Whale Rock reservoir zones will improve network conveyance and redundancy in the system.

The alteration of the zone boundary of the New Horizon reservoir zone together with the implementation of the New Horizon tower zone will improve the low static pressures that is currently experienced in the higher lying erven of the New Horizon reservoir zone.

A new PRV is proposed at the position of the existing Quarry BPT (that is decommissioned) in order to improve the capacity of the existing system to provide fire flow to Robberg Estate and Whale Rock Beach.

A number of distribution pipelines are also required to reinforce water supply within the Plettenberg Bay distribution network and supply future development areas when they develop.

6.3.3. Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table BMW6.5 is a summary of the reservoir and feeder evaluation of the future system for the future water demand.

Water Treatment Plants

Investigation of, and comments on the sufficiency of the existing water sources, the raw water bulk supply system or the capacity of the existing water treatment plants are beyond the scope of this study.

The following information is however relative to the Water Master Plan:

The Plettenberg Bay WTP has a current treatment capacity of 27,0 ML/d. During peak demand conditions water supply can be augmented from groundwater abstraction and through desalination. The existing desalination plant has a capacity of 2,0 ML/d. BM has indicated that they plan to upgrade the capacity of the 2,0 ML/d desalination plant to a future capacity 7,0 ML/d. Provision was made in the Water Master Plan to transfer a capacity of 7,0 ML/d from the Bitou desalination plant to the Brakkloof and Town reservoirs where the bulk water can be distributed through the rest of the bulk system or the reticulation system.

The safe yield of the boreholes in Kwanokuthula and New Horizon (boreholes 3, 6, NH, GWA1C, GWA5, GWA6 & GWA10) is 3 542 kL/d. Provision is made in the Water Master Plan for a raw water system (project BPW-046) in order to collect raw water from these boreholes and conveyed it to the Kwanokuthula East reservoir site.

If the quality of the raw water is too poor to mix it with the potable water from the Kwanokuthula East reservoirs, it is proposed that the raw water is collected at a raw water reservoir and transferred to the Plettenberg Bay WTP where it should be treated to potable standard (project BPW-051).

The safe yield of the Golf course boreholes (boreholes GWA8C & GWA9) and the WTW borehole (WTW3) is 2 074 kL/d. Raw water from these boreholes is pumped to the Plettenberg WTW where it is treated before it is distributed to the reticulation system.

The Airport borehole has a safe yield of 156 kL/d. Raw water from this borehole is pumped to the Brakkloof reservoir where the raw water is blended with the potable water.

The future AADD for the Plettenberg system is calculated at ± 33,0 ML/d. At a peak factor of 1.65 x the AADD, the future treatment capacity for the Water Master Plan is calculated at ± 54,5 ML/d. In addition to this provision is made in the Plettenberg Bay bulk system to supply ± 1,3 ML/d of treated water from the Matjiesfontein reservoir to the Kurland system in future (see section 6.4 further on in the report). The required treatment capacity of the future Plettenberg system is therefore ± 55,8 ML/d.

The required treatment capacity of the Plettenberg Bay WTP is calculated at ± 45,3 ML/d for the future Plettenberg Bay system for a scenario where the Bitou desalination plant is upgraded to a capacity of 7,0 ML/d and the raw water from the Kwanokuthula and New Horizon boreholes (safe yield of 3,5 ML/d) can be treated at the Kwanokuthula East reservoir site (or alternatively be blend with the potable water from the Kwanokuthula East reservoir).

The required treatment capacity of the Plettenberg Bay WTP will however increase to 48,8 ML/d if the quality of the raw water from the Kwanokuthula well field is so that it should be treated at the Plettenberg Bay WTP.

For the analysis of the future Plettenberg Bay bulk system it was assumed that the Plettenberg Bay WTP and desalination plant will in future be able to supply peak day demand to the system.

Reservoirs

A new 2,8 ML reservoir (item BPW13.6) with a TWL of 140 m a.s.l. is proposed for the proposed Ganse Valley Golf Estate (future area P59). This reservoir should be filled through a pump station and accompanying rising main from a sump with a controlled inflow in order to sustain the pressure in the upstream reticulation network. This is seen as private infrastructure for the cost of the developer of future area P59.

Additional reservoir storage capacity of 3,5 ML and additional capacity at the Upper tower of 500 kL are proposed at the existing Kwanokuthula West (Upper) reservoir site to accommodate future developments (items BPW.B62 & BPW.B63). The reservoir and tower will be required when the water demand for the Kwanokuthula West (Upper) tower zone exceeds 2 000 kL/d.

It is proposed that a new 500 kL tower with a proposed TWL of 210 m a.s.l. (item BPW.10.4) is constructed in order to accommodate future development areas P35 & P91. This new tower will also be required to provide sufficient pressure to the higher lying erven in New Horizon.

Additional reservoir storage capacity of 3,5 ML is proposed at the existing Kwanokuthula East (Lower) reservoir site to accommodate future developments (item BPW.B28). The reservoir will be required when the water demand for the Kwanokuthula East (Lower) reservoir and tower zones exceeds 1 500 kL/d.

A new 1,6 ML reservoir (item BPW1.23) with a TWL of 135 m a.s.l. is proposed for the proposed Roodefontein Golf Estate (future development P11). This reservoir should be filled from a sump with a controlled inflow in order to sustain the pressure in the upstream reticulation network. This is seen as private infrastructure for the cost of the developer of future area P11.

It is proposed that the existing Green Valley reservoirs and elevated tank are replaced with a new higher lying 1,25 ML reservoir (item BPW.B74, TWL of 138 m a.s.l.). The existing reservoirs and elevated tank can be decommissioned.

A new 2,8 ML reservoir (item BPW.B94) with a TWL of 185 m a.s.l. is proposed for the proposed Hanglip Golf Estate (future area P70). This reservoir should be filled through a pump station and accompanying rising main from a sump with a controlled inflow in order to sustain the pressure in the upstream bulk supply system. This is seen as private infrastructure for the cost of the developer of future area P70.

When additional storage capacity is required for the Matjiesfontein reservoir zone, a new 2,0 ML reservoir should be constructed at the existing Matjiesfontein reservoir site (item BPW.B53).

A new 0,6 ML Keurboomstrand Upper reservoir (item BPW.B51) with a TWL of 160 m a.s.l. is proposed for the future Keurboomstrand Upper reservoir zone and the Keurboomstrand Upper booster zone.

A new 3,5 ML Roodefontein Lower reservoir with a TWL of 175 m a.s.l. is proposed for the future Roodefontein Lower zone (item BPW.B3).

A new 7,0 ML Roodefontein Upper reservoir with a TWL of 215 m a.s.l. is proposed for the future Roodefontein Upper zone (item BPW.B6). Construction of this reservoir can be phased.

A new 1,0 ML raw water reservoir (item BPW.B10) is proposed on the Kwanokuthula East reservoir site to collect raw water from the Kwanokuthula well field. The safe yield of the boreholes is ± 3,5 ML/d (balancing volume of the reservoir is ± 7 hours x the safe yield of the boreholes). A more detailed study will however be required regarding the size (and requirement) of the raw water storage reservoir and if the quality of the raw water is such that it can be blend with the potable water from the Kwanokuthula East reservoir.

Feeder mains

The following feeder mains require upgrading in future:

- It is proposed that the Archiewood and Brackenridge reservoirs are supplied in future with water only through the existing 200/250 mm Ø pipeline that currently supplies the Town Tower reservoir with water from the Plettenberg Bay WTP. This will alleviate pressure on the so-called “Kwanokuthula” pipeline and consequently improve bulk water supply to the Kwanokuthula East (Lower) reservoir. It is proposed that the 200 mm Ø section of this pipeline between the Plettenberg Bay WTP and the Town Tower reservoir is increased to a 315 mm Ø pipeline (item BPW.B1).
- Upgrading of the 100 mm Ø feeder main between the Town Tower reservoir and the Town Lower & Upper towers (item BPW.B24).
- The existing 200 mm Ø section of the so-called “Kwanokuthula” rising main (between the New Horizon reservoirs and the Kwanokuthula East (Lower) reservoirs) should be reinforced with a new 315 mm Ø rising main when supply from the Plettenberg Bay WTP pump station to Kwanokuthula reached capacity (item BPW.B27).
- Upgrading of the feeder main to the Kwanokuthula West (Upper) tower(s) when the proposed second 500 kL tower is constructed (part of item BPW.B63).
- Upgrading of the feeder main to the Kwanokuthula East (Lower) pump station (item BPW.B29).
- Upgrading of the 200 mm Ø bulk pipe from the WTP PS to the Town reservoir A (item BPW.B77).
- Upgrading of the 90 mm Ø feeder main to Wittedrift reservoir (item BPW.B71).
- Upgrading of the bulk system from the Town reservoirs A & C to the Matjiesfontein reservoir. This bulk system comprises of 4 discreet sections, i.e. section 1 (150 & 315 mm Ø pipelines from the Town reservoirs to opposite the Turtle Creek Golf Estate where the 315 mm Ø pipeline ends), section 2 (150 mm Ø pipeline from opposite the Turtle Creek Golf Estate to the draw-off to Wittedrift & Green Valley at the Rietvlei Road), section 3 (150 mm Ø pipeline along the N2 from the Rietvlei Road to before the

bridge over the Keurbooms River) and section 4 (200 mm Ø pipeline from the bridge over the Keurbooms River to the Matjiesfontein reservoir). It is proposed that section 2 of this bulk system is reinforced with a new 355 mm Ø pipeline (item BPW.B39), section 3 with a new 355 mm Ø pipeline (item BPW.B67) and section 4 with a parallel 315 mm Ø pipeline (item BPW.B47).

- The existing 250 & 300 mm Ø rising mains from the Plettenberg Bay WTP to the Brakkloof reservoir should be augmented when supply problems to the Brakkloof reservoir are experienced. It is proposed that the "old" 300 mm Ø AC pipe is replaced with a new 450/400 mm Ø pipeline (item BPWB17). The "old" 300 mm Ø should then be utilized as a dedicated supply pipe to transfer potable water from the desalination plant to the Brakkloof and Town reservoirs.
- Upgrading of the 100 mm Ø feeder main between the Kranshoek reservoir and the Kranshoek towers (upgrading of this pipeline is currently in progress).
- Upgrading of the 200 mm Ø bulk pipe from the Bitou desalination plant to the existing 300 mm Ø bulk pipeline between the Plettenberg Bay WTP and the Brakkloof reservoir (item BPW.B37).

The following new feeder mains will be required in future:

- Commission the rising main from the so-called "New Horizon" pipeline towards the Kwanokuthula West (Upper) reservoir and tower (item BPW.B59).
- New 200 mm Ø feeder main from the Archiewood reservoir reticulation network to the proposed Ganse Valley Estate (item BPW13.3).
- New 200 mm Ø feeder main from the Town PRV 4 reticulation network to the proposed Roodefontein Golf Estate (item BPW1.17).
- New 160 mm Ø feeder main from the existing Green Valley bulk PS to the proposed higher lying Green Valley reservoir (item BPW.B73).
- New feeder main to the proposed Green Valley booster pump station.
- New 200 mm Ø feeder main from the bulk system between the Town reservoirs and Matjiesfontein to the proposed Hanglip Golf Estate (item BPW.B45).
- New 110 mm Ø rising main from the Keurboomstrand Lower reservoir to the proposed Keurboomstrand Upper reservoir (item BPW.B50).
- New feeder main to proposed Keurboomstrand Upper booster pump station.
- New feeder main to the proposed Goose Valley booster pump station.
- New 315 mm Ø rising main between Roodefontein Lower and Upper reservoirs (item BPW.B5).
- New 200 mm Ø raw water pipeline from the Kwanokuthula East reservoir site to the Plettenberg Bay WTP (item BPW.B11).
- New 200 mm Ø feeder main from the New Horizon PS to the proposed New Horizon tower (item BPW10.3).

Pumping stations

The following pump stations require upgrading in future:

- A back-up pump is proposed for the existing High Lift pump at the Plettenberg WTP PS in order to improve the redundancy of the supply to New Horizon and Kwanokuthula West (Upper) reservoirs (item BPW.B58).
- Upgrading of the Kwanokuthula East (Lower) PS in order to improve supply to the Kwanokuthula East (Lower) tower (item BPW.B18) and to the Kwanokuthula West (Upper) reservoir (item BPW.B31).
- Upgrading of the Kwanokuthula West (Upper) PS in order to augment supply to the Kwanokuthula West (Upper) tower when the proposed second 500 kL Upper tower is constructed (item BPW.B60).
- Upgrading of the pumps at the Plettenberg WTP that pumps to the Town Tower and Brackenridge reservoirs is proposed if supply problems are experienced when future area P59 develops (item BPW.B32).
- Upgrading of the pumps at the Town Tower reservoir pumping to the Town Lower & Upper towers is proposed if supply problems are experience (item BPW.B23).
- Upgrading of the pumps at the WTP PS that pump towards the Town reservoir A (item BPW.B76).

- Upgrading of the Green Valley pump station (item BPW.B72).
- Upgrading of the pumps at the Plettenberg WTP that pumps to the Brakkloof reservoir (item BPW.B16).
- Upgrading of the pumps at the Brakkloof PS that pumps to the Quarry reservoir (item BPW.B9).
- Upgrading of the Kranshoek reservoir to Kranshoek towers pump station (this project is currently in progress).
- Upgrading of the pumps at the Bitou desalination plant bulk PS (item BPW.B36).

The following new pump stations are proposed:

- New pump station to supply bulk water from the Archiewood reservoir zone to the proposed Ganse Valley Estate reservoir (item BPW13.5). This is seen as private infrastructure for the cost of the developer of future area P59.
- New pump station to supply bulk water from the Town PRV 4 zone to the proposed Roodefontein Golf Estate reservoir (item BPW1.19). This is seen as private infrastructure for the cost of the developer of future area P11.
- New booster pump station to Wittedrift (item BPW.B41a).
- Upgrading of the booster pumps to Wittedrift when required (BPW.B41b)
- New Green Valley booster pump station (item BPW.B75).
- New pump station to supply bulk water to the proposed Hanglip Golf Estate reservoir (item BPW.B93). This is seen as private infrastructure for the cost of the developer of future area P70.
- A new booster pump station to augment bulk water supply to Matjiesfontein reservoir (item BPW.100). This pump station should only be constructed after sections 2, 3 & 4 of the bulk system from the Town reservoirs to the Matjiesfontein reservoir is implemented.
- Decommission the existing booster pumps (inside the pipeline) towards the Keurboomstrand reservoir (item BPW.B48.3) and replace with a new pump station (item BPW.B48.1).
- New pump station at Keurboomstrand reservoir to proposed Keurboomstrand Upper reservoir (item BPW.B49).
- New Keurboomstrand Upper booster pump station (item BPW.B52).
- New pump station at proposed Roodefontein Lower reservoir to proposed Roodefontein Upper reservoir (item BPW.B4).
- New Goose Valley booster pump station (item BPW.B35).
- New pump station on the New Horizon reservoir site for the proposed New Horizon tower (item BPW10.1).

Other considerations

The following additional upgrades to the bulk water system and comments regarding the phasing of projects are proposed:

- New flow control valve at the New Horizon reservoir inlet (on the "New Horizon" pipeline) in order to sustain pressure in the bulk pipeline towards the Kwanokuthula West (Upper) reservoir (item BPW.B2).
- The capacity of the existing bulk system to supply water to Kwanokuthula and New Horizon after project BPW-002 ("Kwanokuthula West (Upper) reservoir bulk supply upgrades") is implemented and the supply to the Brackenridge reservoir from the Kwanokuthula pipeline is closed (part of project BPW-011) is calculated at 14,1 ML/d. This can be attributed 2,2 ML/d to the New Horizon reservoir (depending on the setting of the proposed flow control valve at the reservoir inlet), 7,3 ML/d to the Kwanokuthula East (Lower) reservoir and 4,6 ML/d to the Kwanokuthula West (Upper) reservoir respectively.
- It is proposed that supply to the Kwanokuthula East (Lower) reservoir is augmented through the implementation of project BPW-048 ("Kwanokuthula East (Lower) reservoir bulk supply upgrades") when the combined AADD for Kwanokuthula exceeds 6,5 ML/d.

- It is proposed that supply to the Kwanokuthula West (Upper) reservoir is augmented through the implementation of project BPW-019 ("Kwanokuthula West (Upper) reservoir bulk supply augmentation (Longer term upgrades)") when the AADD for the Kwanokuthula West (Upper) tower zone exceeds 3,0 ML/d. Project BPW-019 entails that both the so-called "New Horizon" and "Kwanokuthula" bulk pipelines discharge into the Kwanokuthula East (Lower) reservoirs and that water is then pumped from the Kwanokuthula East PS to the Kwanokuthula West reservoir through the existing 315 mm Ø pipeline.
- New flow control valve at the Town Towers reservoirs inlet (on the pipeline from the WTP to the Town Tower reservoir to the Brackenridge reservoir) in order to sustain pressure in the upstream bulk system (item BPW.B22).
- New flow control valve (item BPW.13.4) at the pipeline from the Archiewood reservoir reticulation network to the proposed Ganse Valley Estate (future area P59) in order to sustain pressure in the upstream reticulation network.
- New flow control valve at the Whale Rock reservoir inlet (on the 200 mm Ø pipeline from the Brakkloof reservoir) in order to sustain pressure in the upstream system (item BPW2.4).
- The Kranshoek reservoir is currently supplied from the Brakkloof to Roodefontein Lower pipeline (newly constructed 400 mm Ø pipeline) through a newly constructed 250 mm Ø pipeline in Trekkers Street (between the position of the proposed Roodefontein Lower reservoir and the Kranshoek reservoir). This pipeline will however in future form part of the Roodefontein Upper reservoir network and it is therefore proposed that the Kranshoek reservoir is supplied through the old 150 mm Ø Brakkloof to Kranshoek supply pipeline. An inter-connection between the old 150 mm Ø pipe and the newly constructed 400 mm Ø pipe is proposed in order to re-commission the old 150 mm Ø pipe as part of the bulk system (item BPW.B33).
- It is proposed that the existing Green Valley reservoirs and elevated tank are decommissioned and that the existing reservoir distribution zone is supplied via 2x PRVs from the proposed higher lying new Green Valley reservoir. The higher lying areas previously supplied through the elevated tank should be accommodated within the new reservoir zone (items BPW21.1 to BPW21.4).
- It is proposed that bulk supply to Wittedrift and Green Valley is upgraded in 3 phases. The first phase is a new booster pump station (item BPW.B41a) on the existing 90 mm Ø bulk pipeline to Wittedrift. This will augment the capacity of the system from ± 285 kL/d to ± 550 kL/d. The second phase is the replacement or augmentation of the existing 90 mm Ø bulk pipeline with a new 200 mm Ø bulk pipeline. This will enable the system to supply the ultimate peak demand of ± 1 500 kL/d under gravity to the Wittedrift reservoir. The 3rd phase is upgrading of the booster pump station (item BPW.B41b) when supply problems to Wittedrift (under gravity) occur as the demand through the bulk system from the Town reservoirs to the Matjiesfontein reservoir increases (with accompanying energy losses through the bulk system).
- New flow control valve (item BPW.B92) at the pipeline to the proposed Hanglip Golf Estate (future area P70) in order to sustain pressure in the upstream bulk system towards the Matjiesfontein reservoir.
- In the Water Master Plan for Kurland (see section 6.4 further on in the report) provision is made to augment the bulk water resources of Kurland with potable water from the Plettenberg Bay system. New bulk water infrastructure is proposed from the Matjiesfontein reservoir (TWL of 55 m a.s.l.) in the Plettenberg system to the existing Kurland bulk system. The proposed bulk infrastructure includes 2 bulk pumping stations, bulk pipelines and a new reservoir at the Pinehaven Road exit from the N2. This proposed so-called "Matjiesfontein Upper" reservoir has a proposed TWL of 217 m a.s.l. and it can be considered to utilize this reservoir as an alternative supply to Keurboomstrand. This will enable the BM to supply future areas P83 to P87 in Keurboomstrand with water from the proposed Matjiesfontein Upper reservoir. The construction of the Keurboomstrand Upper reservoir and booster pump station will then not be required.
- The existing bulk system from the Town reservoirs A & C to the Matjiesfontein reservoir can currently supply ± 13,5 L/s (1 150 kL/d) to the Matjiesfontein reservoir. The biggest constraint on this system is the existing 150 mm Ø sections (sections 2 & 3). During peak demand periods supply to the Matjiesfontein is however augmented from the Goose Valley reservoir network (a closed valve near the Keurbooms River is opened), which increases the capacity of the system to ± 36,0 L/s (3 100 kL/d). In the Water

Master Plan it is proposed that bulk supply to the Matjiesfontein is augmented in 4 phases, as demand from the reservoir increases.

- The first phase is the upgrading of section 2 of the bulk system (project BPW-009). This will increase the capacity of the system from ± 1 150 kL/d to a capacity of ± 2 000 kL/d.
- The second phase is the upgrading of section 3 of the bulk system (project BPW-015). This will increase the capacity of the system from ± 2 000 kL/d to a capacity of ± 4 200 kL/d.
- The third phase is the upgrading of section 4 of the bulk system (project BPW-022). This will increase the capacity of the system from ± 4 200 kL/d to a capacity of ± 6 700 kL/d.
- If a demand of more than ± 6 700 kL/d is required from the Matjiesfontein reservoir, or if supply problems to the Matjiesfontein reservoir is experienced as the demand from the bulk system to Wittedrift and Aventura (and the future Hanglip development) increases, the supply to the Matjiesfontein reservoir can be augmented through the construction of a booster pump station on the bulk pipeline, or alternatively through the upgrading of section 1 of the bulk system (replace remaining 150 mm Ø pipeline with a new 315 mm Ø pipe). In the Water Master Plan it is proposed to implement a booster PS as the fourth phase upgrade as it will be a more economical solution. The alternative solution (upgrading of section 1 of the bulk system) will however enable gravity supply to both the Wittedrift and Matjiesfontein reservoirs during peak demand conditions (booster pump stations BPW.B41b and BPW.B100) will not be required).

6.3.4. Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Plettenberg Bay system are summarised in Table BMW6.4a. These proposed master plan items are grouped together in proposed projects which are summarised in Table BMW6.4b.

The proposed projects with the highest priority in Plettenberg Bay are included in Table BMW6.4c.

6.4. MASTER PLAN - KURLAND

6.4.1. Proposed distribution zones

The proposed distribution zones are indicated on Figure BMW6.4b.

The only change to the existing distribution zone is that the existing boundary of the existing zone is increased to accommodate future development areas.

6.4.2. Proposed future system and required works

The existing Kurland water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure BMW6.5b.

A new bulk supply pipeline from the Kurland reservoirs to the town is proposed in order to reinforce water supply to the Kurland network. The implementation of this project will improve low water pressures in Kurland that are currently experienced during periods of high demand.

Upgrading of the existing Kurland distribution network is proposed in order to accommodate housing developments on Erf 562.

6.4.3. Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table BMW6.5 is a summary of the reservoir and feeder evaluation of the existing system for the future water demand.

Water Treatment Plants

Investigation of, and comments on the sufficiency of the existing water sources, the raw water bulk supply system or the capacity of the existing water treatment plants are beyond the scope of this study.

The following information regarding the Kurland water sources and treatment capacity is however relative to the Water Master Plan:

The Kurland WTP has a capacity of 600 kL/d and is supplied with raw water from the Wit River (registered abstraction volume of 130 ML/a (356 kL/d)) and from two newly drilled boreholes (safe yield of the boreholes is 221 ML/a (605 kL/d)). The production rate of borehole 1 has however deteriorate due to oxidation of the water in the hole and clogging of the infrastructure. BM has consequently abandoned this borehole. The safe yield that can be extracted from the remaining borehole is calculated at 430 kL/d.

The Wit River source can supply raw water during peak week conditions (summer months) to the Kurland WTP at a supply rate of 600 kL/d (peak factor of 1,65 times the registered abstraction volume). This is the same rate as the capacity of the WTP.

It is proposed that the Kurland WTP is upgraded to a future capacity of ± 1,1 ML/d in order to accommodate the supply from the groundwater sources.

The future AADD for the Kurland system is calculated at ± 1,4 ML/d. At a peak factor of 1.65 x the AADD, the future treatment capacity for the Water Master Plan is calculated at ± 2,3 ML/d. As stated above the treatment plant can only be extended to a capacity of ± 1,1 ML/d due to limited water resources. It is proposed in the Water Master Plan that the future deficit of ± 1,2 ML/d (13,9 L/s) is provided from the Plettenberg Bay system via a connection from the Matjiesfontein reservoir.

In the Plettenberg Bay Water Master Plan provision is made in the upgrading of the bulk system in order to provide treated water from the Matjiesfontein reservoir to Kurland up to a flow rate of 17.0 L/s.

Reservoirs

A new 1,5 ML reservoir (item BKW.B9) is proposed at the existing Kurland reservoir site in order to augment reservoir storage capacity. This reservoir will be required when the AADD for Kurland exceeds 750 kL/d.

A new 600 kL balancing reservoir is proposed on the bulk system from the Matjiesfontein reservoir to Kurland, i.e. the proposed Matjiesfontein Upper reservoir with a TWL of 217 m a.s.l. (item BKW.B5).

Feeder mains

A new bulk system in order to augment bulk water to Kurland is proposed. The following new bulk pipelines are proposed in order to implement this system:

- New 200 mm Ø feeder main from the Matjiesfontein reservoir to the proposed Matjiesfontein Upper reservoir (item BKW.B3.1).
- New 160 mm Ø feeder main from the Matjiesfontein Upper reservoir to the existing Kurland bulk system (item BKW.B3.2).

A 3.0 km 160 mm Ø section of the bulk system between Kurland and Plettenberg Bay has already been constructed (from Kurland along the N2 towards Plettenberg Bay). It is proposed that item BKW.B3.2 connect to this pipeline (on the southern side) and that the northern side of this pipeline is connected to the existing 200 mm Ø supply pipeline from the Kurland reservoirs to the Kurland reticulation network.

The existing 200 mm Ø pipe (that is currently part of the reticulation network) should then be transferred to the bulk system (after item BKW1.3 is implemented).

Pumping stations

The following new pump stations are proposed in order to implement the bulk system between the Matjiesfontein reservoir and Kurland:

- New pump station to supply bulk water from the Matjiesfontein reservoir to the proposed Matjiesfontein Upper reservoir (item BKW.B3).
- New pump station to supply bulk water from the Matjiesfontein Upper reservoir to the Kurland reservoirs (item BKW.B6).

6.4.4. Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Kurland system are summarised in Table BMW6.4a. These proposed master plan items are grouped together in proposed projects which are summarised in Table BMW6.4b.

The proposed projects with the highest priority in Kurland are included in Table BMW6.4c.

6.5. MASTER PLAN - NATURE'S VALLEY

6.5.1. Proposed distribution zones

The proposed distribution zones are indicated on Figure BMW6.4b.

There are no changes to the existing distribution zones of Nature's Valley.

6.5.2. Proposed future system and required works

The existing Nature's Valley water distribution system has sufficient capacity to supply the future water demands for the fully occupied scenario. Two reinforcement pipelines are however proposed to improve the conveyance in the network.

The proposed master plan items are presented in Figure BMW6.5b.

6.5.3. Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario.

Table BMW6.5 is a summary of the reservoir and feeder evaluation of the existing system for the future water demand.

Reservoirs

A new 1.0 ML reservoir is proposed at the existing Nature's Valley reservoir site to replace the existing 600 kL reservoir (item BNW.B1).

Feeder mains

No feeder mains require upgrading in future.

Pumping stations

No future pumping stations are required.

6.5.4. Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Nature's Valley system are summarised in Table BMW6.4a.

6.6. MASTER PLAN - HARKERVILLE

6.6.1. Proposed distribution zones

The proposed distribution zones are indicated on Figure BMW6.4a.

There are no changes to the existing distribution zones of Harkerville and Forest View.

6.6.2. Proposed future system and required works

No information was available regarding the layout or sizes of the existing water pipes in Harkerville and Forest View. It is recommended that this information is sourced and the BM hydraulic water model is updated with the information accordingly.

6.6.3. Bulk System

Insufficient information was available to analyse the existing Harkerville and Forest View bulk systems.

6.6.4. Cost estimates of future works

No upgrades are proposed in the Harkerville and Forest View systems in order to accommodate the fully occupied system.

6.7. OPERATION AND MAINTENANCE COSTS

This capital expenditure plan allows only for capital expenditure required to upgrade the system to meet future growth. No provision is made in this master plan for the following:

- Increased operation and maintenance costs that go hand in hand with the infrastructure upgrades
- Replacement of old infrastructure that reaches the end of reliable operation.

6.8. UPDATING AND MAINTENANCE OF THE COMPUTER MODEL AND MASTER PLAN

The calibrated computer model of the 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.

6.9. MONITORING OF THE SYSTEM

An extensive monitoring programme is suggested which will gather information to assist with the updating of the master plan and the day to day management of the system. This programme has even more significance in the context of the Water Services Act 2007, which basically enforces proper system- and water demand management.

Monitoring of the system could be through a live link like telemetry and through a system which is updated only periodically such as SWIFT. Telemetry monitoring can be used for a number of reasons, some of which are:

- To monitor reservoir levels for operational reasons.
- To monitor pumps on or off for operational reasons.
- To continuously log flow meters to determine flow/demand patterns, also giving an indication of when the maximum flow velocities or pipeline capacities are reached.
- To monitor network residual/static pressures where problems are expected/ experienced.

Monitoring of the system through SWIFT is a more long-term process and typical objectives are:

- To determine the total system non-revenue water (NRW) as obtained from the meter database.
- To determine the NRW per subsystem, again as per meter database.
- To pick up meter irregularities such as broken meters, meters slowing down, meters which were replaced, meters which clocked over, etc.

6.10. WATER DEMAND MANAGEMENT

Continuous attention and support to water demand management with the aim of permanent reduction in demand should be considered as it could substantially impact the capital expenditure required to meet the future demand. A long-term water conservation and water demand management strategy study was conducted for the BM in April 2014, defining priorities for water loss reduction and demand management measures for each town. The BM should ensure that these strategies are pursued actively.

6.11. 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). 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 databases 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 was 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 in line with current replacement cost (CRC), fair values according to depreciated replacement cost (DRC) and budgets which include both operational expenditure (OPEX) and capital expenditure (CAPEX).

6.12. CONCLUSION

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

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7. MASTER PLAN COST SUMMARY

This report describes the study undertaken with respect to the updating of the master plan for the water distribution 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 water distribution system for BM.

The initial water 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 WATER MASTER PLAN STUDY

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

- Updating of existing computer models for the BM water distribution systems.
- The linking of these models to the latest water meter data and analysis of water demand based on the treasury's financial system.
- Evaluation and master planning of the water distribution systems.
- Present all information electronically in geographic information system (GIS) format as well as a master plan document including tables and plans.

7.2. STUDY AREA

The location of BM within the Western Cape is shown on Figure BMW1.1. 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 BMW1.2 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.

7.3. WATER SOURCES

<u>Plettenberg Bay</u>

Plettenberg Bay is supplied with water from four sources, namely the Keurbooms River, the Piesang River, desalination and groundwater abstraction.

Water from the abstraction point in the Keurbooms River is pumped to two raw water reservoirs through a 0,9 km pipeline (500 mm diameter) from where it flows through a 16,4 km long 500 mm diameter pipeline to Plettenberg Bay where it is purified at the Plettenberg Bay WTP. Surplus water from this source can be transferred to the Roodefontein dam.

The Roodefontein dam receives its water from the Piesang River. In the dryer summer months when there is a shortage from the Keurbooms River source water is supplemented from the Roodefontein dam. The water from the Roodefontein dam gravitates through a 1,8 km 350 mm diameter pipeline to the Roodefontein dam raw water reservoir from where it is pumped via a 2,1 km 350 mm diameter steel pipeline to the Plettenberg WTP where water is purified. The treatment capacity of the Plettenberg Bay WTP is 27,0 ML/d.

During peak demand conditions water supply can be augmented from groundwater abstraction and through desalination. Water from the boreholes is pumped directly to the treatment plant or to the existing reservoirs where water is treated.

The Bitou desalination plant (located next to the Beacon Isle hotel) has a treatment capacity of 2,0 ML/d.

Kurland

The source of bulk water for Kurland is the Wit River where BM has an allocation of 356 kL/d. Water abstracted from the Wit River is pumped through a 0,7 km 150 mm diameter pipeline to the Kurland WTP where it is purified. Raw water supply is augmented from 2 boreholes close to the Kurland WTP. The safe yield of the boreholes is 605 kL/d.

The treatment capacity of the Kurland WTP is 0,6 ML/d.

Nature's Valley

Nature's Valley receives raw water from the Groot River. The Nature's Valley WTP has a treatment capacity of 1,0 ML/d and is located next to the abstraction point in the Groot River.

Harkerville

No information with regards to the Harkerville water sources was available at the time when the report was compiled except that the settlement is supplied with water from 2 boreholes.

Note:

Investigation of, and comments on the sufficiency of the existing water sources are beyond the scope of this study.

7.4. GENERAL DESCRIPTION OF THE WATER SUPPLY SYSTEM

The water distribution system layouts are shown on Figures BMW2.1, with a separate Figure for each area operated by the BM, i.e. Plettenberg Bay & Harkerville and Kurland & Nature's Valley.

7.4.1. Bulk supply system

The analysis of the raw water system upstream of the WTP's is beyond the scope of this study.

7.4.2. Water treatment plants

Raw water from the various sources in BM is supplied to the following WTP's where it is treated:

• Plettenberg Bay WTP	- Capacity	27,0 ML/d
• Plettenberg Bay desalination plant	- Capacity	2,0 ML/d
• Kurland WTP	- Capacity	0,6 ML/d
• Nature's Valley WTP	- Capacity	1,0 ML/d
Total Capacity		**30,6 ML/d**

The total WTP capacity of the systems in BM treating raw water is roughly equal to 2,9 x the present annual average daily demand (AADD) of 10,5 ML/d for these systems.

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

7.4.3. Reticulation systems

With reference to Figures BMW2.1 &BMW2.2, the following water systems are operated by the BM:

<u>Plettenberg Bay</u>

The system is operated in 25 zones supplied from 22 reservoirs and 7 towers (on 16 reservoir sites). There are 7 PRVs in the system to control static pressures and 14 pump stations to supply bulk water to the reservoirs and towers or to increase water pressure to higher lying areas. The PRVs feed into discrete sub-zones.

<u>Kurland</u>

The system is operated in a single zone, supplied from the Kurland reservoirs.

<u>Nature's Valley</u>

The system is operated in two zones, supplied from a single reservoir. There is one PRV in the system to control static pressures. The PRV feeds into a discrete sub-zone.

<u>Harkerville</u>

Little information was available at the time when the report was compiled. From the available information it is believed that the system is operated in two zones (Forest View Tanks and Harkerville Reservoir).

7.4.4. Reservoirs

The reservoir storage volumes for the potable water systems in BM are:

• Plettenberg Bay	- Capacity	52,591 ML
• Kurland	- Capacity	1,500 ML
• Nature's Valley	- Capacity	0,600 ML
• Harkerville	- Capacity	0,510 ML
Total Capacity		**55,201 ML**

The total storage capacity of 55,201 ML represents ± 126 hours x the present AADD of 10,485 ML/d for the BM.

7.4.5. Pumping stations (PS)

The following PS are in the respective systems:

- Plettenberg Bay: 14 PS
- Kurland: 1 PS
- Nature's Valley: 2 PS
- Harkerville: 2 PS

7.4.6. Pipelines

The total length of pipelines in the BM supply system amounts to 382,9 km.

7.4.7. Replacement value

The year 2019/20 replacement value of the system (excluding raw water storage dams, control valves and other small components) is estimated as follows:

Plettenberg Bay	R 1 268,75 million
Kurland	R 40,07 million
Nature's Valley	R 37,72 million
Harkerville	R 6,89 million
Total	**R 1 351,44 million**

7.5. WATER DEMAND

A summary of all the present and future water demands on the water supply system is shown on Table BMW4.2.

7.5.1. Present water demand

The analysis of the meter reading data from the municipal treasury data as well as bulk water meter reading data indicated that:

- The present annual total water demand (TWD) supplied from November 2018 to October 2019 is 3 826 563 kL (bulk water input from the WTP's) which equates to an AADD of 10,48 ML/d.
- The present water sold to consumers during the same period is 2 645 794 kL.
- The non-revenue water (NRW) is therefore 1 180 769 kL, or 31% of total bulk water input.
- The present water demand used for modelling of the existing BM water systems equates to an AADD of 10,485 ML/d.

7.5.2. Future water demand

With all vacant erven within the municipality occupied and the municipal wide NRW figure for BM reduced, the AADD of the existing BM could increase from 10 485 kL/d to 13 815 kL/d. In addition to this it is estimated that the future developments (as shown on Figure BMW4.1) can contribute a further 20 999 kL/d, bringing to 34 814 kL/d the total future AADD for the BM reticulation system for which this planning study was performed.

7.6. COMPUTER MODEL ANALYSIS AND EVALUATION OF EXISTING SYSTEM

The existing computer model of the existing water supply system was updated with the latest as-built information, using the water distribution system optimization program (WADISO) SA 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 present peak hour demand (PHD), and evaluated with respect to:

- Supply rates to reservoirs in relation to demand served
- Reservoir capacities in relation to demand served by reservoir
- Flow velocities
- Minimum pressures
- Static pressures

7.6.1. Reticulation system

Presently the water supply systems operates and functions without major problems, and this was reflected in the computer model analysis. A few localised problems were however identified. The analysis of the water systems for each area can be summarised as follows:

Plettenberg Bay

- The static analysis indicates areas in the network where pressures are below 24 m and above 90 m. The most significant areas where the static pressures are below 24 m are the northern areas of Kranshoek, the higher lying areas of the Quarry reservoir zone, the areas closest to the Town reservoir in the Town reservoir zone, the western part of New Horizon, the higher lying areas in the Kwanokuthula tower zone and the higher lying areas of the Green Valley tower zone. These low static pressures are due to the topography of the area. There are however 2 booster pump stations in private developments in the Quarry reservoir zone to improve the low static pressure in this zone.
- The most significant areas where the static pressures are above 90 m is the lower lying areas adjacent to the Piesang River in the Town reservoir, New Horizon reservoir and Schoongezicht PRV zones. The eastern area of the Whale Rock reservoir zone experience static pressure of between 60 m and 90 m.
- The residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 90m range, except for the areas that already do not have sufficient static pressures
- There are a few pipes in the Brakkloof/Town reservoir zone which have a velocity under peak hour demand conditions which exceeds 1,5 m/s. These high flow velocities are due to the relative small diameters of the supply pipelines in the area.

Kurland

- The static analysis indicates no areas where pressures exceed 90 m
- The residual pressures in the existing system under peak hour demand conditions are marginally below 24m for the biggest part of Kurland.
- The only pipe with a flow velocity exceeding 1,5 m/s in the system is the 100 mm Ø supply pipe where the 200 mm Ø bulk main from the Kurland reservoirs reduces to a 100 mm Ø pipe before it reaches the Kurland distribution zone. The velocity in this pipe is exceeds 2 m/s.

Nature's Valley

- The static analysis indicates no areas where pressures exceed 90 m.
- The residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 90m range.
- The flow velocities in the existing system do not exceed 1,5 m/s.

Harkerville

No information with regards to Harkerville reticulation system was available when the report was compiled.

7.6.2. Bulk supply system

The analysis of the existing pump stations and supply rates to reservoirs and reservoir capacities in relation to demand served by the reservoir (as shown in Table BMW6.2) showed that:

- Evaluated on a town-for-town basis, Plettenberg Bay, Kurland and Nature's Valley have sufficient reservoir storage in all of its zones and requires no additional storage. The total reservoir storage capacity for Plettenberg Bay is 129 h x AADD supplied, for Kurland it is 67 h x AADD supplied and for Nature's Valley it is 84 h x AADD supplied.
- In the larger Plettenberg Bay system the Kranshoek reservoir has only 33 h x AADD supplied reservoir storage capacity. This is however not a concern as Kranshoek is supplied from the 2x towers (supplied from the reservoir) which have sufficient spare storage capacity available.
- The condition of the existing 600 kL reservoir in Nature's Valley is in a bad state of repair and should be replaced.
- Minimal information was available regarding the Harkerville system to evaluate the reservoir storage capacity, but from the information available it appears that the existing 500 kL Harkerville reservoir has more than sufficient storage capacity available.

The following feeder mains are near capacity and should be upgraded in the near future:

- The 150 mm Ø section of the bulk supply from the Town reservoirs A & C to Matjiesfontein reservoir. Bulk supply to Matjiesfontein is however currently augmented through the network of the Goose Valley reservoir zone through a 250 mm Ø pipe (part of the Goose Valley reservoir network) that runs parallel to the existing 150 mm Ø pipe).
- The 90 mm Ø bulk supply pipe towards Wittedrift and Green Valley.
- The 63 mm Ø bulk supply pipe from the Wittedrift to Green Valley.

All the other feeder mains in BM have sufficient capacity.

The following pump station are near capacity and should be upgraded in the near future:

- Kwanokuthula is currently supplied through only the Kwanokuthula Upper (New) tower as the motors of the pumps pumping to the Lower (Old) tower has been removed. In the case where the entire supply to Kwanokuthula is from the Kwanokuthula West pump station, the capacity of the pump station is insufficient to supply peak hour demand to the tower.
- The Green Valley PS has insufficient capacity. This is mainly due to insufficient conveyance capacity in the bulk pipeline between Wiittedift and Green Valley.
- The existing Kranshoek reservoir to Kranshoek tower pumps have sufficient capacity only when both pumps run simultaneously (no stand-by pump). It is recommended that pump stations should always have one stand-by pump available. The new pumps at Kranshoek reservoir has been sized for the future scenario, where a portion of the Kranshoek tower zone will rezoned into the Roodefontein Upper reservoir, subsequently lowering the pumping capacity required at Kranshoek reservoir. Therefore, no additional pumps will be proposed at Kranshoek reservoir, as they would become redundant in the future. However, the implementation of the master plan should be prioritised to ensure stand-by pump capacity is secured for the Kranshoek tower zone.
- The capacities of the pumps at the Tower reservoir to the Upper and Lower towers, the pumps at Kwanokuthula East PS, the pumps in Keurboomstrand as well as the pumps in Nature's Valley is unknown and may possibly require upgrading.

7.7. MASTER PLAN FOR SYSTEM EXTENSIONS/AUGMENTATION

7.7.1. Planning horizon

The extensions to the existing system were planned to keep in step with a growth in demand from the present (2019) AADD of ± 10,49 ML/d, to a planning horizon AADD of 34,82 ML/d. This AADD will be realised in the year ± 2050 if the demand increases at a compounded growth rate of ± 4% per year (30 - 35 year planning horizon).

At a lower growth rate of 2,0 to 2.5% this AADD will be realized in the year 2070 to 2080 (50 to 60 years planning horizon).

7.7.2. Raw water source

The analysis of the raw water sources is beyond the scope of this study.

7.7.3. Water treatment plants

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

7.7.4. Required works

An extended computer model representing the future scenario was set up to plan and size the components of the future water supply system. The motivation for the works and a detailed description for each component, are 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 BMW6.5 and listed with short descriptions in Table BMW6.4a. These proposed master plan items are grouped together in proposed projects which are summarised in Table BMW6.4b.

The major new components of the future system with the highest priorities are summarized below:

Project no.	**Description**	**Estimated cost *** (R-yr 2019/20 value)
PRJ-BPW-002	Kwanokuthula Upper bulk supply upgrades	R 295 000
PRJ-BPW-040	Development related infrastructure: Wittedrift (Priority)	R 872 000
PRJ-BPW-003	Town PRV 4 zone: Alteration of zone boundaries & improvement of network conveyance & redundancy	R 367 000
PRJ-BPW-007	Plettenberg Bay network upgrades - Priority	R 1 203 000
PRJ-BKW-001	Kurland network upgrade	R 9 044 000
PRJ-BPW-004	Brakkloof reservoir zone: Alteration of zone boundaries	R 497 000
PRJ-BHW-001	Establish Harkerville & Forest View hydraulic water models	R 100 000
PRJ-BPW-006	Green Valley bulk supply upgrades - Phase 1	R 12 317 000

PRJ-BKW-002	Kurland WTP augmentation	R 9 317 000
PRJ-BPW-010	Development related infrastructure: Kwanokuthula (Short term)	R 7 806 000
PRJ-BNW-002	New Nature's Valley reservoir	R 5 040 000
PRJ-BPW-012	Construct and implement New Horizon Tower	R 11 850 000
PRJ-BPW-008	Implement Green Valley booster pump station	R 1 879 000
PRJ-BKW-003	Development related infrastructure: Kurland	R 1 405 000
PRJ-BPW-001	Construct new 3,5 ML Roodefontein Lower reservoir	R 11 920 000
PRJ-BPW-057	New Keurboomstrand bulk pump station	R 2 127 000
PRJ-BNW-001	Nature's Valley network upgrades	R 706 000

7.7.5. Cost estimates and phasing in of works

The total cost (year 2019/20 value) for the required works is estimated at R371,35 million (including P&G's, contingencies and fees, excluding VAT). This total can be broken down as follows:

Water reticulation network	:	R	99,83 million
Bulk supply pipelines	:	R	113,65 million
Additional pump capacity	:	R	38,30 million
Additional storage capacity (reservoirs)	:	R	93,23 million
Additional storage capacity (towers)	:	R	15,96 million
Water demand management	:	R	1,07 million
Water Treatment plants *	:	R	9,32 million
Total		**R**	**371,35 million**

The capital investment of R 371,35 million is required over time to increase the system capacity from the present AADD of roughly 10,49 ML/d, to the future horizon of 34,81 ML/d AADD.

* (only costs for upgrades to the Kurland WTP is included. Analysis of the WTP's is beyond the scope of this study).

Tables BMW6.4a & BMW6.4b also gives an indication of when the works are required. The required expenditure should be phased to remain in line with the increase in AADD.

The proposed projects with the highest priority in the BM system are included in Table BMW6.4c. The estimated cost of items required over the next 3 to 5 years is ± R 76,7 million.

7.8. MASTER PLAN UNIT COST

The required capital expenditure (CAPEX) for these priority water infrastructure projects is as follows:

- R 24,70 million for the 2020/21 financial year
- R 22,16 million for the 2021/22 financial year
- R 29,89 million for the 2022/23 financial year

Table BMW7.1 is a summary of the total costs associated with the proposed master plan for the water system for the next 30 to 35 years, which amounts to R 371,347 million.

The master plan implementation at cost of R 371,347 million will increase the BM system capacity from its present AADD of 10,485 ML/d to the future AADD of 34,814 ML/d. This amounts to an implementation unit cost of R 15 264 R/kL/d.

7.9. UPDATING AND MAINTENANCE OF THE COMPUTER MODEL AND MASTER PLAN

The calibrated computer model of the 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.

7.10. MONITORING OF THE SYSTEM

An extensive monitoring programme, mainly through an extension of the already established telemetry system, is suggested which will gather information to assist with the updating of the master plan and the day to day management of the system.

7.11. WATER DEMAND MANAGEMENT

Continuous attention and support to water demand management with the aim of permanent reduction in demand should be given as it could substantially impact the capital expenditure required to meet the future demand.

7.12. 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).

7.13. CONCLUSION

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

Table BMW 7.1 Master plan cost summary24