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THE WORLD BANK

REPUBLIC OF ZIMBABWE

GREATER HARARE WATER AND SANITATION STRATEGIC PLAN

GREATER HARARE WATER AND SANITATION INVESTMENT PLAN

INVESTMENT PLAN REPORT

(FINAL)

VOLUME I: MAIN REPORT

June 2014

Gauff JBG Ingenieure

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June 2014

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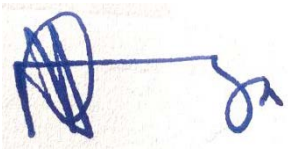

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Preface

This report is the outcome of a combined financing and supervisory effort by the Zimbabwe Multi-Donor Trust Fund (Zim-Fund) and the Multi-Donor Analytical Trust Fund (MDTF) under the World Bank as well the operational contributions of the beneficiary local authorities. The Zim-Fund financed the study that generated the Harare and Chitungwiza input data, while the MDTF financed the additional investigations in Ruwa, Epworth and Norton and the development of the integrated water and sanitation investment plan for Greater Harare.

The Consultant signed two separate contracts with the two financiers with different contractual obligations regarding submission of reports. Under the Zim-Fund project, the Consultant is obliged to issue individual reports for Harare, Chitungwiza, Kwekwe, Chegutu, Masvingo and Mutare. Under the World Bank project (which includes Harare and Chitungwiza), the consultant is required to issue a single report covering all the project towns.

Considering the inter-linkages and dependencies of the technical and institutional aspects of water and sanitation service provision in the Harare area, the financiers resolved that it would be in the best interest of the Clients to receive a single combined report for the Zim-Fund and the World Bank projects instead of issuing two separate reports for Harare and Chitungwiza as per the Zim-Fund contract. This arrangement will allow the Consultant to provide the necessary information on the integrated Greater Harare water and sanitation systems in one consolidated document.

GREATER HARARE WATER AND SANITATION INVESTMENT PLAN

INVESTMENT PLAN REPORT

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List of Acronyms

AC	Asbestos Cement
AfDB	African Development Bank
BOD	Biological Oxygen Demand
BoQ	Bill of Quantities
COD	Chemical Oxygen Demand
CMMP	Computerised Maintenance Management Programme
DMA	District Metering Areas
DPC	Dynamic Prime Cost
ECZ	Engineering Council of Zimbabwe
EIA	Environmental Impact Assessment
EMA	Environmental Management Agency
FRC	French Red Cross
ESIA	Environmental and Social Impact Assessment
GI	Galvanized Iron
GIS	Geographic Information System
GPS	Global Positioning System
HDPE	High Density Polyethylene
HR	Human Resources
IE	Implementing Entity
JBG	Ingenieurbüro Gauff
MoW	Ministry of Water Resources Development and Management
N	Nitrate
ND	Nominal Diameter
NRW	Non Revenue Water
OD	Outside Diameter
P	Phosphate
PRV	Pressure Reducing Valve
PVC	Polyvinylchloride
RCP	Reinforced Concrete Pipe
RPF	Request for Proposal
ToR	Terms of reference
USD	United States Dollars
UV	Ultraviolet
UWSSRP	Urgent Water Supply and Sanitation Rehabilitation Project
WSS	Water and Sewerage Service
WTW	Water Treatment Works
WWTW	Waste Water Treatment Works
ZIE	Zimbabwean Institution of Engineers
ZIMRA	Zimbabwe Revenue Authority
ZIMSTAT	Zimbabwe National Statistics Agency
ZINWA	Zimbabwe National Water Authority
ZISCO	Zimbabwe Iron and Steel Company

CHAPTER 01: BACKGROUND AND INTRODUCTION

1 BACKGROUND AND INTRODUCTION

1.1 Project Background

Zimbabwe Multi-donor Trust Fund (Zim-Fund)

The economic and humanitarian crisis in 2008 that included widespread cholera outbreaks prompted the Zimbabwean Government and the donors to begin dialogue on the modalities of financing relief and remedial efforts. The African Development Bank was asked by a group of donors, with the consent of the Zimbabwean Government, to establish and administer a 'basket' fund - the Zimbabwe Multi-Donor Trust Fund (the "Zim-Fund"). The main purpose for the Zim-Fund is to mobilise and administer donor resources needed for the economic recovery and development efforts in Zimbabwe. Part of the resources mobilised by the Zim-Fund have been applied towards the Urgent Water Supply and Sanitation Rehabilitation Project (UWSSRP) whose main scope is the urgent rehabilitation of water supply and sanitation systems in six urban centres, namely Harare, Chitungwiza, Mutare, Masvingo, Kwekwe and Chegutu.

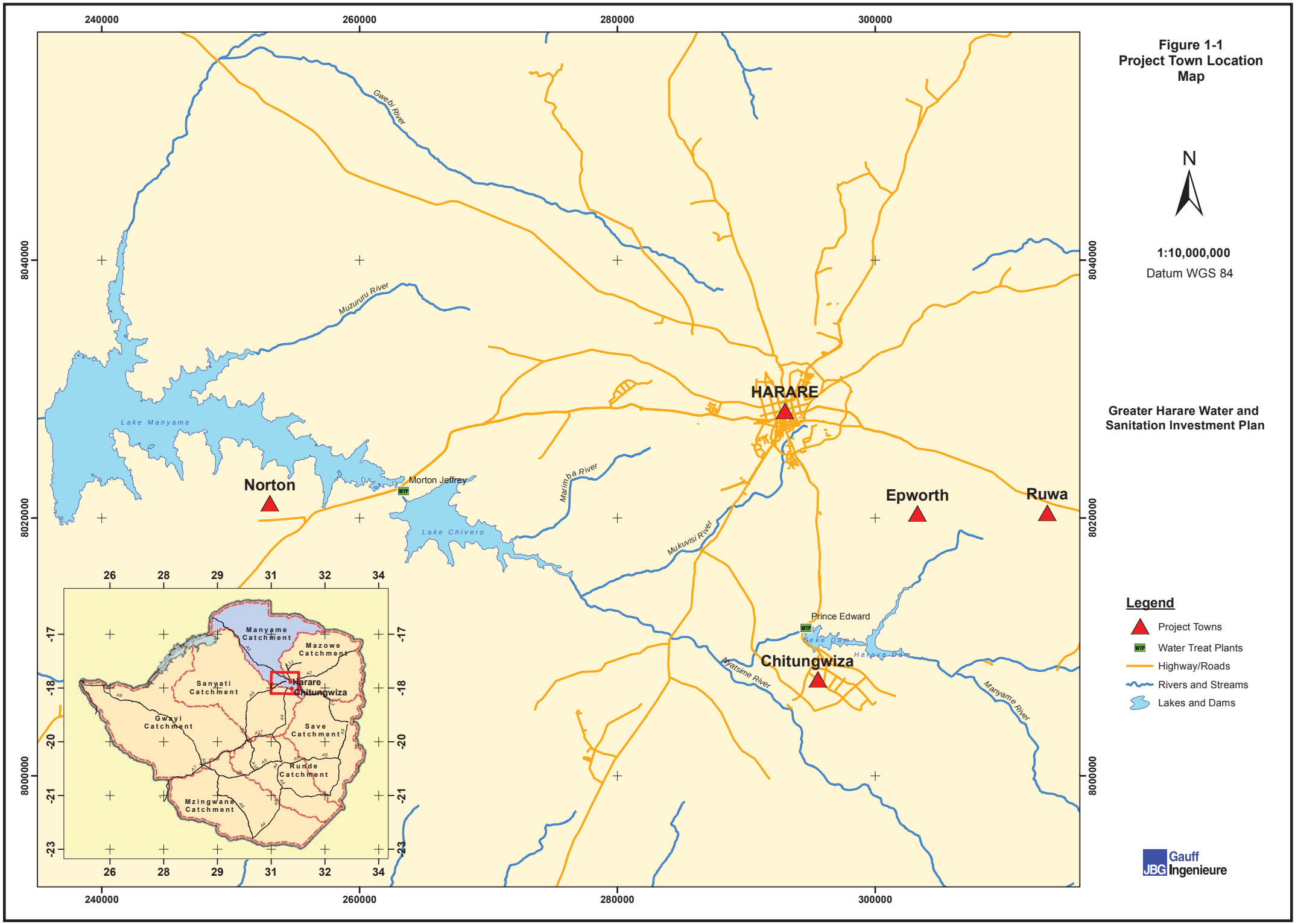
Under the UWSSRP, the Zim-Fund is also financing consultancy services for the development of Medium to Long Term Water Supply and Sewerage Investment Plans in the same towns and cities. The contract for these services was awarded to HP Gauff Ingenieure GmbH after an international competitive procurement process. The contract was signed on 22nd April 2013 and the project officially commenced on 20th May 2013.

Multi-Donor Analytical Trust Fund

The City of Harare requested the World Bank to support the development of a water supply and sanitation strategic plan for Greater Harare - the metropolitan area that includes Harare, Chitungwiza and the satellite towns of Epworth, Ruwa and Norton. The purpose of the strategic plan is to assess the infrastructure requirements for the Greater Harare area as a single water and wastewater infrastructure system that can be managed as one entity. The long term vision is to have a well-structured and sustainable single utility able to raise its own capital on the financial markets.

The World Bank, therefore, engaged HP Gauff Ingenieure GmbH (i.e. further referred to as Gauff) to develop the Greater Harare Water and Sanitation Investment Plan – a key input to the strategic plan -, parallel to the on-going study financed by the Zim-Fund.

The Investment Plan will outline the medium (until 2020) to long term (until 2030) water supply and sanitation infrastructure requirements. It is intended to be a 'blue-print' that will guide future infrastructure and institutional development necessary for sustainable water and sanitation services.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Muzururu River
Lake Manyame
Norton
Morton Jeffrey
WTP
Lake Chivero
Marimba River
HARARE
Epworth
Ruwa
Mukuvisi River
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Datum WGS 84
Greater Harare Water and Sanitation Investment Plan
Legend
Project Towns
Water Treat Plants
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Lakes and Dams
Gauff
JBG Ingenieure

1.2 Background to the Consulting Services

Zim-Fund financed project

The Ministry of Finance of the Republic of Zimbabwe (hereafter called the Recipient) appointed "The Crown Agents for Oversea Governments and Administrations Limited" (hereinafter called the Client) to act as its Procurement Agent under the Zim-Fund. The recipient also appointed Lahmeyer GKW Consult GmbH (formerly Pöyry Environment GmbH) (hereafter called the Implementing Entity) to act as its Implementing Entity under the Project under the Zim-Fund.

The Client invited pre-selected consulting firms to submit technical and financial proposals for the preparation of "Water Supply and Sewerage Medium to Long Term Investment Plans" for six selected municipalities in Zimbabwe. After a thorough selection process, the Client selected HP Gauff Ingenieure GmbH (hereafter called Gauff) to carry out the services and concluded a contract with Gauff on 16th April 2013.

On 22nd April, Crown Agents issued the "Notice to Commence the Services". In accordance with the consulting service contract (GC 11.1), the date of the notice was the "Effective Date for the Contract" and subsequently the commencement of services was agreed not to be later than 20th May 2013.

World Bank financed Project

Recognising the linkages and similarities with the Zim-Fund financed study, the World Bank requested Gauff to submit a proposal for providing services necessary to develop the Greater Harare Water and Sanitation Investment Plan. The proposal was submitted in July 2013. Contract negotiations started in August and the contract was signed on 4th October 2013. The project officially commenced on 28th October 2013.

The Consultant mobilised to Harare on 27th October 2013 and carried out kick-off meetings with the various local authorities and agencies involved in the project and made the initial inspection visits to Ruwa, Norton and Epworth. An Inception Report was submitted on ……, which covered the principle approach and planning criteria proposed for application under this project. The Consultant held various technical and non-technical meetings with the councils, provided details of the project progress in various meetings with the WB and submitted discussion papers for various relevant topics. Project Objectives

The main objective of the project is to develop an integrated Water Supply and Sanitation Investment Plan for the **Greater Harare** metropolitan area. The Investment Plan will outline the medium (until 2020) to long term (until 2030) water supply and sanitation infrastructure requirements. It is intended to be a 'blue-print' that will guide future infrastructure and institutional development necessary for sustainable water and sanitation services.

The specific objective for this project component is to develop detailed water supply and wastewater investment plans that meet medium term (until 2020) and long term (until 2030) infrastructure requirements for the Greater Harare area, combining Harare, Chitungwiza, Epworth, Ruwa and Norton.

The investments cover the entire supply chain including water resources development, water and wastewater treatment, transmission and distribution, including institutional and sustainability issues. The consulting services do not cover other important urban infrastructure components, such as solid waste management and do not cover the important aspect of urban drainage.

The project objective and the objective of the consulting service contract are considered in in line with the overall policy goal of the National Water Policy, defining the vision that "all urban water users should enjoy adequate, continuous, readily accessible, safe, hygienic, sustainable and affordable domestic water and sanitation services provided by accountable, efficient, coordinated, funded and capacitated institutions".

1.3 Scope of Services

In order to achieve the above outlined specific project objectives, the scope of services for the project shall be as outlined in the consulting service contract, which included the ToR and the proposed methodology statement prepared by Gauff. The main activities undertaken in each project town are outlined in the table below:

Table 1-1: Scope of Services

Task	Brief Description
Data collection and establishment of planning framework	Collection and review of available data, reports, existing drawings, plans and maps related to the project for Epworth, Ruwa and Norton. Establishment of a GIS planning platform for Epworth, Ruwa and Norton
Use of Planning and Design Criteria	Adaptation of approved planning and design criteria used on the Zim-Fund project
Water demand forecasts until the year 2030	Population and water demand forecasting, taking into account the 2012 Census population data, factors influencing population growth, population growth rates, service levels, service coverage, spatial development of the towns, land use, per capita consumption, water losses and peak factors,
Assessment of existing water and sewerage infrastructure	Assessment of the capacity of the existing infrastructure in Ruwa, Epworth and Norton based on the work undertaken for Harare and Chitungwiza, under the Zim-Fund project and engagement with relevant officials in the local authorities. The purpose of this activity was to estimate the capacity deficits with regard to the medium and long term water requirements.
Development of medium and long term investment plans	Development of proposals for medium and long term investment measures based on the projected water and wastewater service requirements and the assessed capacities of the existing facilities for Greater Harare
Preparation of cost estimates	Preparation of cost estimates of the proposed investment measures, starting with realistic unit costs that take into account the current country/regional market conditions and inflationary expectations.
Financial analysis	Development of a simple financial utility model for the Greater Harare area for water and sanitation. The financial model is for the provision of financially sustainable water and sanitation services for Greater Harare, taking into account investment needs, affordability, realistic tariffs, efficient operating costs and a realistic performance improvement

Task	Brief Description
	trajectory.
Institutional assessment	Brief assessment of the existing capacity for provision of water supply and sanitation in the project towns, describing staff numbers and skill levels and any other relevant measures of capacity and competence to undertake the necessary tasks effectively. As per the consulting contract, it is not the task of this consultancy to develop or determine the future institutional and organisational set-up of the of the Greater Harare utility.
Environmental and social	Elaboration of the relevant environmental management framework governing the planning and implementation of the investment measures.

The critical path of activities for achieving the objectives is illustrated in the figure 1-2 overleaf.

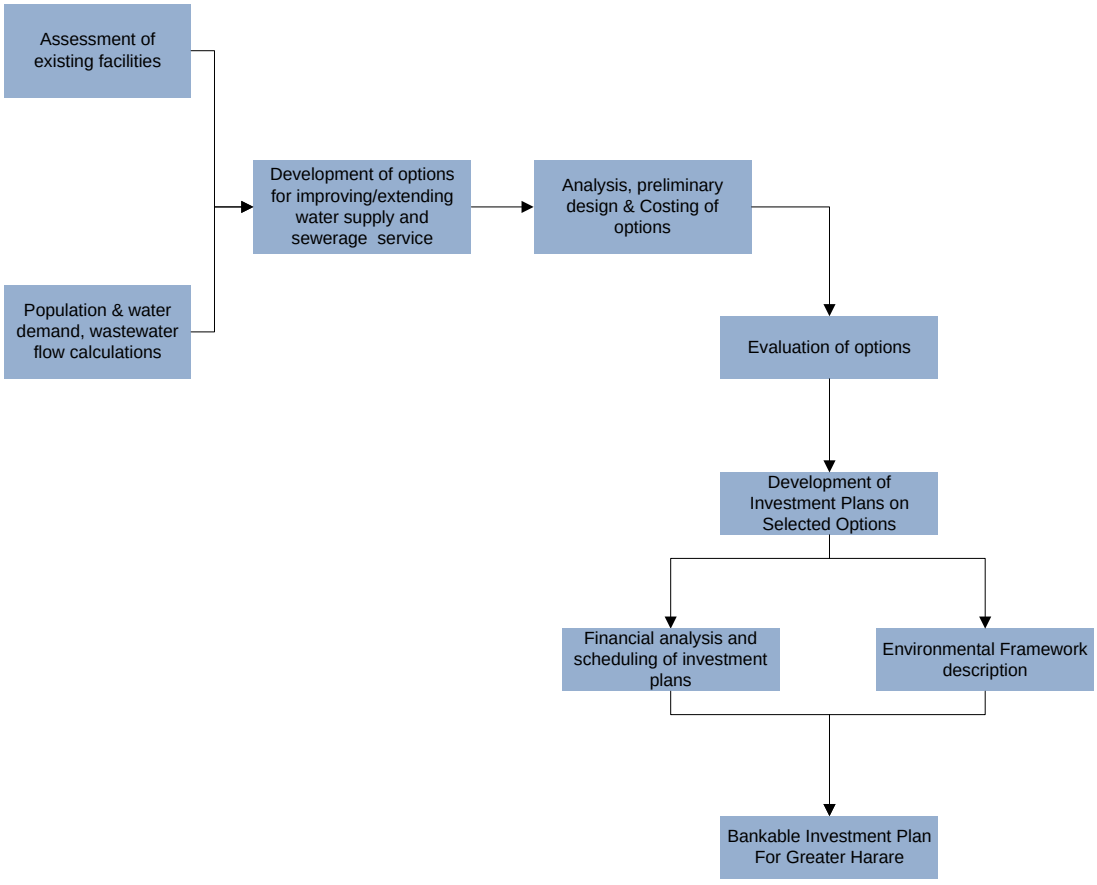

Figure 1-2: Critical project path

The project area in each town will be the present urban extent under the service jurisdiction of the city council or municipality of the project city/municipality, plus peri-urban areas and rural districts supplied or managed by the councils and municipalities and areas into which the Councils and Municipalities are due to grow.

1.4 Linkages with other Consulting Contracts

This consultancy is closely linked to the Zim-Fund study contract previously awarded to Gauff in the sense that Harare and Chitungwiza intersect both projects. It is important to state that the work done under the Zim-Fund study was not be duplicated; but used as input to this study.

Within this study, additional investigations were carried out in Ruwa, Epworth and Norton such that investment plans for these Councils were integrated with those developed for Harare and Chitungwiza into a single investment master plan for the Greater Harare area.

Throughout this report, the study on the Water Supply and Sewerage Medium to Long Term Investment Plans for Harare, Chitungwiza, Mutare, Masvingo, Kwekwe and Chegutu is referred to as the 'Zim-Fund study'.

1.5 Planning Principles

The planning principles of this study are aligned to the National Water Policy Document, which provides the necessary framework for the development of planning strategies. The policy document demands for adequate and affordable services to all residents and underlines the importance of efficient and conservative management principles when producing and supplying drinking water. Recurrent cost recovery is a key feature of the policy, which also underlines the importance of private and public users to pay for services. Metering of water production and consumption is an important instrument for effective operation and demand management, which is also promoted by the policy document. Also the reduction of unaccounted for water is promoted by the policy document and considered an important aspect of demand management. The policy also acknowledges the fact that operations can be provided by private service providers and that capacity building and investments in operation and maintenance equipment are necessary for sustainable service provision.

The policy document considers the past service standards as being high and suggests that such high standards could be reduced until Zimbabwe has reached again a normalised situation. We believe that this aspect of the policy may be reconsidered as we suggest to promote sustainable service level standards, which are adequate to provide safe water supply and sewerage services and affordable to the residents in low, medium and high density areas. The principle planning strategies resulting from the National Water Policy are further elaborate in Chapter 6.

1.6 Investment Components

The investment plan is subdivided into specific investment components, which are developed to support the objective of the project and are aligned to the service level objectives as outline above. The investments packages are as follows: (a) water demand management and NRW Reduction, (b) water supply service improvement, (c) extension of water supply services, (d) sanitation service improvements, (e) extension of sanitation services and, (f) accompanying measures. Table 1-2 gives a detailed explanation on each investment component.

Table 1-2: General Investment Components

Category	Components	General Remarks
Water Demand Management and NRW Reduction Programme	Rehabilitation/replacement of water distribution network, Replacement/ Installation of section valves, Rehabilitation/ Installation of valves to facilitate zoning, Installation of bulk meters, Rehabilitating/ Installation of pressure reducing valves, Replacement of service connections, Replacement of service water meters, NRW Reduction programme	Investment measures aimed at rehabilitating the distribution network and reducing NRW
Water Supply Service Improvements	Rehabilitation of source works, Rehabilitation of existing water treatment facilities, Replacement/ rehabilitation of existing transmission and primary distribution Mains, Rehabilitation of storage tanks	Investment measures aimed at improving water production, transmission and distribution.
Extension of Water Supply Services	Extension of water abstraction and treatment facilities, Installation of new transmission and primary mains, Construction of new storage reservoirs, Extension of distribution system in expansion areas, Installation of section valves in expansion areas, Installation of fire hydrants in expansion areas, Installation of service connections in expansion areas, Installation of service water meters in expansion areas, Other new bulk management water facilities	Investment measures aimed at increasing water production and extending services to new areas resulting from population increase.
Sewerage Service Improvements	Rehabilitation of wastewater treatment facilities, Rehabilitation of sewage pump stations, Rehabilitation/ replacement of existing sewer network,	Investment measures aimed at improving sewerage services by rehabilitating existing sewage collection and treatment infrastructure
Extension of Sewerage Services	Extension of wastewater treatment facilities, Extension of sewage pumping stations, Construction of new sewer trunk mains, Extension of sewer reticulation system in new development areas, Installation of sewer service connections in new development areas	Investment measures aimed at increasing capacity for wastewater treatment and service coverage to the new development areas
Accompanying measures	Technical operations management, Commercial operations management,	Investment measures aimed at improving

Category	Components	General Remarks
	commercial and technical information systems Professional services and contingencies	capacity to carry out technical and commercial operations Professional services accompanying implementation of investments, uncertainties in estimating physical quantities.

1.7 Structure of this Report

This report is divided into thirteen (13) chapters. The chapters deal with the key elements of the investment plan, whilst data, tables and additional technical information are compiled in the appendices. The chapters are outlined in the figure below.

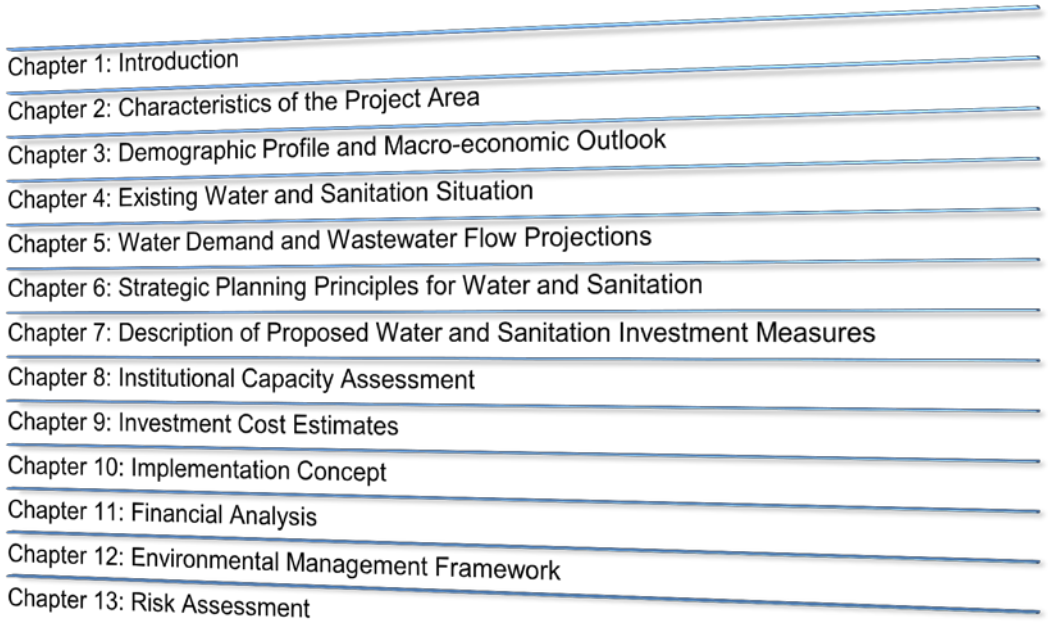

Figure 1-3: Report Structure

CHAPTER 02: CHARACTERISTICS OF THE PROJECT AREA

2 CHARACTERISTICS OF THE PROJECT AREA

2.1 Location and geography

The project covers Harare and the surrounding satellite towns of Chitungwiza, Epworth, Norton and Ruwa, collectively known as Greater Harare. Greater Harare is situated on Zimbabwe's Highveld between latitudes 17° 40' S and 18° 06' S, and between longitudes 30° 37' E and 31° 16' E. It is an urban sprawl with a total current population of around 2.35 Million according to the 2012 National Census.

2.2 Project area

2.2.1 Harare

Harare is the capital city of Zimbabwe. It is the seat of government, industrial hub and commercial centre of Zimbabwe.

Harare was founded in 1890 under the name of Fort Salisbury. It was granted municipality status in 1897 and city status in 1935. Harare has heavy and light industries which are presently operating at low capacity due to the collapse of the country's economy. It is also surrounded by farms and mines.

The city is well connected to other parts of Zimbabwe by railway lines and paved, all weather highways. The Mutare highway links Harare to Mutare, the provincial headquarters of Manicaland Province and far afield to the port City of Beira in Mozambique. The Harare – Beit Bridge highway links Harare to South Africa, while the Harare-Chirundu highway links Harare to the northern neighbouring countries of Zambia and Congo. The

The National Railways of Zimbabwe operates a daily overnight passenger train service that runs from Harare to Mutare and another one from Harare to Bulawayo. Harare is linked by long distance bus services to most parts of Zimbabwe. The Harare International airport links the city to other parts of the world with both commercial passenger flights and freigt flights.

The project area is the urban metropolitan under the jurisdiction of the City of Harare. There are currently 46 wards within the city boundaries covering an area of 85,000 hectare – including the recently incorporated Ward 1 (Harare South). The project also covers areas outside of the current city boundary where the council provides water and sewerage services and the peripheral areas earmarked for future inclusion into the city boundary. This includes the fast growing low density suburbs such as Rainham, Mt Hampden, Mt Pleasant Heights and Sally Mugabe and high density areas such as Whitecliffe and Caledonia.

The wards are the planning units for population estimations and projections, however, the most commonly known areas in the city are suburbs. Harare has a number of low density, medium density and high density suburbs. It also has some informal settlements in Harare South, Caledonia and Whitecliffe. The low density suburbs are generally spread across the northern and north-eastern parts of the city, while the low density suburbs are in the west, save for a few exceptions such as Mabvuku and Tafara. The table below lists some of the suburbs in the city

Table 2-1: Harare Suburbs

	Low or medium density Suburbs	High density suburbs	Industrial Areas
Northern	Alexandra Park; Avenues; Avondale, Belgravia; Groombridge; Gun Hill; Kensington; Mount Pleasant; Northwood; Newlands; Vainona**, ,**		
North-eastern	Ballantyne Park; Borrowdale; Borrowdale Brooke; Borrowdale West; Chisipite; Mandara(Lichendale); Colne Valley; Colray; Dawn Hill; Eastlea; Glen Lorne; Glenwood; The Grange; Greendale**,** Greystone Park; Highlands; Helensvale; Hogerty Hill; Kambanji; Lewisam; Luna; Mandara; Philadelphia; Pomona; Quinnington; Rhodesville; Rietfontein; Rolf Valley; Runniville; Shawasha Hills; Umwinsdale**,**	Hatcliffe,	
Eastern	Amby; Athlone; Beverley; Beverley West; Chizhanje; Coronation Park; Green Grove; Hillside;; Manresa; Msasa; Letombo Park; Eastlea	Mabvuku, Tafara	
Southern	Arcadia; Aspindale Park; Braeside; Budiriro; Chadcombe; Cranborne; Grobbie Park; Harare Airport; Hatfield; Hopley; Houghton Park; Induna; Kutsaga; Lochinvar; Logan Park; Malvern; Msasa Park; Midlands; Park Meadowlands; Parktown; Prospect; Queensdale; Southerton; St. Martins; Uplands; Waterfalls; Wilmington Park;	Mbare; Sunningdale, Glen Norah; Glen View, Highfield; Rugare	Workington; Willowvale; Graniteside; Ardbennie;
Western	Adylinn; Ashbrittle; Avonlea; Avondale West; Belvedere North; Belvedere South; Bluff Hill; Bluff Hill Park; Cotswold Hills; Lincoln Green; Marimba Park; Marlborough; Meyrick Park; Milton Park; Monovale; New Marlborough; Ridgeview; Sentosa; Sherwood Park; St. Andrews Park; Strathaven; Sunridge; Sunrise; Tynwald; Tynwald South; Warren Park; Westgate, Milton Park; Haig Park; Ashdown Park, Mabelreign; Greencroft; Emerald Hill; Westlea	Crowborough North; Dzivaresekwa; Kambuzuma; Kuwadzana;; Budiriro, Mufakose, Warren Park.	

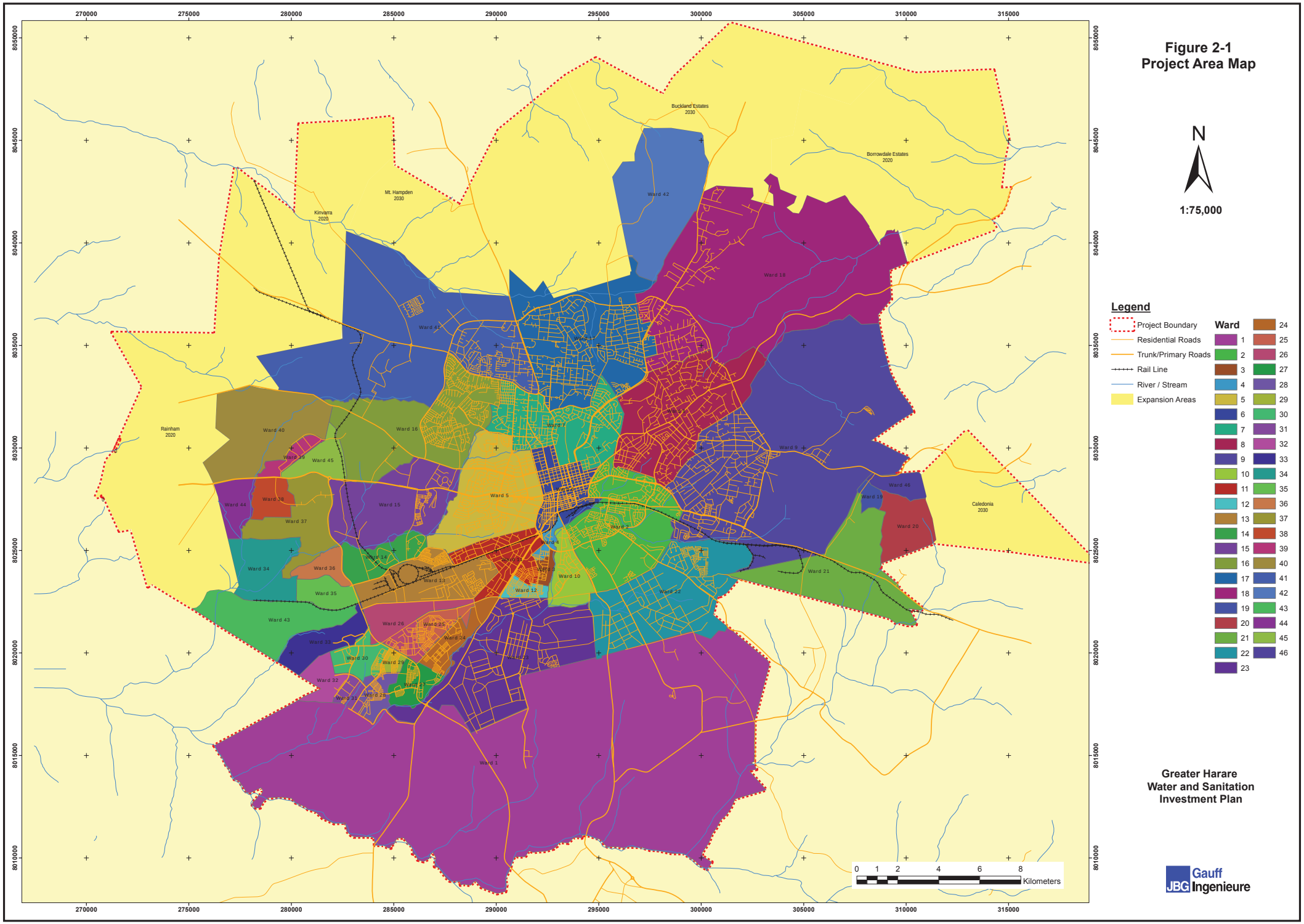
Figure 2-1
Project Area Map
N
1:75,000
Legend
Project Boundary
Residential Roads
Trunk/Primary Roads
Rail Line
River / Stream
Expansion Areas
Ward
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Buckland Estates 2030
Borrowdale Estates 2020
Mt. Hampden 2030
Kinvarra 2020
Rainham 2020
Caledonia 2030
0 1 2 4 6 8
Kilometers
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

2.2.2 Chitungwiza

Chitungwiza started off as dormitory town in 1978 by creation of an urban council which initially incorporated St. Marys, Zengeza townships (formerly under the City of Harare), the Seke area (formerly under the African Development Fund of Internal Affairs) and the TILCOR industrial complex. Chitungwiza was granted town council status in 1981 and became a municipality in 1996.

The project area is the urban metropolitan under the jurisdiction of Chitungwiza Municipality. It stretches from Manyame River in the north-west to Duri River in the south-east. It is bound by Seke Road on the north and the Nyatsime River on the south. This project also covers areas outside of the current municipality boundary earmarked for conversion into urban development. The area across the Nyatsime River has been identified as the expansion area where the future additional population will settle. The area has already been planned and demarcated into 5 wards. The council is planning to develop 50,000 stands in this area over the next 30 years. The town will also grow northwards, taking up communal land in Seke District.

The most commonly known areas in the municipality are suburbs, sections and “units”. The main suburbs in Chitungwiza are St Mary’s, Seke and Zengeza. St Mary’s, located in the northern part, is the oldest suburb in Citungwiza and is divided into two areas generally known as St Mary’s South and St Mary’s North. Zengeza is located in the central section of the municipality and is divided into five sections numbered from 1 to 5.

Seke is a conglomeration of more than 15 housing estates commonly known as “Units”. The units are named alphabetically from unit A to P (skipping I). The northern part of Seke is called Seke North, while the southern part is called Seke South. The houses are mostly high density detached units of single storey with a small yard.

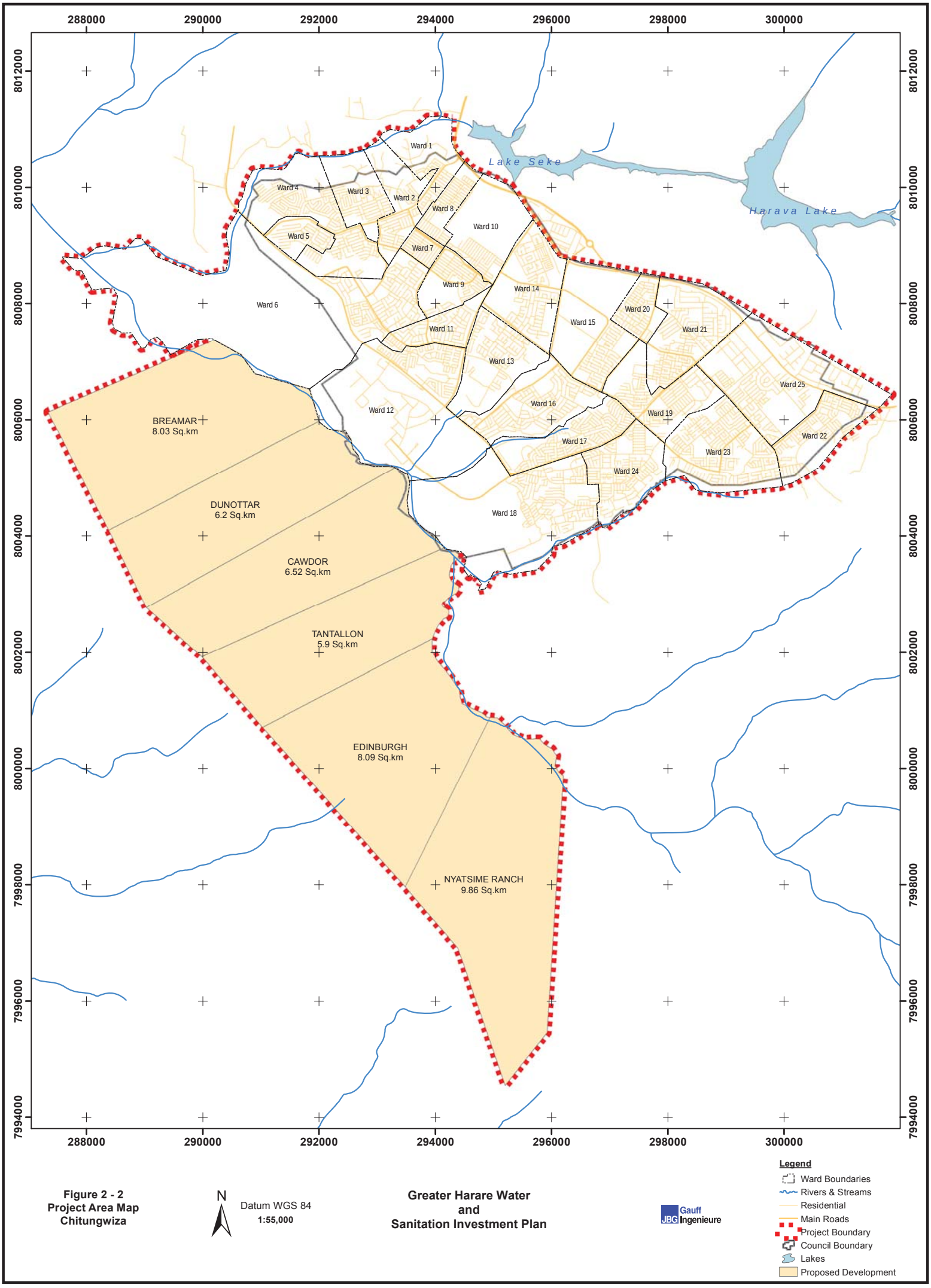


Figure 2 - 2
Project Area Map
Chitungwiza

N

Datum WGS 84
1:55,000

Greater Harare Water
and
Sanitation Investment Plan

Gauff JBG Ingenieure

2.2.3 Epworth

Epworth is located about twelve kilometres south-west of the Harare City Centre. It is a high density dormitory town administered by a Local Board – the local authority mandated with the provision of municipal services. It started off a Methodist Mission Post before it was inundated by the large influx of people in the late 70s and early 80s from the rural areas in search of economic opportunities in Harare. The Methodist Church could not control the influx of people, and therefore transferred ownership of the farm to the Ministry of Local Government in 1983. Given that the area was not planned as an urban settlement, it quickly became an informal settlement. It was formalised as a Local Board in 1986 under the Urban Councils Act. Since its inception, the area has grown rapidly, but the rate of growth has not been matched with the provision of basic services such as water, roads and decent sanitation. The local board however is in the process of formalising most of the area to facilitate land ownership rights and provision of services to the residents.

There is very little for commercial activity in Epworth. The majority of the people get by as street vendors and informal manufacturers. Even though most of the stands are numbered, the streets are not named. The regularisation processes includes street naming as well.

The project area is the current local board area, which comprises 7 wards. The project area also includes peripheral areas envisaged for inclusion into the local board boundaries within the planning horizon.

Epworth is expected to grow southwards towards Twentydales farm. The population growth in the short term will be absorbed within the current council boundaries. The Twentydales Farm is likely to be incorporated only in the long term.

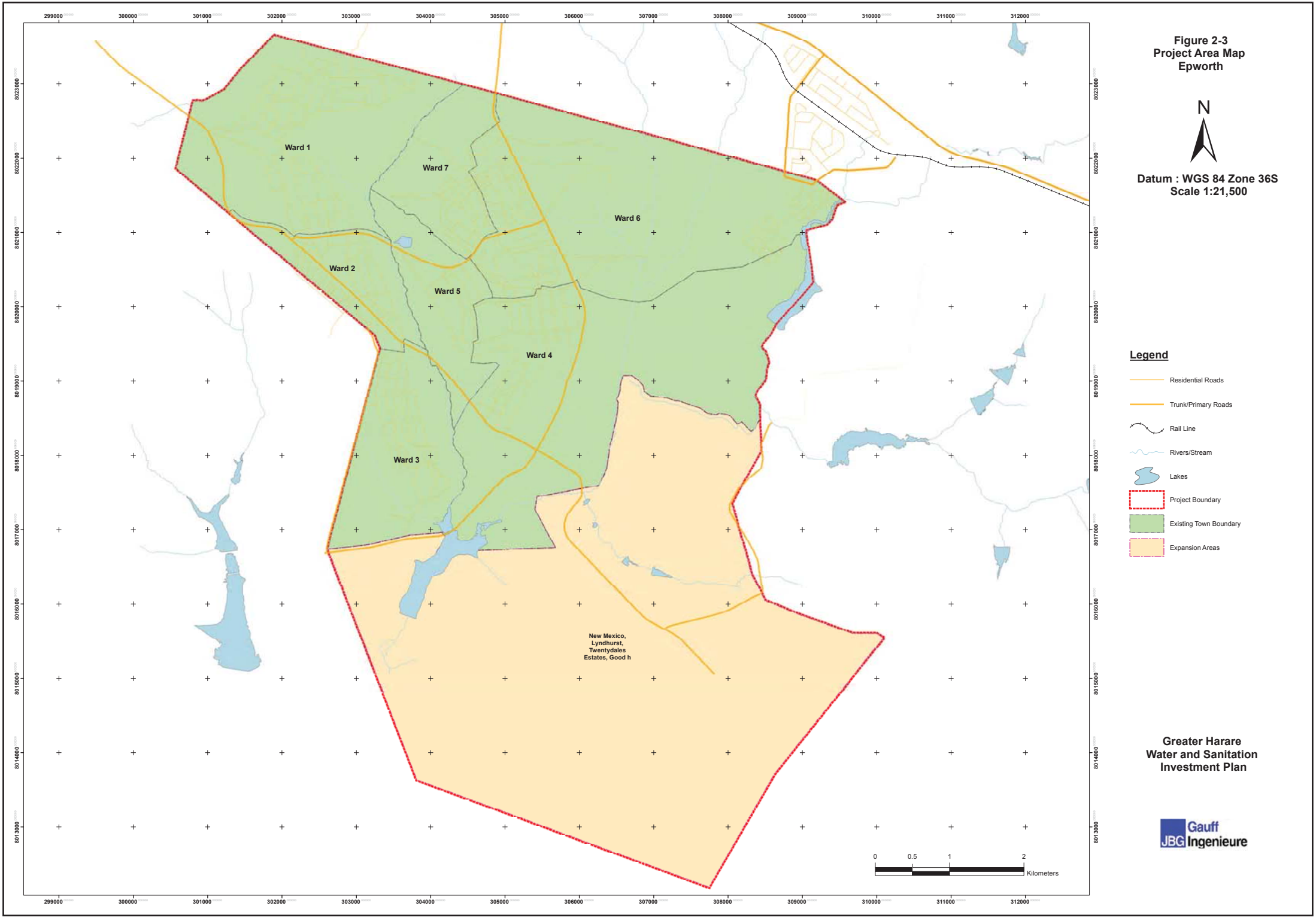


Figure 2-3
Project Area Map
Epworth

Datum : WGS 84 Zone 36S
Scale 1:21,500

Greater Harare
Water and Sanitation
Investment Plan

Gauff JBG Ingenieure

2.2.4 Norton

Norton is a satellite town of Harare, located approximately 40km to the west of Harare along the A5 Harare to Bulwayo Road. It is in Chegutu district of Mashonaland West Province. It lies between latitudes 17° 50' S and 17° 54' S, and between longitudes 30° 38' E and 30° 45' E. Norton was originally a farming support and industrial town but has since developed significantly as a dormitory town serving Harare.

The town was established in 1914 and was initially administered by a Town Management Board under the Rural Councils Act. It was upgraded to Town Council status in 1994. The current council area is made up of residential and industrial developments divided into 13 wards with a total area of around 6,000 ha. The 2012 National Census estimated the population of Norton to be around 68,000. Most of this population resides in the high density areas of Katanga and Ngoni.

The town is surrounded by large commercial farms. In fact, the town has expanded over the years by incorporating and subdividing surrounding farms. In recent years, areas such as Knowe, Galloway, Maridale and Johannes have been established by subdividing surrounding farms. The subdivision and development was typically done by private developers.

The phenomenal expansion of Norton over the last 10 years has been driven by private developers seeking housing development investments targeting the working population in Harare. Given its proximity to Harare (only 40 km from the city centre), the town is very attractive for investments in residential housing and agro-processing industry (huge urban market in Harare).

The town is host to the largest Grain Marketing Board Depot. Key local industry includes the Hunyani Pulp and Paper Company (currently dormant), the Dandy Sweets factory and the Allied Cotton Ginnery.

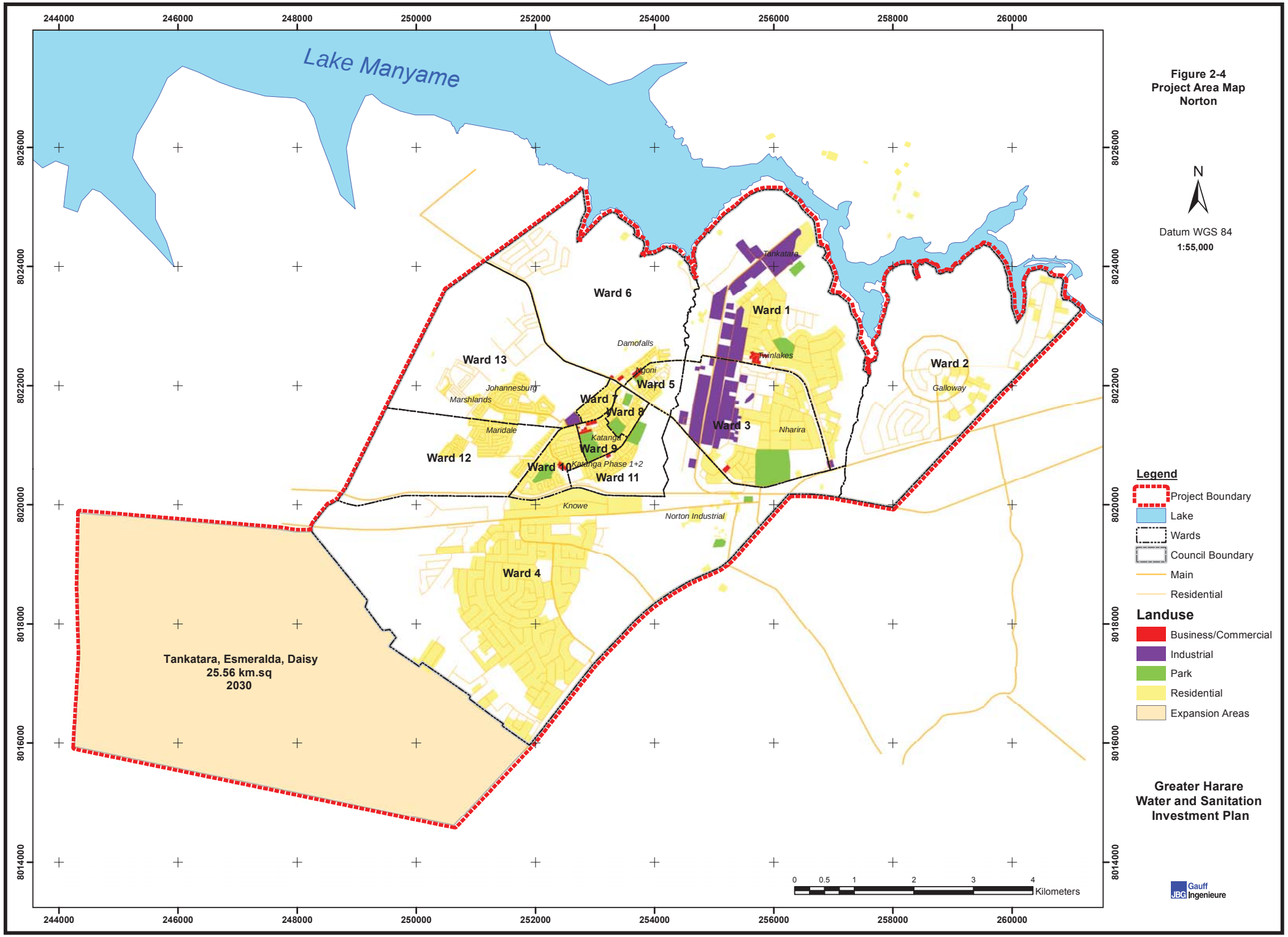


Figure 2-4
Project Area Map
Norton

Greater Harare
Water and Sanitation
Investment Plan

Gauff Ingenieure

2.2.5 Ruwa

Ruwa is a town in Mashonaland East Province, situated 22 km south-east of Harare city centre. It is bisected by the main Harare-Mutare highway and railway line. It serves as a small administrative and trading centre for the surrounding mixed farming area. The town has seen rapid growth in recent years mainly because of the housing development opportunities. It has become a popular area for private housing developers and people moving out of Harare.

Ruwa is lies between latitudes 17° 52' S and 17° 55' S, and between longitudes 31° 18' E and 31° 15' E. Originally an industrial suburb it has continued to provide for both industry and increasingly as a dormitory town for Harare.

Originally formed as a Local Board, Ruwa is in the process of attaining Town Council status. Development has generally been formal and well planned.

The project area is the urban wards under the current jurisdiction of the local authority and the peripheral areas that the council intends to provide water and sanitation services to in future. The town is divided into 9 wards cover a land area of approximately 4,000 ha. Most of the wards are high density residential areas except for Wards 7, 8 and 9, which are either medium or low density residential areas. Most of the industrial and commercial land use is located in wards 7 and 9. The 2012 National Census estimated the population in Ruwa to be approximately 56,000

The town is expected to expand into Anthelney Farm, Mara Farms and Tarisa Farms. This expansion is likely to happen in the long term. In the short-term, the population increase will be absorbed within the current council boundary, especially in Wards 7, 9 and 5. It is important to note that the extension area to the east includes the catchment for the Green Sykes Dam – a water source and storage reservoir for the raw water from Nora Dam. This area must be protected from excessive human development.

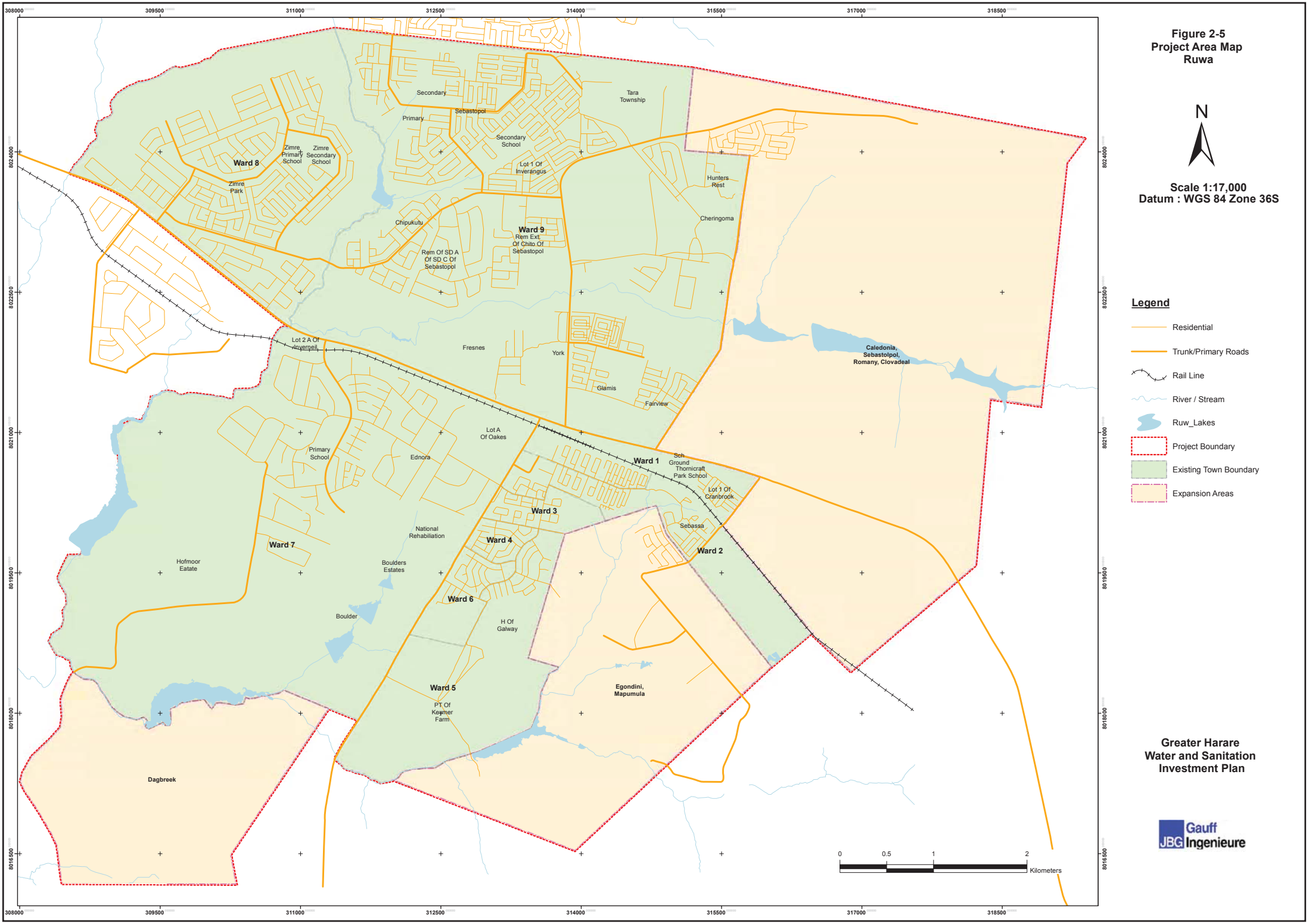


Figure 2-5
Project Area Map
Ruwa
N
Scale 1:17,000
Datum : WGS 84 Zone 36S
Legend
Residential
Trunk/Primary Roads
Rail Line
River / Stream
Ruw_Lakes
Project Boundary
Existing Town Boundary
Expansion Areas
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure
0
0.5
1
2
Kilometers
Ward 1
Ward 2
Ward 3
Ward 4
Ward 5
Ward 6
Ward 7
Ward 8
Ward 9
Tara Township
Secondary
Primary
Sebastopol
Secondary School
Lot 1 Of Inverangus
Hunters Rest
Cheringoma
Zimre Primary School
Zimre Secondary School
Zimre Park
Chipukutu
Rem Ext Of Chito Of Sebastopol
Rem Of SD A Of SD C Of Sebastopol
Lot 2 A Of Invernell
Fresnes
York
Glamis
Fairview
Caledonia, Sebastolpol, Romany, Clovadeal
Lot A Of Oakes
Primary School
Ednora
Sch Ground Thornicraft Park School
Lot 1 Of Cranbrook
Sebassa
National Rehabiliation
Hofmoor Eatate
Boulders Estates
Boulder
H Of Galway
PT Of Kenmer Farm
Egondini, Mapumula
Dagbreek

2.3 Climate

Greater Harare has a subtropical highland climate. The average annual temperature is 18°C, rather low for the tropics. This is perhaps due to its high altitude position and the prevalence of a cool south-easterly airflow.

The Greater Harare area experiences three main seasons: a warm, wet season from November to March/April (rainy season); a cool, dry season from May to August (winter); and a hot, dry season in September/October. In the coldest month of July the average daily temperature ranges from about 7°C to 20°C, while in the hottest month (October), it ranges from about 13°C to 28°C. The figure below shows the average highs and lows over an average year.

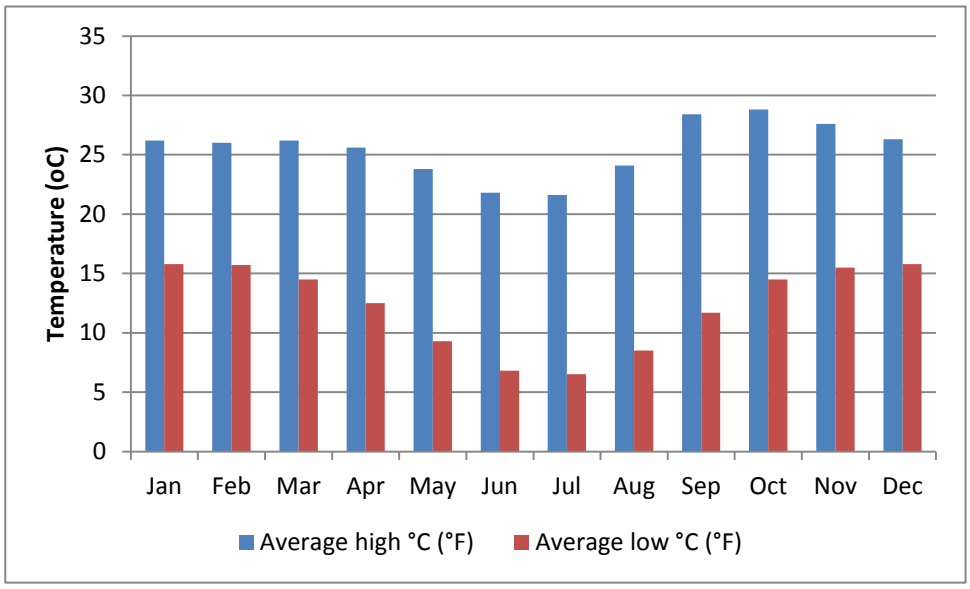


Figure 2-6: Temperature Variation Chart

Source: Zimbabwe Meteorological Service Department

The rainy season starts around November and lasts for approximately five months until April. The average annual rainfall is about 825 mm. Very little rain typically falls during the period May to September, although sporadic showers occur most years. The wettest month is January with around 200 mm of rainfall. Rainfall varies a great deal from year to year and follows cycles of wet and dry periods from 7 to 10 years long. The figure below shows the variations of rainfall over an average year.

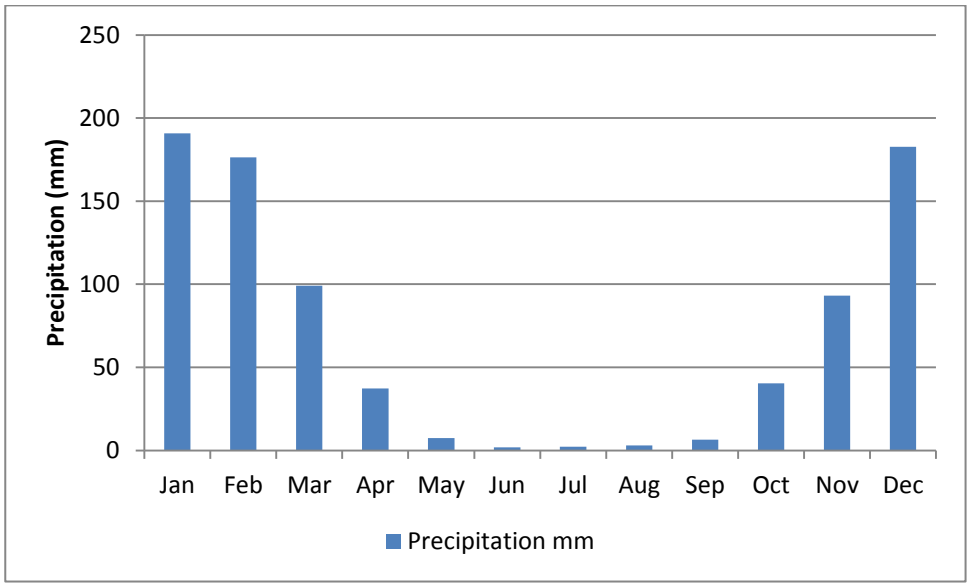


Figure 2-7: Precipitation Variation Chart

Source: Zimbabwe Meteorological Service Department

2.4 Topography

The general topography of Zimbabwe is characterised by a central watershed which stretches across the country from the north-east to the south-west. The Greater Harare sits on one of the higher parts of the watershed. It was constructed on naturally flat and marshy plateau bounded by rocky hills in the central watershed. The terrain gently galls towards the south-west and the north-east. The ground elevation over the city averages around 1,500 m amsl. The southern, western, central and south-eastern parts of Harare drain southwards into the Manyame River, while the north-eastern part drains northwards into the Mazoe River system.

The landscape is covered by a natural vegetation of open woodland. The most common tree of the local region is the Msasa (Brachystegia spiciformis) that colours the landscape wine red with its new leaves in late August. Two South American species of trees, the Jacaranda and the Flamboyant, which were introduced during the colonial era, contribute to the city's colour palette with streets lined with either the lilac blossoms of the Jacaranda or the flame red blooms from the Flamboyant.

2.5 Hydrological and Hydrogeological conditions

Greater Harare lies in the upper Manyame sub-catchment – part of the Manyame catchment. Manyame catchment covers areas that are drained by three main rivers; Manyame, Musengezi and Angwa. The catchment is reasonably well endowed with water due to the relatively high mean annual rainfall of around 750mm. The upper Manyame Sub-catchment receives the highest rainfall.

The general geology of Upper Manyame Sub-Catchment consists of greenstones of the Bulawayan Group, Older gneisses and granites of the Basement Complex, Great dyke mafics and ultra-mafics, doleritic and gabbroic dykes. The greenstone belt occupies the central part of the sub-catchment and consist of tightly folded, extremely sheared and metamorphosed volcanic and volcaniclastic or sedimentary rocks of the Bulawayan Group. Because of the fissures in these formations, groundwater potential is very high. Water

yields do vary from 0.5-3.0 l/s. Borehole depths range from 30-60 m and water strikes vary from 10-40 m. Groundwater levels range from 1-20 m and are mostly less than 10 m.

Granitic rocks are more abundant than any other rock type in the sub-catchment and stretch from NW to the SE part of the sub-catchment. They are varied in age and range from older gneissic rocks to younger granites. These rocks have poor groundwater potential as they have no primary permeability and porosity. These rocks cover the largest part of the Upper Manyame Sub-Catchment. Groundwater is from secondary structures such as faults, fractures and regoliths. Groundwater potential under such conditions is invariably related to the amount of rainfall, fracture pattern distribution and regolith development. Borehole depths in areas containing gneisses and granites range from 30-50 m. Groundwater levels range from 5- 30 m and are mostly less than 20 m deep. Yields are equally variable ranging from 0.1-0.2 litres per second. Values occurring outside these ranges should be expected depending on the prevailing hydrogeological conditions.

Very few dolerite dykes occur in Upper Manyame Sub-C and they are more or less parallel to the Great dyke. The doleritic intrusions may be easily traced in the field as they form streaks of red soils and sometimes accompanying ridges of black weathering, rounded boulders, supporting a lot of vegetation.[1]

2.6 Water Resources

The municipal water required in the greater Harare area is abstracted from the Manyame River system. The water is impounded at four main dam sites: Manyame (Darwendale), Chivero, Seke and Harava. In a recent study conducted by ZINWA, the 4% yield of the dams was estimated to be 480,000 m^3/day. In addition to the yield of the dams, the catchment receives substantial amounts of water via the return of wastewater effluent (mostly untreated) into the river system.

Studies have already been carried out on potential water sources for Greater Harare in other catchments. Sources such as Kunzvi and Shavanhove in the Mazoe Catchment, and Muda in the Sanyati Catchment have already been verified and will be developed when need arises. The need to develop new sources will be determined on consideration of yield and the quality of the water in the Upper Manyame catchment.

The 4% risk yield of the dams in the Upper Manyame Catchment has already been exceeded by the installed capacity of the water production facilities. The water demand has also already surpassed the yield of the dams – strengthening the case for developing new water sources in other catchments.

2.7 Environmental Situation (Raw water Quality)

The raw water quality in the catchment has been deteriorating at an alarming rate. This is mainly because domestic and industrial wastewater is being discharged into the natural water courses with hardly any treatment as most of the wastewater treatment facilities are dilapidated. A comparison of water quality data from 1996 and 2011 carried out by JICA [2]shows a considerable increase in BOD in the catchment over the last 15 years. The comparison data used was from a 1996 JICA study and the Environmental Management Agency (EMA). The table below shows the water quality comparisons.

[1] ZINWA Manyame RSOP

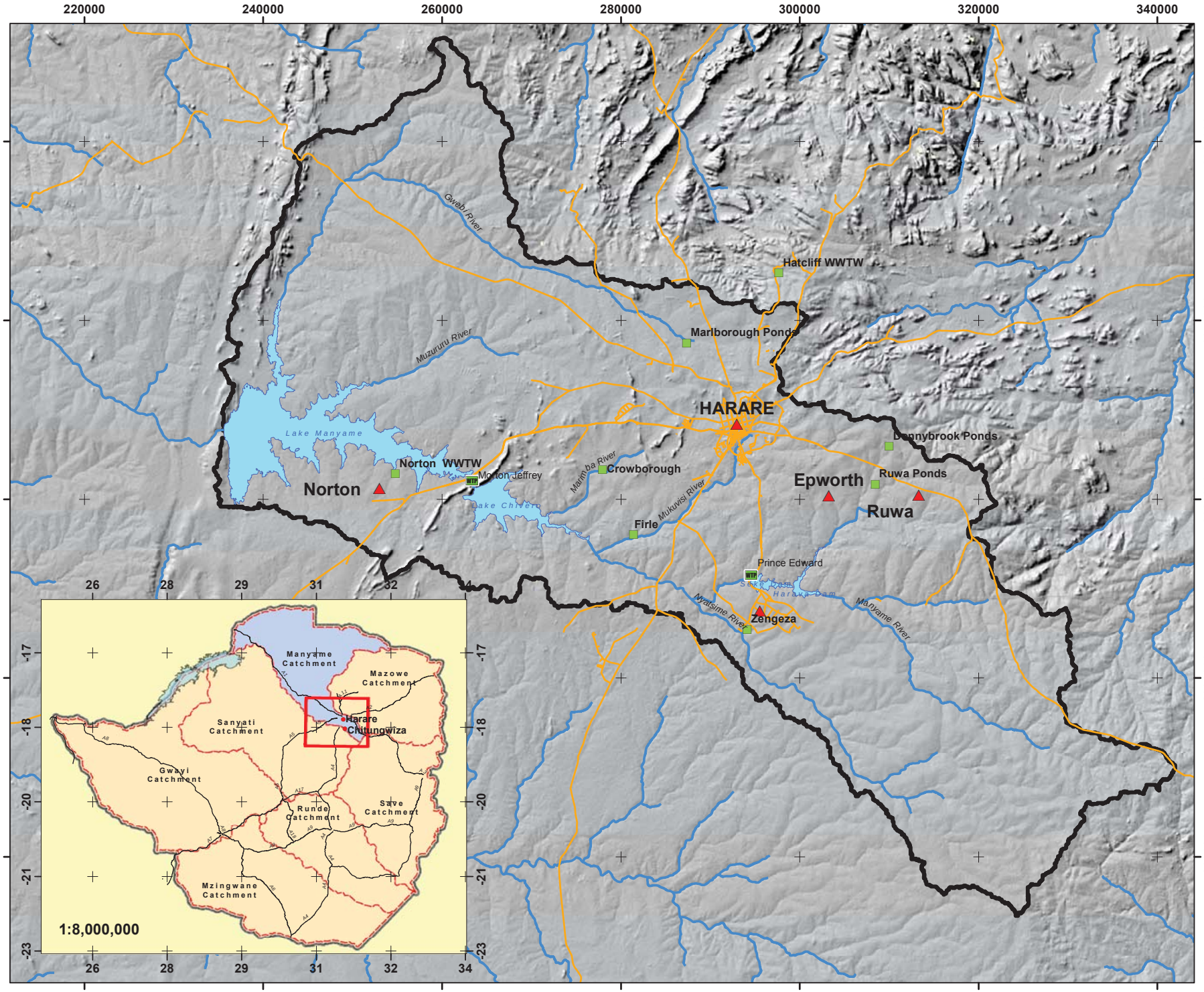
[2] The Project for Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza, JICA, 2013

Table 2-2: Raw Water Quality Comparison over Time

Sampling Point	1996		2011	
	BOD (mg/l)	COD (mg/l)	BOD (mg/l)	COD (mg/l)
Upstream of Harava Dam	1.1		51.1	36.8
Harava Dam		9.5	39.1	36.8
After Seke Dam	0.6		52.1	70.2
Nyatsime after Zengeza WWTW	2.1		51.4	460
Morton Bridge after Lake Manyame			57.4	62.3

Source: JICA Report on Chitungwiza (2013)

Given these findings, there is clear need to rehabilitate the existing wastewater treatment facilities in the catchment and to consider appropriate wastewater technologies that will help clean up the catchment.


220000
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-18
-20
-21
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26
28
29
31
32
34
Gweb River
Muzururu River
Lake Manyame
Norton WWTW
Morton Jeffrey
Norton
Lake Chivero
Marimba River
Crowborough
Hatcliff WWTW
Marlborough Ponds
HARARE
Mukuvisi River
Firle
Dennybrook Ponds
Ruwa Ponds
Epworth
Ruwa
Prince Edward
Seke Harare Dam
Nyatsime River
Zengeza
Manyame River
Manyame Catchment
Mazowe Catchment
Sanyati Catchment
Harare
Chitungwiza
Gwayi Catchment
Runde Catchment
Save Catchment
Mzingwane Catchment
1:8,000,000
Figure 2-8
Map of the Upper Manyame Catchment
N
1:400,000
Datum WGS 84
Greater Harare Water and Sanitation Investment Plan
Legend
Project Towns
Water Treat Plants
Waste Water TP
Highway/Roads
Rivers and Streams
Lakes and Dams
Upper Manyame Catchment
Gauff
JBG Ingenieure

CHAPTER 03: URBAN PLANNING AND DEMOGRAPHIC PROFILE

3 URBAN PLANNING AND DEMOGRAPHIC PROFILE

3.1 Introduction

The Greater Harare Metropolitan Area includes the five component settlements of Harare Chitungwiza, Epworth, Ruwa and Norton. Each of these centres is managed by an independent urban authority: the Harare City Council, Chitungwiza Municipality, the Epworth Local Board, the Norton Town Council and the Ruwa Local Board. Each town has its own unique history and pattern of development and, to date, there has been little in the way of coordinated planning between the individual towns. However, to a large extent, these centres do function as part of single urban and economic entity. In particular they are linked together on the basis of sharing a common water supply system and, also, all their wastewater treatment systems discharge upstream of the water supply dams on the Manyame River and consequently affect their common water supply.

The four centres of Harare, Chitungwiza, Epworth and Ruwa form a single contiguous urban area whilst Norton is located some 45 km to the west of Harare. Norton and Ruwa are both situated alongside primary access roads and railway lines, to the west and east respectively. Both were initially developed to provide opportunity for industrial expansion outside of Harare, although more recently the focus has been on residential development. Chitungwiza has a limited industrial area and, together with Epworth, they primarily serve as satellite residential areas for Harare.

Harare, with an area of 850 km^2 is by far the largest of the entities, and accounts for 81.9% of the overall extent of 1,037 km^2 currently included under the Greater Harare Metropolitan Area. Corresponding figures for the other centres are Chitungwiza 51 km^2 (4.9%), Epworth 34 km^2 (3.3 %), Norton 60 km^2 (5.8%), and Ruwa 42 km^2 (4.0%).

Harare is situated on the watershed between the Manyame catchment to the south and west and the Mazowe catchment to the northeast. Other than the small parts of Harare to the north and east (Hatcliffe, Borrowdale, Highlands, Greendale and Caledonia) which drain north into the Mazowe River, the bulk of the city together with all of Ruwa, Epworth, Chitungwiza and Norton drain to the west into the Manyame River. This leads to the unfortunate position whereby Harare, Chitungwiza, Epworth and Ruwa are all situated upstream of the main water supply dams of Lake Chivero and Lake Manyame, and even for Norton drainage is to the north directly into Lake Manyame.

As the capital of Zimbabwe, Harare strongly dominates Greater Harare in terms of area, population and development of commerce and industry. Harare has a well defined Central Business District (CBD) which is lacking for the other centres of Chitungwiza, Epworth, Norton and Ruwa. In each case plans exist for development of a town centre but these have yet to be developed. As the capital city, Harare also supports the bulk of the institutional development, in particular hosting a large number of national organizations. For the other centres, institutional development is limited, the most numerous organizations being educational facilities, particularly schools, and churches.

Harare also includes the largest industrial areas. Chitungwiza, Norton and Ruwa each have some industry; indeed the modern development of Norton and Ruwa was specifically in order to reduce pressure on industrial areas in Harare. Despite previous industrial development in these smaller centres, many of the large companies have now ceased operation or have relocated, This is largely due to the prevailing national economic malaise, but has been compounded by erratic water supplies to these towns.

All towns include a mix of two or more types of housing: these being low density (LD), medium density (MD), high density (HD) and informal settlements, although the proportions of each differ widely between the different towns according to their individual histories of development.

The overall purpose of this chapter is to provide detailed spatial population estimates that can serve to inform calculations of future water demand for Greater Harare. The remainder of this chapter presents historical population data (Section 3.2) and projected future populations (Section 3.3) and, in Section 3.4, these are broken down according to individual wards and by housing types. Calculation of institutional, commercial and industrial water demand is based on indirect methods, such that the focus of this analysis is primarily on residential populations. All population data is derived from official ZIMSTAT reports, and ward boundaries are those used by ZIMSTAT for the 2012 census. It should be noted that these ward boundaries have been subject to marked changes in recent years, often for political purposes, and that the ZIMSTAT boundaries do not necessarily coincide with those currently in use by the respective urban authorities. More detailed reports relating to each town are included in Appendices 3-1 to 3-5.

3.2 Historic and Present Population

Population census data for Harare and Chitungwiza goes back to at least 1969, whilst disaggregated data was first reported for Norton in 1982, and for Epworth and Ruwa only in 1992 (Table 3-1, Figure 3-1). Corresponding annual rates of population growth for the respective census intervals are shown in Table 3-2. It should be noted that the 2012 population figure for Harare includes the population of six adjacent wards, currently outside of the official city boundary, but for which neighbouring parts are already in the process of being incorporated or, in the near future, are expected to be incorporated into the city. These are Wards 35 and 24 of Zvimba District, Ward 20 of Mazowe District, and Wards 6, 7 and 25 of Goromonzi District (Figure 3.2). Collectively, these six wards add an additional 109,708 people to the 2012 Harare population.

Harare strongly dominates the overall population of Greater Harare, in 2012 accounting for 72.5% of the overall population of 2,356,764 people. Corresponding figures for the other centres were 15.1% for Chitungwiza, 7.1% for Epworth, 2.9% for Norton and 2.4% for Ruwa.

Summing the individual populations, Greater Harare has grown in population from 379,000 in 1969 to nearly 2.4 million in 2012. This represents a six fold increase over a span of 43 years. During this period the mean annual growth rates for Greater Harare have consistently been markedly higher than for the country as a whole, such that Greater Harare has grown to account for a steadily increasing proportion of the overall national population, from 7.4% in 1969 to 18.2% in 2012. This trend is shared with many of the big cities in Africa and can be expected to continue. The expected result will be the increasing concentration of population, economic activity and wealth within Greater Harare.

A second key point to note is the marked decline in mean annual growth rates for both the country as a whole and for Greater Harare during the last twenty years (1992-2012) as compared to the previous period from 1969-1992. For Greater Harare the growth rates were over 6% in the earlier years, decreasing to 2.62% for the period 1992-2002 and to 1.84% for the following period to 2012. The primary causes of this decline include the devastating HIV pandemic, leading to markedly increased mortality rates, and the

pronounced economic decline from the late 1990s to the present, which has stifled economic growth and resulted in high levels of out-migration.

Given the present unpromising macroeconomic outlook, future urban growth is likely to be due more to the push of continued high levels of poverty in rural areas rather than the pull of new urban opportunities resulting through investment and economic growth. Thus, whilst Greater Harare appears to have adequate land available to support continued growth, actual development is likely to be strongly constrained by the prevailing adverse investment climate.

Table 3-1: Population Data for Greater Harare from 1969 to 2012 (Source: ZIMSTAT)

YEAR	1969	1982	1992	2002	2012
Harare*	364,390	658,364	1,148,073	1,458,807	1,708,538
Chitungwiza	14,970	172,000	274,912	323,260	356,840
Epworth			62,630	114,067	167,462
Norton		12,438	29,000	44,397	67,591
Ruwa			1,447	23,681	56,333
Total Greater Harare	**379,360**	**842,802**	**1,516,062**	**1,964,212**	**2,356,764**
ZIMBABWE	5,134,300	7,608,432	10,412,548	11,631,657	12,973,808
Total as % of Zimbabwe	**7.4**	**11.1**	**14.6**	**16.9**	**18.2**

* Note that the Harare population figures from 1992 onwards include Harare South (Ward 1), and the figure for 2012 also includes populations from six adjacent wards amounting to a total of 109,708 people.

Figure 3-1 below shows the population growth in Greater Harare from 1969 to 2012. (Source: ZIMSTAT).

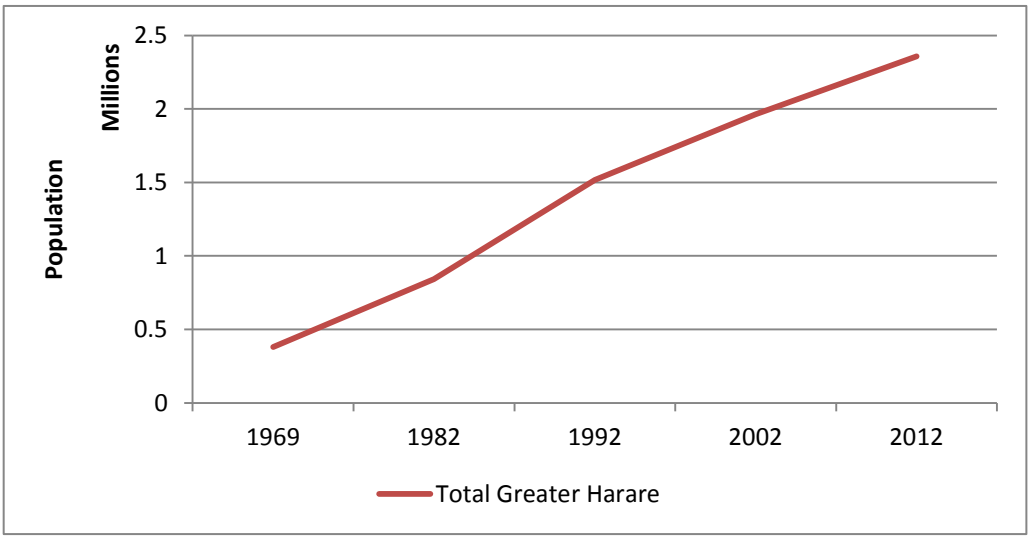

Figure 3-1: Population Growth in Greater Harare from 1969 to 2012

Table 3-2 below shows mean inter census annual population growth rates for Greater Harare from 1969 to 2012. (Source: ZIMSTAT).

Table 3-2: Inter Census Annual Growth Rates

PERIOD	1969-82	1982-92	1992-02	2002-12
Harare	4.66%	5.72%	2.42%	1.59%
Chitungwiza	20.66%	4.80%	1.63%	0.99%
Epworth			6.18%	3.91%
Norton		8.83%	4.35%	4.29%
Ruwa			32.25%	9.05%
Total Greater Harare	**6.33%**	**6.05%**	**2.62%**	**1.84%**
ZIMBABWE	3.07%	3.19%	1.11%	1.10%

Historical mean annual rates of growth have varied greatly from one town to another. In general the rates of growth over the last 20 years for Epworth, Norton and Ruwa have been substantially higher than those for Harare or Greater Harare as a whole. Chitungwiza, in contrast, has experienced considerably lower growth rates over this period, probably due to limited space for further expansion. Ruwa and Norton have offered ample space for growth, and have attracted considerable levels of state and private investment, whilst in Epworth there has been a massive expansion of informal settlement. This has also been the case for Harare Ward 1 (Harare South or Harare rural) which has increased in population from 23,023 in 2002 to 113,599 in 2012, with virtually all the increase being of informal settlement, as well as the neighbouring areas of Caledonia (Goromonzi Ward 25) and Whitecliff (Zvimba Ward 35).

3.3 Population Projections

A key limitation to projecting urban population is the unpredictability of some of the population change factors, especially net migration. While births and deaths could potentially be estimated from historical trends, since they take some time to change significantly, net migration can be influenced by and can quickly respond to short-term changes such as economic swings and patterns of investment. For this reason the approach adopted here was to estimate growth rates of the population from historical data and make reasonable scenarios about these growth rates into the future.

Future population growth rates for Greater Harare were estimated through consideration of historical rates of growth (Table 3-2), comparison to regional data (Table 3-3), comparison to estimated growth rates for towns included under the associated Urgent Water Supply and Sanitation Rehabilitation Project (Table 3-4) and through discussions with the respective urban authorities. A number of workshops were held to debate and achieve consensus on the proposed future growth rates.

Data on population growth was obtained from 87 urban centres (>25,000 people) in seven comparable Southern and East African countries for which data was available (Namibia, Botswana, Mozambique, Zambia, Malawi, Tanzania, Kenya), as recorded over their most recent census interval (variously 1997-2007 to 2002-2012). For all 87 towns the overall range of annual growth rates over the last decade was -0.03% to 6.97% with a mean value of 3.23% (Table 3-3). The data further suggests that growth is stronger in the largest cities

(> 1 million inhabitants = 3.94%) and slightly lower in smaller centres (3.1% for centres smaller than 250,000 people).

Table 3-3 shows comparative annual growth rates for 87 Southern and East African urban areas (>25,000 people) over their respective most recent census intervals (from 1997-2007 to 2002-2012).

Table 3-3: Comparative Annual Growth Rates

Population	Number	Range (%)	Median (%)	Mean (%)
> 1 Million	4	1.25% - 5.78%	4.36%	3.94%
500,000 – 1 Million	5	2.79% - 4.69%	4.06%	3.88%
250,000-500,000	12	0.83% - 7.16%	3.39%	3.47%
100,000-250,000	32	0.38% - 6.55%	2.71%	3.08%
25,000-100,000	34	-0.03% - 6.97%	3.14%	3.11%
Total	**87**	**-0.03% - 7.16%**	**3.32%**	**3.23%**

Under the UWSSRP future population growth rates for the six project towns (Chegutu, Masvingo, Kwekwe, Mutare, Chitungwiza and Harare) were examined and debated at a combined workshop held in Harare on 09 July 2013. A key outcome of the workshop was to estimate future annual rates of population growth to 2020 and 2030 for each of the project centres, based on specific conditions pertaining to each of the centres.

Table 3-4 shows the projected annual growth rates for the medium (2012-2020) and long term (2020-2030) for the six UWSSRP project towns. (Source: Workshop, Harare, 09 July 2013).

Table 3-4: Projected Annual Growth Rates for UWSSRP Centres

	Annual Growth Rate (%)		
PERIOD	**2002-2012**	**2012-2020**	**2020-2030**
Chegutu	1.39%	4%	2%
Masvingo	2.45%	3%	1.5-2%
Kwekwe	0.71%	3%	4%
Mutare	1.00%	3%	4%
Chitungwiza	0.93%	1.1%	2%
Harare	0.23%	4%	4%

The resulting estimates varied between 1.1-4% for the period 2012-2020 and from 2-4% for the subsequent interval from 2020-2030.

Now that the 2013 national election has been concluded, the extent of the macroeconomic challenges facing the country is clear, and there is little to suggest that the population growth trajectory for the coming years should be substantially different from the recent past. Certainly, there seems no feasible justification for predicting an immediate increase to the level of 4% per annum for Harare. The future mean rate of growth for Greater Harare for the period 2012-2020 was thus estimated at 2%, this being slightly higher than the figure of

1.84% obtained during the previous census interval. Consistent with this overall figure the individual growth rates of Chitungwiza, Norton and Ruwa for the period 2012-2020 were maintained at their same levels as for 2002-2012 (Table 3-5). For Epworth, the rate of growth is expected to decline due to restricted opportunities for further expansion within its existing footprint, combined with the fact that the town is hemmed in between Harare and Ruwa such that the opportunities for additional external growth are also strongly constrained. The future rate of growth for Epworth from 2012-2020 is therefore expected to be 2.5% as compared to the former value of 3.91% for the period 2002-2012. For Harare, it was assumed that the relatively restricted opportunities for growth in Chitungwiza and Epworth would be compensated for by marginally higher rates of growth here, such that the future growth was forecast to increase from the previous figure of 1.59% for 2002-2012 to that of 1.75% for 2012-2020.

Table 3-5: Projected Future Annual Growth Rates for Greater Harare

	Annual Growth Rate (%)			
PERIOD	**2002-2012**	**2012-2020**	**2020-2025**	**2025-2030**
Harare	1.59%	1.75%	4.00%	5.00%
Chitungwiza	0.99%	0.99%	2.00%	4.00%
Epworth	3.91%	2.50%	2.00%	2.00%
Norton	4.29%	4.29%	4.00%	5.00%
Ruwa	9.05%	9.05%	4.00%	5.00%
Total Greater Harare	**1.84%**	**2.00%**	**3.59%**	**4.68%**

Population growth for Greater Harare is projected to escalate markedly after 2020. Individual projections for Harare, Ruwa and Norton are estimated at 4% to 2025 and 5% to 2030. Corresponding estimates for Epworth are lower (2% and 2%) again due to space constraints, and also for Chitungwiza (2% and 4%), on the basis that the targeted area of expansion on the Nyatsime Farms is further away from the city centre than much of Harare, such that development in this area is likely to be slower until such time as the closer areas are beginning to reach capacity. These figures imply overall growth for Greater Harare of 3.59% for the period 2020-2025, and increasing to 4.68% for the subsequent interval to 2030.

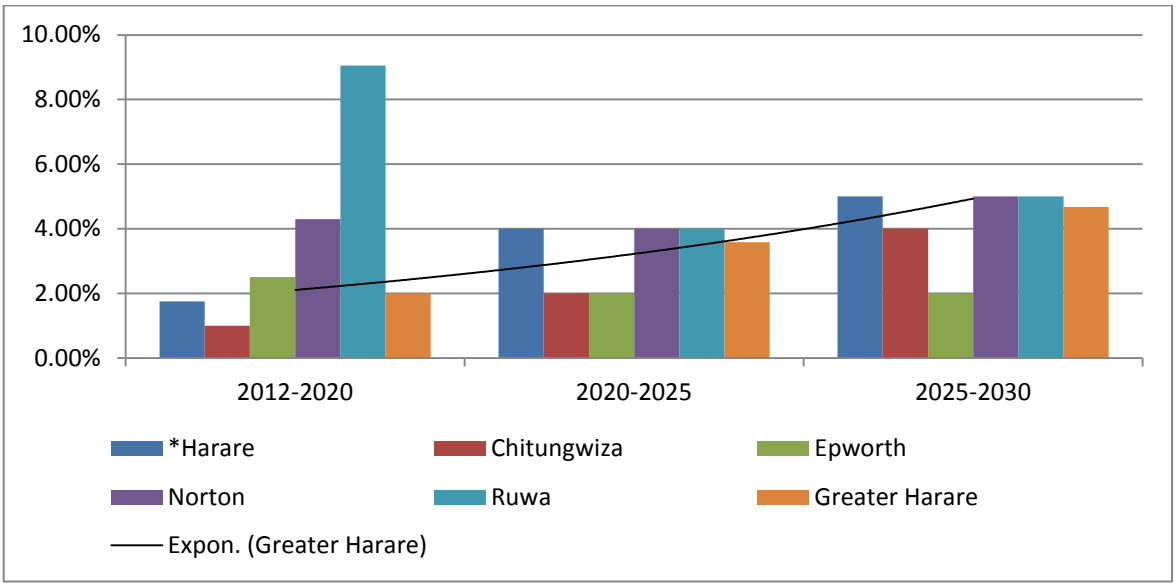

Figure 3-2: Projected Population Growth Rates

Applying these estimated growth rates the resulting projected populations are shown in Table 3.6. For Greater Harare, the overall population is projected to grow from 2.4 million in 2012 to 2.8 million in 2020 and to 4.1 million in 2030.

Over this same period Harare is estimated to increase from 1.7 million in 2012 to 2.0 million in 2020 and 3.0 million in 2030. Chitungwiza is anticipated to increase to over half a million by 2030, Epworth to reach nearly 250,000 people and Norton and Ruwa to both expand to well over 100,000 people each, to roughly the current size of Epworth.

Table 3-6: Projected Future Populations for Greater Harare

YEAR	2012	2020	2025	2030
Harare	1,708,538	1,962,908	2,388,178	3,047,987
Chitungwiza	356,840	386,199	426,395	518,774
Epworth	167,462	204,036	225,272	248,719
Norton	67,591	94,606	115,102	146,903
Ruwa	56,333	112,682	137,094	174,971
Total Greater Harare	**2,356,764**	**2,760,430**	**3,292,042**	**4,137,355**

Given the inherent high level of uncertainty as regards these future predictions, it is essential that these population estimates should be revisited, at a minimum prior to any detailed planning for the second investment horizon (2020-2030), and particularly in 2022 after the next census has been completed.

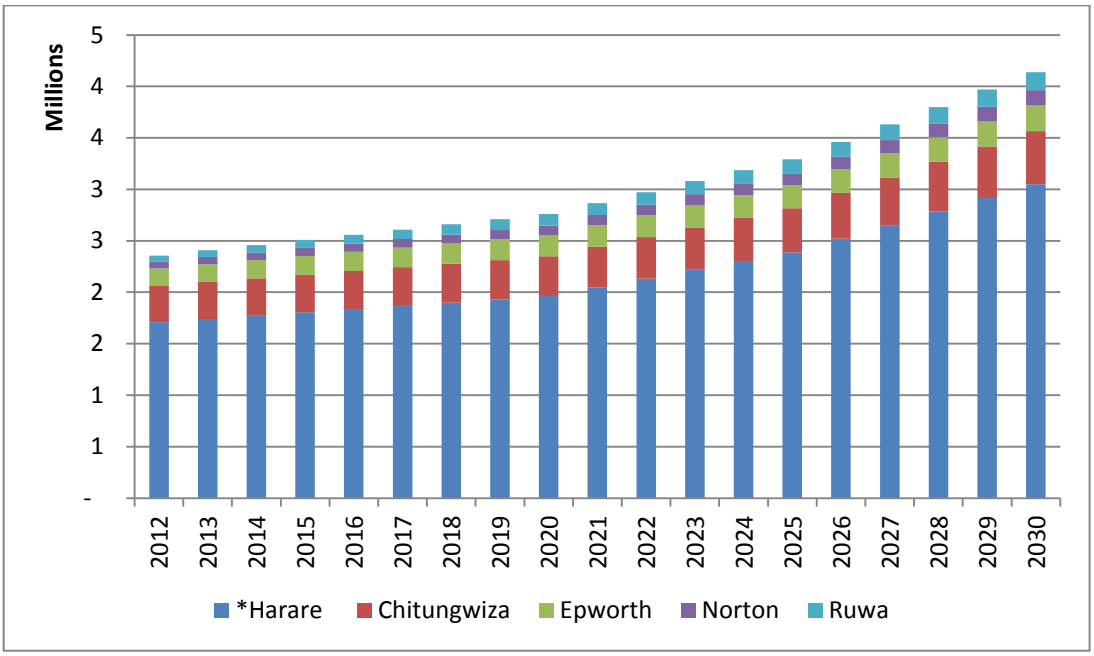

Figure 3-3: Projected Population in Greater Harare

3.4 Urban Planning

There has never been any comprehensive planning carried out for the whole of the Greater Harare Metropolitan Area and none of the component towns have an updated master plan (although for Chitungwiza, JICA has recently completed a detailed study on future water supply and sanitation[1]). The data presented below is largely derived through detailed discussions with the individual urban authorities.

The general approach followed for each town was to examine the existing pattern of land use, including the allocation of 2012 ward populations by residential types. This was followed by consideration of existing plans for future growth and identification of possibilities for growth of different residential types both in existing wards and in neighbouring areas, together with analysis of predicted future demand for different types of housing to 2020 and to 2030. By comparison of expected growth by housing types against identified opportunities for growth, it was then possible to estimate future ward populations by housing types for the two periods to 2020 and 2030. The analysis was largely confined to residential use, since water demand for institutional, commercial and industrial purposes is being estimated through indirect means.

3.4.1 Harare

Harare strongly dominates the Greater Harare Metropolitan Area. With a 2012 census count of 1,708,538 (including peripheral areas) Harare accounted for 72.5% of the overall population, and with an area of 84,994 ha accounts for 81.9% of the overall extent of Greater Harare (Table 3-7). As the capital city of Zimbabwe, Harare hosts many national and local institutions, is the centre of commercial and industrial activity and, unlike the other component towns of Greater Harare, has a well-developed central business district.

[1] The Project for Improvement of Water Supply, Sewerage and Solid Waste Management in Chitungwiza, JICA, 2013

Table 3-7: Areas and 2012 Populations for Greater Harare

	Area (ha)	% of Total Area	Population 2012	% of Total Population
Harare	84,994	81.9%	1,708,538	72.5%
Chitungwiza	5,106	4.9%	356,840	15.1%
Epworth	3,438	3.3%	167,462	7.1%
Norton	6,006	5.8%	67,591	2.9%
Ruwa	4,187	4.0%	56,333	2.4%
TOTAL	**103,730**	**100.0%**	**2,356,764**	**100.0%**

Harare is divided into 46 wards. All wards include residential areas of various types: low density (LD), medium density (MD), high density (HD) or informal (INF) settlements. Low density housing dominates over most of the northern and eastern parts of the city, plus the city centre and a substantial band to the south. There are ten wards that comprise entirely of LD housing (City Centre, Belvedere, Marlborough, Avondale, Mt. Pleasant, Borrowdale, Eastlea, Highlands, Greendale and Waterfalls), plus Mabelreign and Hatfield which are predominantly LD but also include smaller portions of MD housing. MD housing does not dominate in any wards, but rather occurs as a component in association with either LD housing (as for Mabelreign and Hatfield), or else HD housing, as is the case for Sunningdale, Kambuzuma, Highfield, Glen View and Dzivarasekwa. See ward map in Figure 3-4 overleaf.

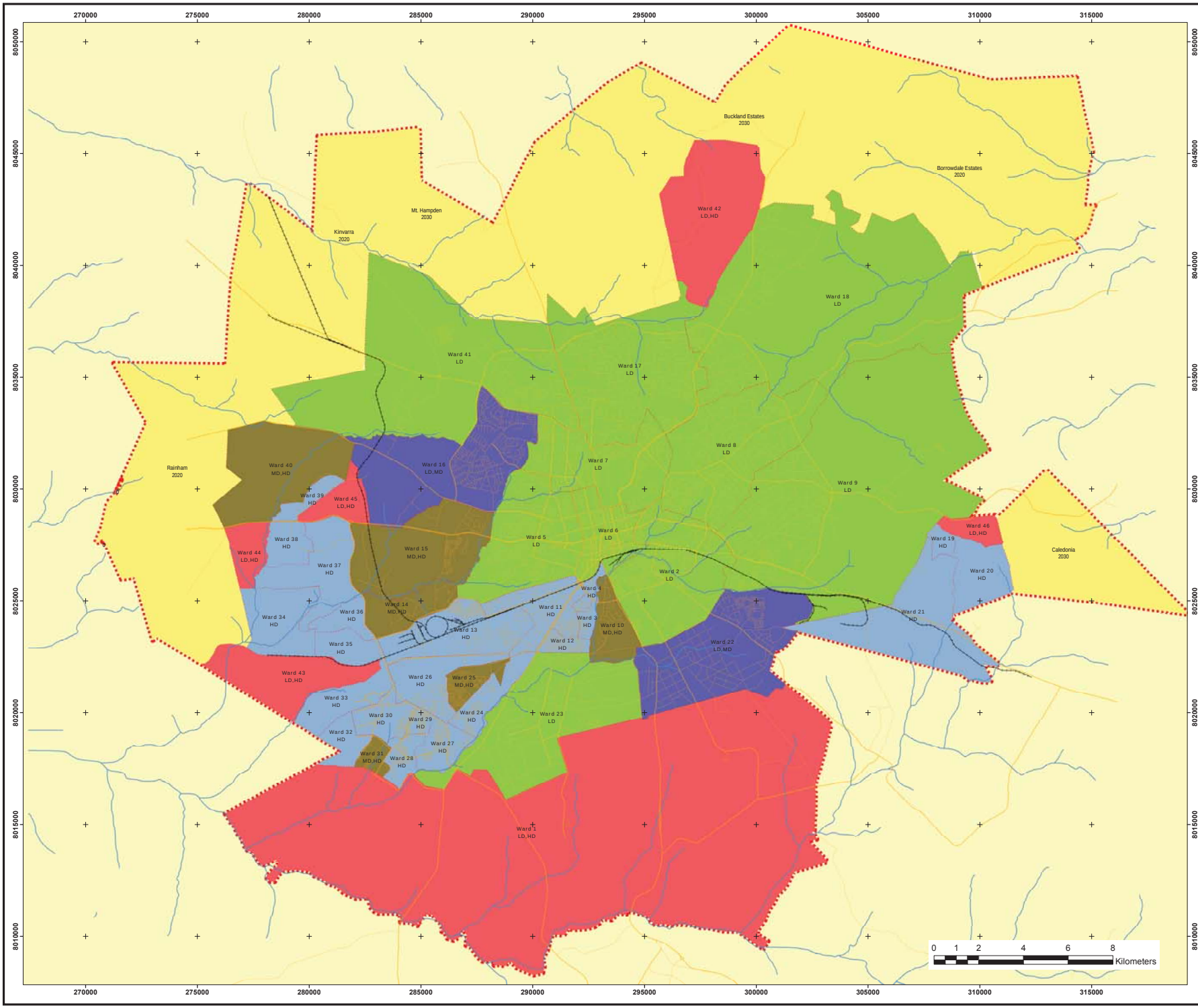

Figure
Ward Map with Housing Categories Harare

N

1:75,000

Legend

- Residential Roads
- Trunk/Primary Roads
- Rail Line
- River / Stream

Category

- HD
- LD
- LD,HD
- LD,MD
- MD,HD
- Project Boundary
- Expansion Areas

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HD housing dominates the southwestern and western portions of the city, with relatively small occurrences to the north (Hatcliffe) and to the east (Mabvuku and Tafara). Immediately to the south of the City Centre are Mbare and Sunningdale. Continuing to the southwest, the sector bounded by the Simon Mazorodze Road (leading south to Masvingo), the High Glen Road (to the west) and the Bulawayo Road, includes the HD areas of Highfield, Rugare, Kambuzuma and Warren Park. Further out, to the west of High Glen Road, are the suburbs of Glen Norah, Glen View, Budiriro, Mufakose, Kuwadzana and Dzivarasekwa. Ward 1 (Harare Rural or Harare South) covers a vast swathe across the southern portion of the city from the headwaters of Lake Chivero in the west to Epworth in the east, and from Chitungwiza in the south to the remainder Harare in the north. Previously commercial farm land, this portion is now dominated by informal settlement.

For the purpose of this project it was decided to include portions of six adjacent wards parts of which have been, or are anticipated as being, incorporated into the city in the near future. These wards comprise Wards 35 (Whitecliff, Rainham, Spitzkop, Heaney and Rydale Ridge) and 24 (Mt. Hampden) of Zvimba District to the west; Ward 20 (Mt. Pleasant Heights) of Mazowe District and Wards 6 (Sally Mugabe Heights) and 7 (Echo and Rumani farms) of Goromonzi District to the north and, to the east, Ward 25 (Caledonia) also of Goromonzi District. Zvimba Ward 24 and the three northern wards currently include and are expected to be developed as LD settlements. Caledonia comprises entirely of informal settlement, while Whitecliff is dominated by informal settlement (75%), but also includes portions of MD (20%) and LD (5%) housing.

For Harare, for all 52 wards, the estimated break down of population in 2012 by housing types was as follows: 28.3% LD (482,961 people), 3.0% MD (50,409 people), 59.4% HD (1,014,130 people) and 9.4% informal settlement (161,038) (Table 3-8). Based on discussions with City of Harare planning officials, it is expected that the combined proportion of LD and MD residents will gradually decline over the planning period from a combined figure of 31.3% for 2012, to 29% for 2020 to 25% by 2030. During the same period the proportion of informal settlement is expected to grow from 9.4% for 2012 to 13.6% for 2020 and 19.6% for 2030. This implies a corresponding decrease in the proportion of HD population from 59.4% in 2012 to 57.4% in 2020 to 55.4% in 2030.

Using these figures, the future estimated populations by housing types for the years 2020 and 2030 are shown in Table 3-8. This suggests that the LD population will grow from 483,000 in 2012, by 29,000 people to 512,000 in 2020, and then by 173,000 people to reach 686,000 in 2030. The MD population is forecast to increase from 50,000 in 2012 to 57,000 in 2020 and to 76,000 in 2030.

The HD population was just over 1 million in 2012. This is forecast to grow by 113,000 to 1.13 million in 2020 and then by 562,000 to reach 1.69 million in 2030. Coupled with this, the informal population is expected to grow from 161,000 in 2012, by 106,000 to reach 267,000 in 2020, and by a further 330,000 to reach a total of 597,000 in 2030.

The expected general pattern of development is for continued expansion of LD housing to the north and northeast (between the Lomagundi and Murewa roads), and for continued HD expansion to the west and south of the city. This will serve to confine future extension of the sewer network to the southern and western portions of the city, whilst the LD residents to the north can continue to rely on septic tanks.

Twelve areas were identified for future LD expansion, eight within the boundaries of the current 46 wards and four in the peripheral areas to the north (Table 3-8). The existing wards appear to offer a total LD growth opportunity of 14,500 stands or 101,500 people.

This is more than adequate to cater for the anticipated demand of 29,358 extra LD residents to 2020, but substantially short of the projected demand of 173,478 new residents to 2030. Thus, by 2030 all LD growth within the existing wards is expected to be fully taken up, and a similar amount of growth will have taken place in the neighbouring areas to the north. However, growth in all prospective areas, other than Goromonzi Ward 7, is expected to start prior to 2020 and to continue into the subsequent interval to 2030.

The picture for MD expansion is similar to that of LD, in that the identified four opportunities for expansion within the existing wards, which give a total of 12,600 people, are sufficient to cater for demand to 2020 (6,515 people) but not to 2030 (25,791 people). The major MD development is expected to occur to the west within Zvimba Ward 35, where a further 2,000 stands (14,000 residents) are expected. Again, development in all five potential areas appears likely to span both time horizons to 2020 and to 2030. It is also feasible that there might be additional MD developments in the peripheral areas to the north, although this has not been provided for in this working model.

Fifteen of the existing wards appear to offer possibility for HD expansion, collectively amounting to a total of 14,510 stands or 145,100 residents. This compares to an estimated demand of 112,579 people to 2020 and of 674,455 to 2030. Thus, all HD expansion to 2020 is projected to be accommodated within the existing wards, with the balance of opportunities being taken up during the subsequent period to 2030. From 2020-2030 the bulk of HD growth is expected to occur in Ward 1 and the peripheral areas of Caledonia and Whitecliff, and will come about through upgrading of existing informal settlements (550,000) to formal HD housing.

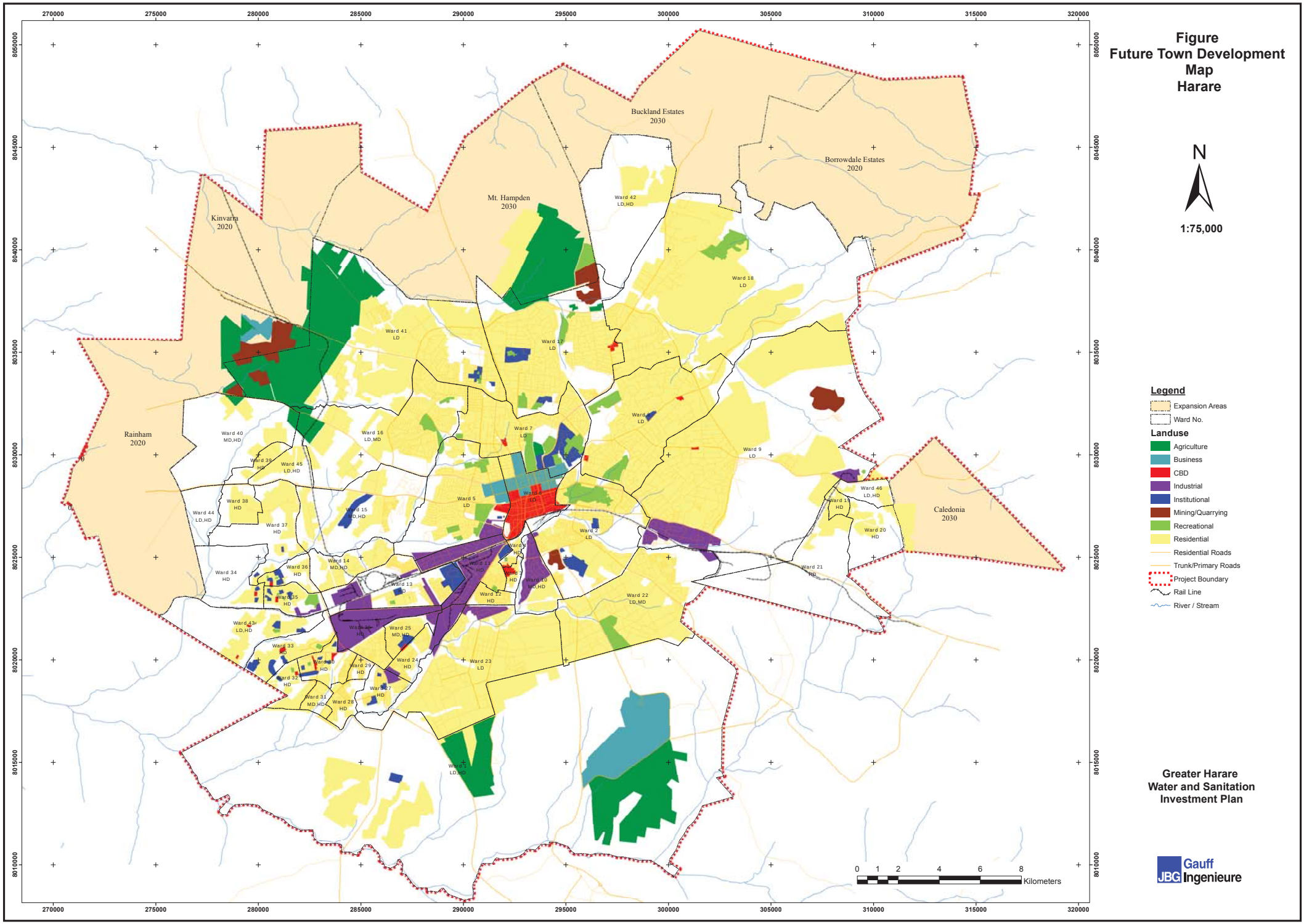
The bulk of the low income development is expected to comprise informal housing, and is anticipated to occur primarily within Ward 1 and the peripheral wards of Zvimba 35 to the west and Goromonzi 25 to the east. Collectively, these areas have an estimated capacity for an additional of 99,500 stands or 995,000 people. All growth in these areas in the medium term to 2020 is expected to comprise informal housing. However, during the subsequent interval to 2030, while it is assumed that informal growth will continue, it is further assumed that a substantial portion of the informal settlement in each of these areas will be provided with services and thus upgraded to formal HD housing (total of 550,000 people). The estimated capacity appears more than adequate to cope with the expected demand through to 2030 of 436,367 people, even allowing for the anticipated ongoing conversion of informal to formal HD settlements.

Resulting estimated ward populations for 2020 and 2030 broken down by housing types are shown in Appendix 3-1.

Table 3-8: Estimated Future Populations for Harare by Housing Types

Residential Type	LD	MD	HD	INF	Total
			Estimated Proportion (%)		
2012	28.3%	3.0%	59.4%	9.4%	100%
2020	26.1%	2.9%	57.4%	13.6%	100%
2030	22.5%	2.5%	55.4%	19.6%	100%
			Estimated Population		
2012	482,961	50,409	1,014,130	161,038	1,708,538
2020	512,319	56,924	1,126,709	266,956	1,962,908
2030	685,797	76,200	1,688,585	597,405	3,047,987
			Estimated Population Increase		
2012-20	29,358	6,515	112,579	105,918	254,370
2020-30	173,478	19,276	561,876	330,449	1,085,079
2012-30	202,836	25,791	674,455	436,367	1,339,449
			Opportunities for Growth		
Existing 46 wards	101,500	12,600	145,100	0	259,200
Adjacent 6 wards	101,360	14,000	(550,000)	995,000	1,110,360
Harare Total	202,860	26,600	695,100	(445,000)	1,369,560

Figure
Future Town Development Map
Harare



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Legend

- Expansion Areas
- Ward No.

Landuse

- Agriculture
- Business
- CBD
- Industrial
- Institutional
- Mining/Quarrying
- Recreational
- Residential
- Residential Roads
- Trunk/Primary Roads
- Project Boundary
- Rail Line
- River / Stream

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3.4.2 Chitungwiza

Chitungwiza primarily serves as a dormitory residential town to Harare. With a 2012 population of 356,840 it was the second largest component of Greater Harare, accounting for 15.1% of the overall population (Table 3-7). Yet with an area of 5,106 ha, or 51 km^2 it accounts for just 4.9% of the overall extent of Greater Harare, and is in fact less extensive than Norton.

Chitungwiza includes 25 wards. The three constituent portions of St. Marys, Zengeza and Seke form a single contiguous block of high density residential settlement, broken up in places by minor drainages which take the form of vlei areas generally draining in a southwest direction into the Nyatsime River. Interspersed amongst this are minor portions of LD and MD housing. Adjacent to the Duri drainage, in the eastern parts of Wards 18, 22, 23 and 24, there are small portions of informal settlement. There are a number of shopping centres with associated commercial activities and home industries and, in Ward 14, space has been reserved for development of a town centre but this has yet to come to fruition. There is also a heavy industrial portion, principally within Ward 12 but with provision to extend into the adjacent Ward 18 to the east.

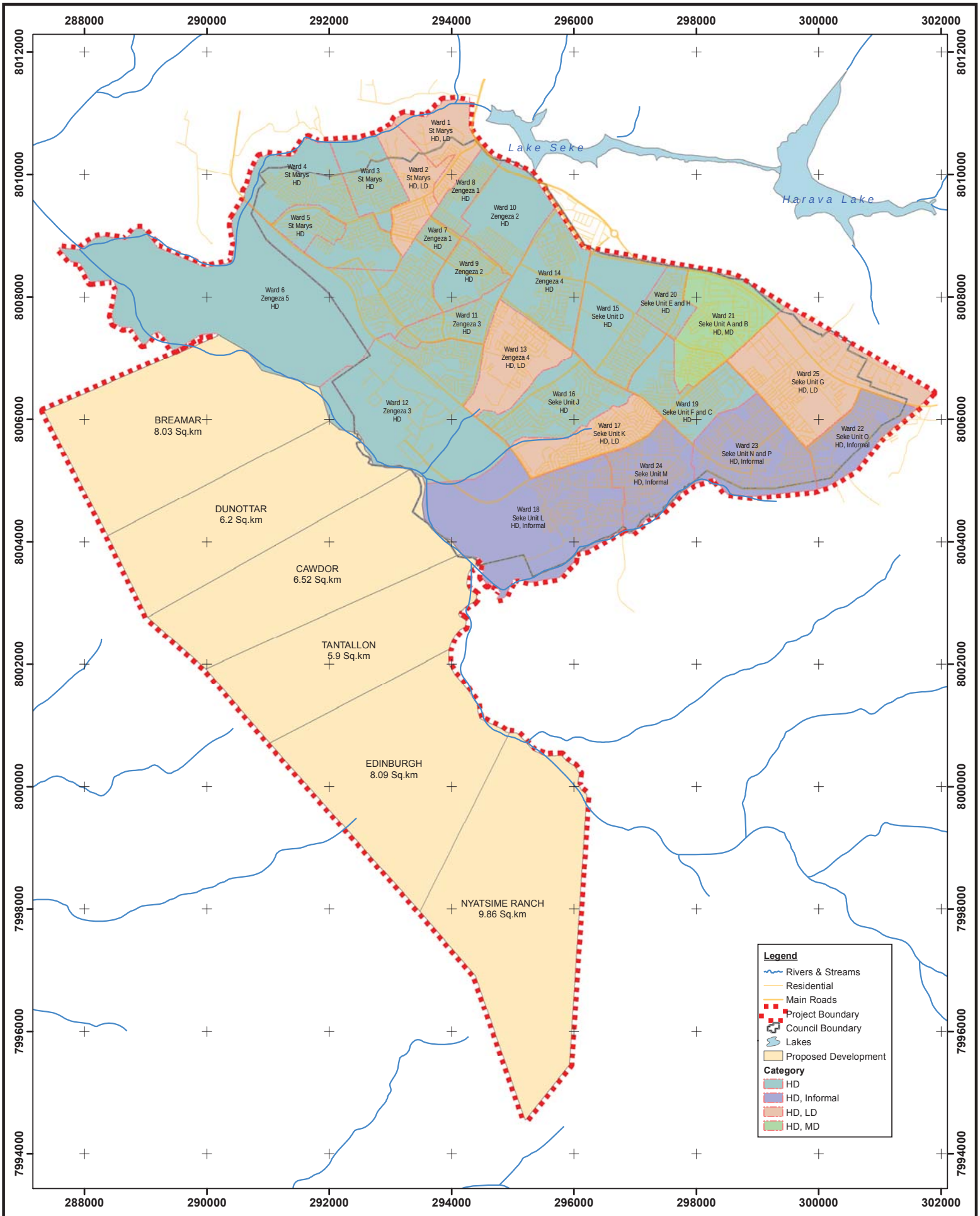

Figure
Ward Map with Housing Categories
Chitungwiza

N

Datum WGS 84

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For Chitungwiza the 2012 HD population was estimated to be 330,017 which equates to 92.5% of the overall population (Table 3-9). The remaining population comprised of 4,489 LD residents, 5,600 MD residents and 16,734 informal settlers, comprising respectively, 1.3%, 1.6% and 4.7% of the overall population. It was assumed that future proportions of housing types will generally be maintained at the 2012 values, except that future informal settlement will be restricted to the Duri River area, and will be completed by 2020. This gives rise to minor fluctuations in the proportions of HD and informal categories of housing.

Applying these figures, the future estimated populations for the years 2020 and 2030 broken down by housing categories are shown in Table 3-9. This suggests that the LD population will grow from 4,489 in 2012 by 369 people, to give a 2020 population of 4,858, and then by 2,034 people to give a 2030 population of 6,523. MD growth will similarly be limited, growing from 5,600 in 2012 by 461, to 6,061 in 2020, and by 2,542 to 8,142 in 2030.

The bulk of the growth is expected to be in HD housing, which will expand from 330,017 in 2012 by 26,279 people to 356,296 in 2020, and by 155,108 people to 485,125 in 2030.

Growth in informal population is expected to be limited to 2,250 people during the interval from 2012 to 2020, resulting in a small rise in population from 16,734 in 2012 to 18,984 in 2020, and which will be maintained to 2030.

For Chitungwiza, a key expectation is to incorporate the six adjacent farms of Longlands, Braemar A, Dunnotar, Cawdor, Tantallon and Edinburgh into the municipal area of Chitungwiza. Collectively known as the Nyatsime Farms, these form a single contiguous block of land situated to the south of the Nyatsime River and extending for some 10 km to the south of Ward 6. The intention is that this area should be developed in phases, through to perhaps 2040, with the anticipation of providing 35,889 HD stands on 890 ha; 11,514 MD stands on 576 ha; 2,257 LD stands on 339 ha, and with 157 ha being reserved for industrial stands. It is also planned to incorporate a neighbouring portion of Seke Communal Land, adjacent to Ward 22.

Table 3-9: Estimated Future Populations for Chitungwiza by Residential Types

Residential Type	LD	MD	HD	INF	Total
			Estimated Proportion (%)		
2012	1.3%	1.6%	92.5%	4.7%	100%
2020	1.3%	1.6%	92.2%	4.9%	100%
2030	1.3%	1.6%	93.4%	3.7%	100%
			Estimated Population		
2012	4,489	5,600	330,017	16,734	356,840
2020	4,858	6,061	356,296	18,984	386,199
2030	6,523	8,142	485,125	18,984	518,774
			Estimated Population Growth		
2012-20	369	461	26,279	2,250	29,359
2020-30	1,665	2,081	128,829	0	132,575
2012-30	2,034	2,542	155,108	2,250	161,934
			Opportunities for Growth		
Existing 25 wards	6,370	3,920	22,550	2,250	35,090
Adjacent areas	20,125	11,690	125,420	0	157,235
Chitungwiza Total	26,495	15,610	147,970	2,250	192,325

Eight areas were identified for future LD expansion, seven within the existing 25 wards plus on the Nyatsime Farms (Table 3-9). For MD housing, a single opportunity for expansion was identified in Ward 6, plus additional potential for the Nyatsime Farms. For both LD and MD the overall identified opportunities for growth (26,495 for LD and 15,610 for MD) far outstrip the projected demand to 2030 (respectively 2,034 and 2,542 people). Although much of the supply relates to development of the Nyatsime Farms, the existing wards have more than enough capacity to satisfy the projected demand, such that future LD and MD growth to 2030 is anticipated to be confined to the existing wards and allocated proportionally in relation to the identified opportunities.

Informal growth is expected to be confined to the interval 2012-2020 and to be restricted to the three wards along the Duri River where this is already taking place, collectively resulting in an additional informal population of 2,250 people.

Opportunities for future HD growth were identified in three wards, amounting to a total of 22,550 additional residents. Additional opportunities were identified for Seke Communal Land (20,000 people) and the Nyatsime Farms (105,420 people). The estimated expansion to 2020 (26,729 people) is expected to be split between the existing wards and Seke Communal Land. During the subsequent interval to 2030, the remaining opportunities in the existing wards and Seke Communal Land will be fully developed, with the balance being accommodated on the Nyatsime Farms. Overall the expected demand for HD housing (155,108 people) is projected to marginally outstrip the estimated potential supply to 2030 (147,970 people). If necessary, the balance could be accommodated either by

reallocation of some of the proposed Nyatsime LD and MD housing to HD, or else through continued expansion of HD housing further to the south within Nyatsime.

Resulting estimated ward populations for 2020 and 2030 broken down by housing types are shown in Appendix 3-2.

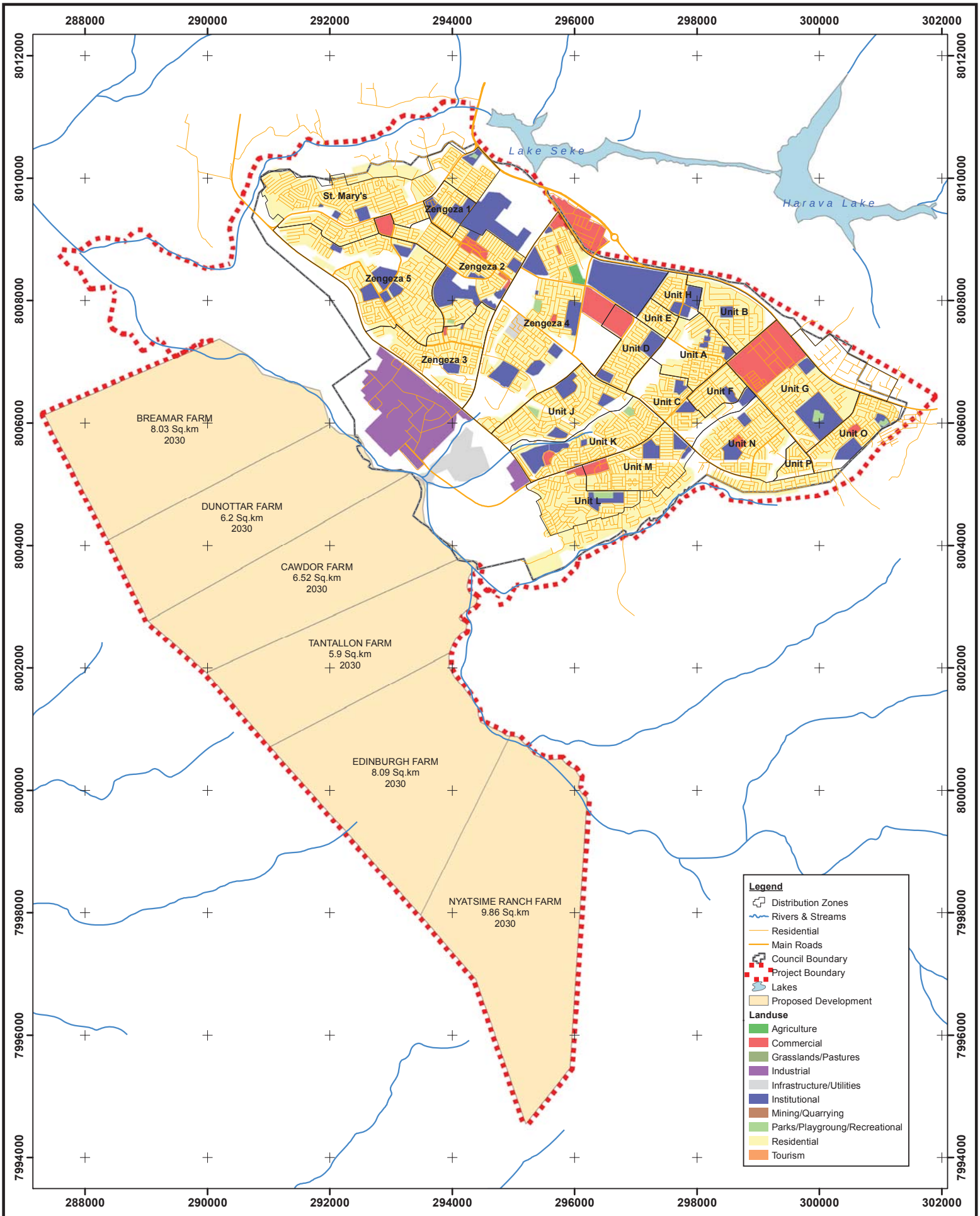

Figure
Future Town Development Map
Chitungwiza

N

Datum WGS 84

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3.4.3 Epworth

Epworth, like Chitungwiza, serves as a residential dormitory town for Harare. It contains a number of shopping centres with associated commercial and light industry activities, but there is no CBD and no formal industrial areas. With a 2012 population of 167,462 Epworth had grown to become the fifth largest town in Zimbabwe, and accounted for 7.1% of the overall population of Greater Harare (Table 3.7). In terms of area, Epworth covers just 3,438 ha or 3.3% of the overall area of Greater Harare.

Epworth is divided into seven wards. Unlike, the other component towns of Greater Harare, Epworth is dominated by informal settlement (100,870 people), which in 2012 accounted for 60.2% of the overall population (Table 3-10). Informal settlement occurs in all wards and dominates in Wards 1, 4, 6 and 7. The HD population is confined to a single ward (Ward 3) and is limited to just 9,612 people, or 5.7% of the 2012 population. Due to its particular history of development as a mission station, Epworth contains sizeable MD (42,100 people) and LD (14,880 people in Wards 1 and 4) populations, respectively accounting for 25.1% and 8.9% of the overall 2012 population. Wards 2 and 5 are dominated by MD housing.

Table 3-10: Estimated Future Populations for Epworth by Residential Types

Residential Type	LD	MD	HD	INFORMAL	Total
			Estimated Proportion (%)		
2012	8.9%	25.1%	5.7%	60.2%	100%
2020	10.0%	20.6%	6.7%	62.7%	100%
2030	8.2%	16.9%	32.1%	42.7%	100%
			Estimated Population		
2012	14,880	42,100	9,612	100,870	167,462
2020	20,480	42,100	13,612	127,844	204,036
2030	20,480	42,100	79,896	106,243	248,719
			Estimated Population Growth		
2012-20	5,600	0	4,000	26,974	36,574
2020-30	0	0	66,284	-21,601	44,683
2012-30	5,600	0	70,284	5,373	81,257
			Opportunities for Growth		
Existing 7 wards	5,600	0	4,000	27,000	36,600
Adjacent areas	0	0	0	50,000	50,000
Epworth Total	5,600	0	4,000	77,000	86,600

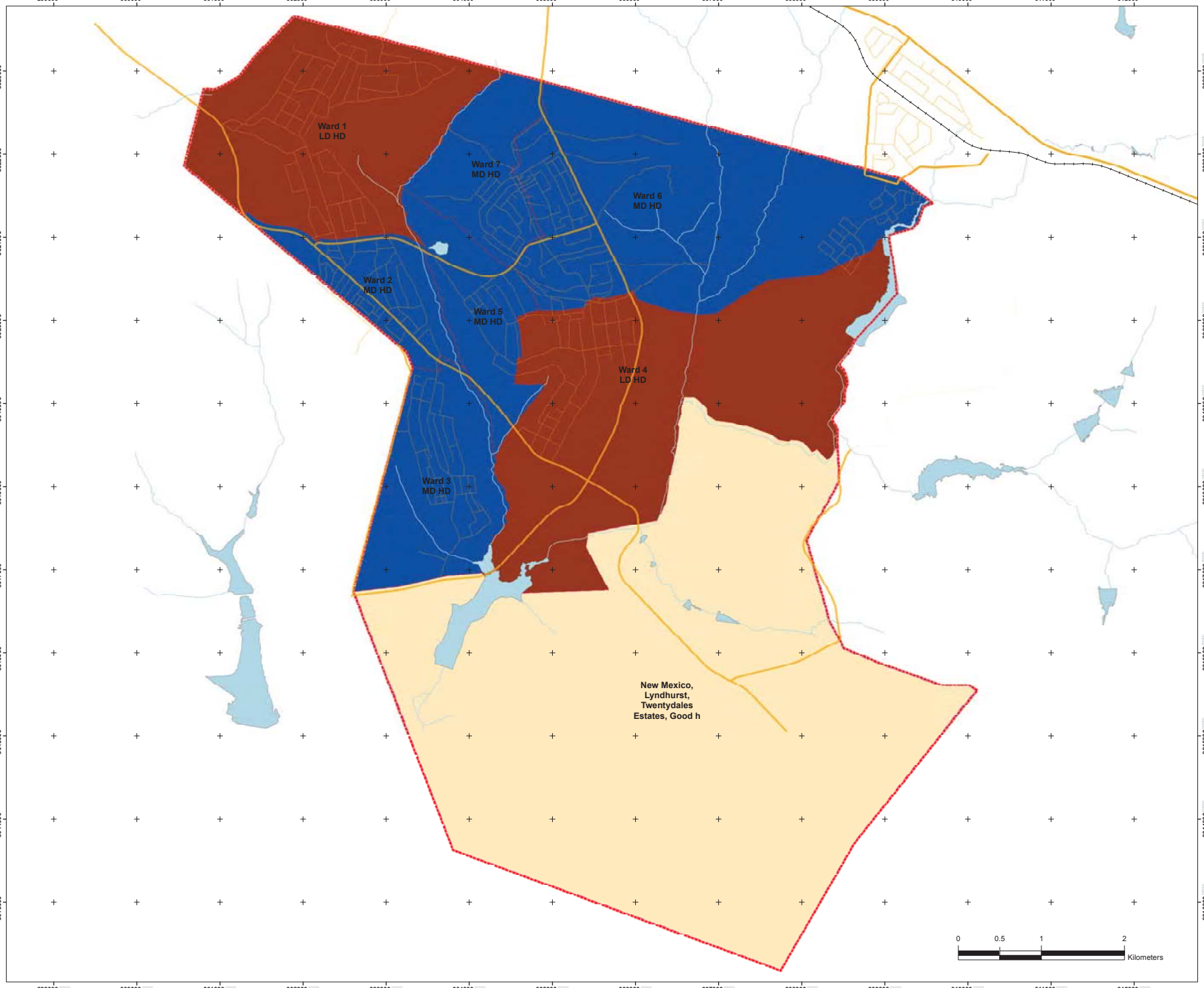

Figure 3-8
Ward Map With Housing Categories Epworth

N

Datum : WGS84 Zone 36S
Scale 1:21,500

Legend

- Residential Roads
- Trunk/Primary Roads
- Rail Line
- Rivers/Stream
- Lakes

Project Boundary

Category

- Mixed (LD,HD)
- Mixed (MD,HD)
- Project Boundary
- Expansion Areas

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Epworth has relatively limited opportunity for future expansion within the existing wards, and, other than to the south, most of the surrounding areas are already incorporated into either Harare or Ruwa, again limiting opportunities for future expansion. Thus, although some expansion is envisaged into the adjacent southern areas (Gormonzi Wards 23 and 24), the limited availability of land is expected to lead to slower rates of growth than has been the case in the past.

Analysis of future opportunities for growth (Table 3-10) indicates that there is limited opportunity for LD growth, and no MD growth is anticipated. In fact the bulk of the future growth is expected to be informal settlement, but in the long term (2020-30) this will be tempered by conversion of some of the informal settlement to formal high density housing. This is one of the key planning concerns in Epworth, how to regularise and provide services to the existing informal settlements, many of which have been settled in a haphazard manner. This presents numerous challenges to the provision of services, and will necessarily be a demanding and slow process. Based on discussions with town authorities it is assumed that no progress will be made in this respect during the medium term to 2020. However, during the subsequent interval to 2030 it is anticipated that roughly half of the existing informal settlement in Epworth will be upgraded to formal high density housing (with individual household water and sewer connections).

The resulting changes in proportions of housing to 2020 and 2030 are shown in Table 3-10. The general trend is of a decrease in the combined proportion of LD and MD housing from 34.0% in 2012 to 30.6% in 2020 to 25.1% in 2030. The proportions of HD and informal housing (currently at 5.7% and 60.2%) are expected to expand marginally to 2020 (to 6.7% and 62.7%, respectively), but thereafter the anticipated conversion of informal settlements to HD housing is expected to lead to a marked drop in the proportion of informal settlements by 2030 (42.7%) and a corresponding increase in the proportion of HD housing (32.1%).

Using these figures, the future estimated populations for the years 2020 and 2030 broken down by housing categories are shown in Table 3-10. Essentially, all remaining opportunities within the existing wards will be taken up by 2020 for all housing categories. For the subsequent interval to 2030 all growth (44,683 people) will occur in the adjacent areas to the south, and it will all be informal in nature. However this will be accompanied by substantial conversion of existing informal settlements to HD settlements within Wards 1 to 7.

This suggests that the LD population will grow from 14,880 in 2012 by 5,600 people, to give a 2020 population of 20,480, and that there will be no further LD growth to 2030. Similarly, there will be no MD growth such that the 2012 MD population of 42,100 will be maintained to 2030.

The largest change is projected for HD housing, which will experience modest growth of 4,000 people from 9,612 in 2012 to 13,612 in 2020, and thereafter will increase by 66,284 people to 2030 to give a total 2030 population of 79,896.

The informal population is expected to grow from 100,870 in 2012 by 26,974 to give a 2020 population of 127,844, and then to reduce by 21,601 people to 2030 (through conversion to formal HD housing) to give a 2030 informal population of 106,243.

Resulting estimated ward populations for 2020 and 2030 broken down by housing types are shown in Appendix 3-3.

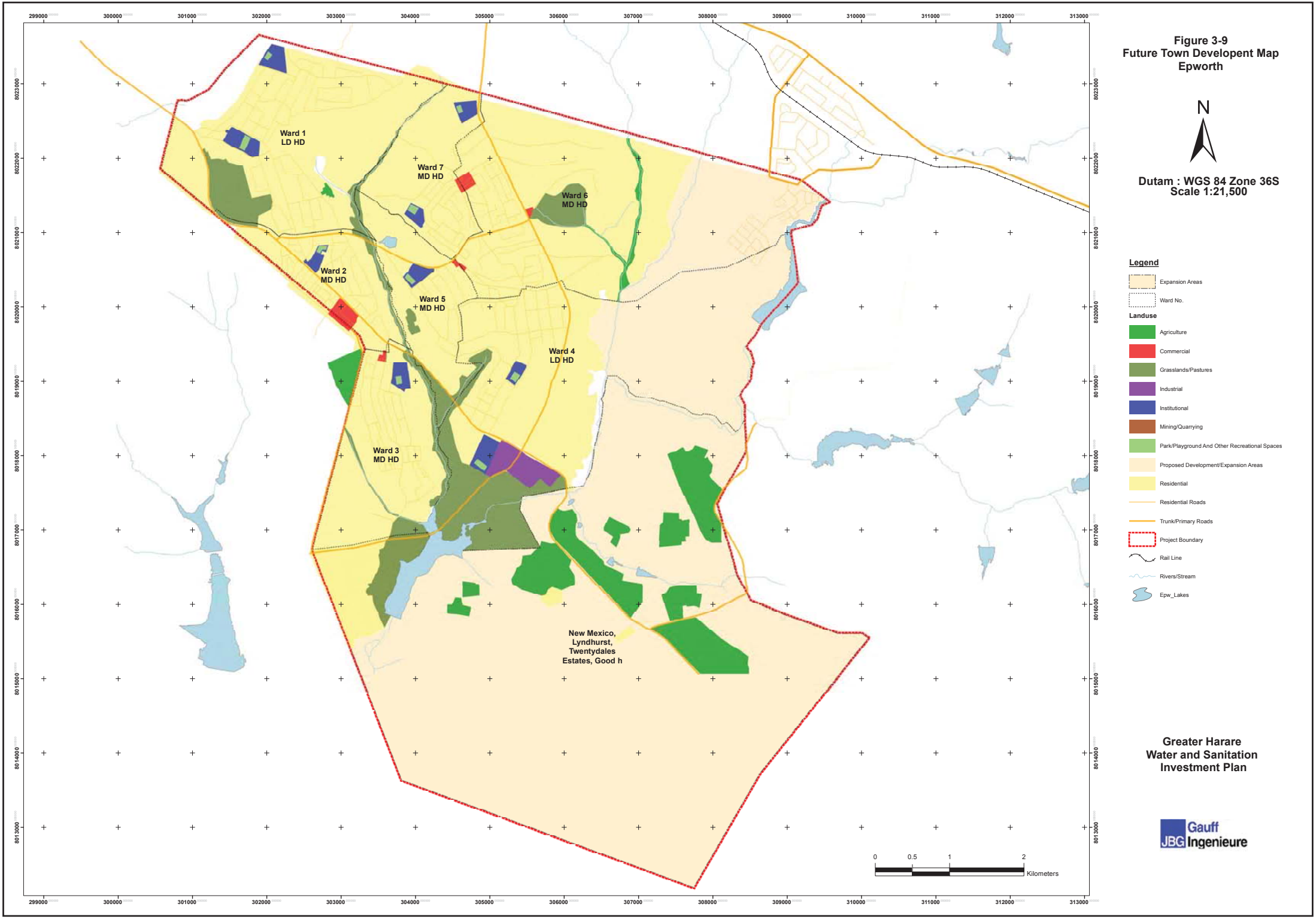


Figure 3-9
Future Town Developent Map
Epworth

Greater Harare
Water and Sanitation
Investment Plan

Gauff JBG Ingenieure

3.4.4 Norton

Norton is situated some 45 km to the west of Harare such that it is not contiguous with the remainder of Greater Harare. With a 2012 population of 67,591 Norton accounted for just 2.9% of the overall population of Greater Harare, yet with an area of 6,006 ha, Norton is larger than either Chitungwiza or Epworth, and accounts for 5.8% of the overall extent of Greater Harare (Table 3-7).

Starting during the 1950's, Norton was specifically planned and developed in order to provide opportunity for industrial expansion outside of Harare. The town comprises of a CBD, industrial area and a mix of low and high density residential housing. There is little in the way of medium density housing and informal settlements are absent.

Norton is divided into thirteen wards. Wards 1, 2, 3 and 4 comprise LD housing and include the CBD and the industrial area, and collectively account for two thirds of the overall area. The remaining nine wards are dominated by HD housing. With respective 2012 populations of 16,112 LD and 51,479 HD residents, LD accounted for 23.8% of the overall population and HD the remaining 76.2% (Table 3-11). In the absence of any plans to introduce any MD housing or informal growth, it was assumed that future proportions of housing types will be maintained to 2030 at these same values of 23.8% LD and 76.2% HD.

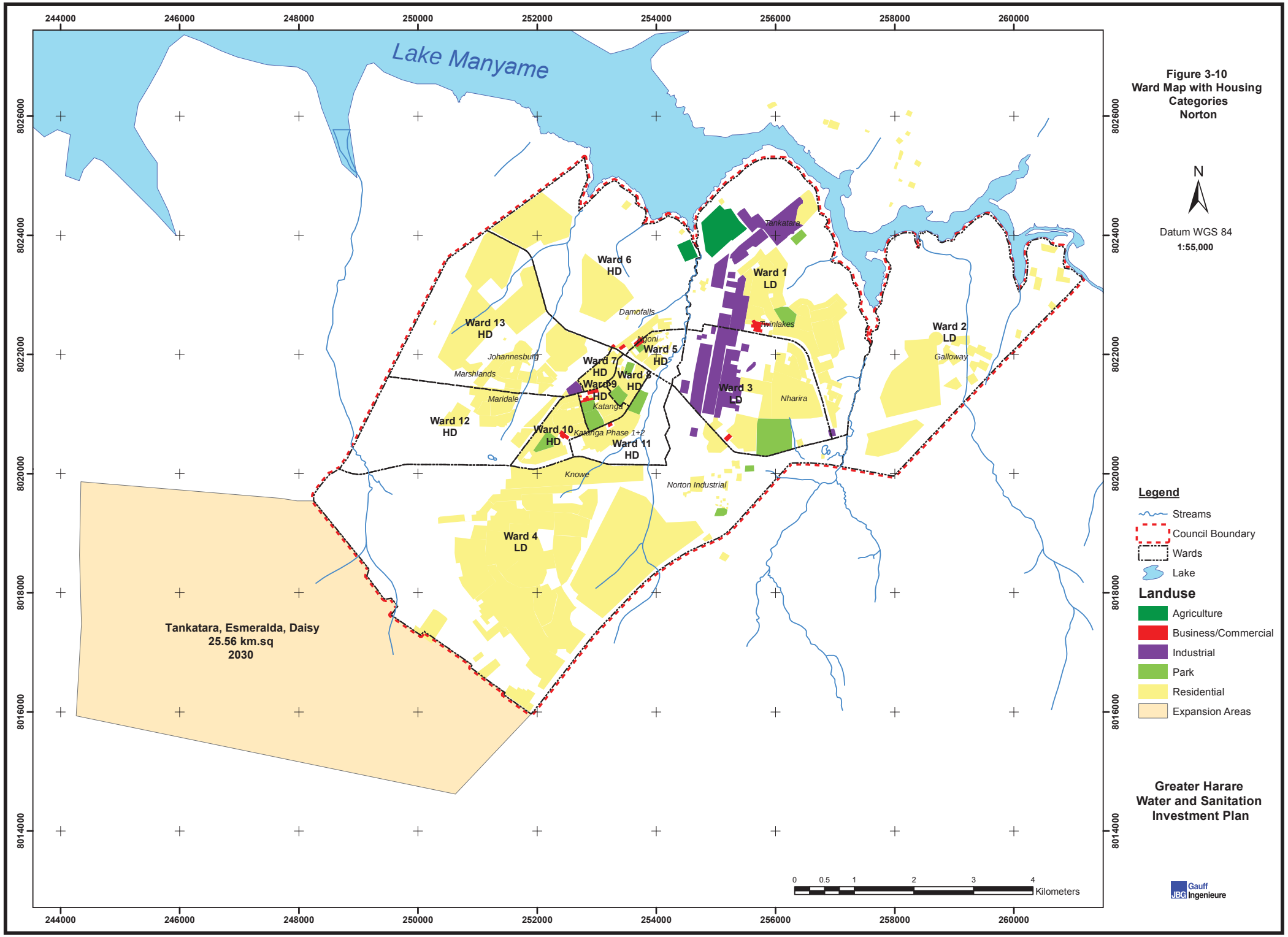


Figure 3-10
Ward Map with Housing Categories
Norton

Greater Harare Water and Sanitation Investment Plan

Using these figures, the future estimated populations for LD and HD residents for the years 2020 and 2030 are shown in Table 3-11. This suggests that the LD population will grow from 16,112 in 2012 by 6,440 people, to give a 2020 population of 22,552, and by a further 12,467 people to give a 2030 population of 35,019. Similarly, HD residents are expected to grow from 51,479 in 2012, by 20,575 people to give a 2020 population of 72,054, and by an additional 39,830 people to give a 2030 population of 111,884.

The expected general pattern of development for Norton is for continued expansion of LD housing within Wards 1-4, plus additional expansion within Wards 6 and 13, specifically targeting those portions closest to Lake Manyame (which were previously zoned for HD development). For HD housing, in addition to Wards 11, 12 and 13, the most logical direction of expansion for HD housing would be to continue to the west of Wards 12 and 13 (i.e. to the north of the railway line). However, this is apparently not possible and, instead, the town envisages expanding into the portion to the south of the railway line and to the west of Ward 4, within what is now Ward 14 of Chegutu District.

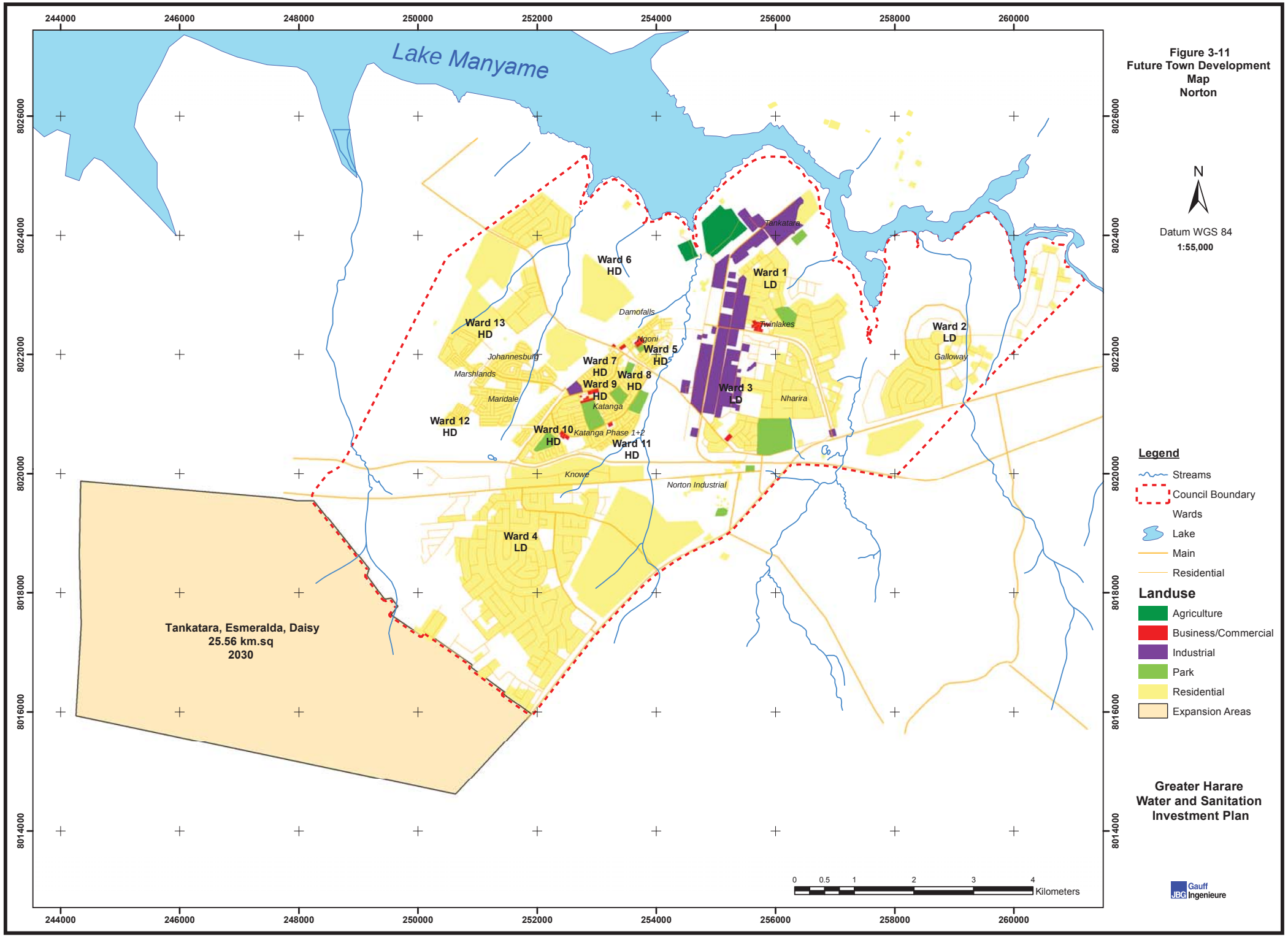
Eight areas of possible expansion were identified within the extent of the current 13 wards of Norton, five for LD housing (Wards 1, 2, 4, 6 and 13) and three for HD housing (Wards 11, 12 and 13). Collectively, these provide opportunity to accommodate an additional 18,837 LD residents and 21,980 HD residents.

For LD housing, this should be just sufficient to cater for the total expected growth to 2030, which is projected to amount to 18,907 people. For HD housing, the expected growth of 20,575 people to 2020 will virtually exhaust the estimated growth opportunities within Wards 11, 12 and 13 (21,980 people). For the subsequent period from 2020 to 2030 it is therefore assumed that the anticipated HD growth of 39,830 people will need to be accommodated outside of the existing town boundary within what is now Ward 14 of Chegutu District.

Resulting estimated ward populations for 2020 and 2030 broken down by housing types are shown in Appendix 3-4.

Table 3-11: Estimated Future Populations for Norton by Residential Type

Residential Type	LD	MD	HD	INFORMAL	Total
			Estimated Proportion (%)		
2012	23.8%	0%	76.2%	0%	100%
2020	23.8%	0%	76.2%	0%	100%
2030	23.8%	0%	76.2%	0%	100%
			Estimated Population		
2012	16,112	0	51,479	0	67,591
2020	22,552	0	72,054	0	94,606
2030	35,019	0	111,884	0	146,903
			Estimated Population Growth		
2012-20	6,440	0	20,575	0	27,015
2020-30	12,467	0	39,830	0	52,297
2012-30	18,907	0	60,405	0	79,312
			Opportunities for Growth		
Existing 13 wards	18,837	0	21,980	0	40,817
Adjacent areas	0	0	40,000	0	40,000
Norton Total	18,837	0	61,980	0	80,817


Lake Manyame
Tankatara
Ward 6
HD
Ward 1
LD
Damofalls
Twinlakes
Ward 2
LD
Galloway
Ward 13
HD
Johannesburg
Marshlands
Maridale
Ngoni
Ward 5
HD
Ward 7
HD
Ward 8
HD
Ward 9
HD
Katanga
Ward 3
LD
Nharira
Ward 12
HD
Ward 10
HD
Katanga Phase 1+2
Ward 11
HD
Knowe
Norton Industrial
Ward 4
LD
Tankatara, Esmeralda, Daisy
25.56 km.sq
2030
244000
246000
248000
250000
252000
254000
256000
258000
260000
8026000
8024000
8022000
8020000
8018000
8016000
8014000
N
Datum WGS 84
1:55,000
Legend
Streams
Council Boundary
Wards
Lake
Main
Residential
Landuse
Agriculture
Business/Commercial
Industrial
Park
Residential
Expansion Areas
0
0.5
1
2
3
4
Kilometers
Figure 3-11
Future Town Development
Map
Norton
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

3.4.5 Ruwa

Ruwa with a 2012 population of 56,333 was the smallest of the component towns of Greater Harare, accounting for just 2.9% of the overall population (Table 3-7). In terms of size, Ruwa is 4,187 ha in extent, making it slightly larger than Epworth, and equating to 4% of the overall area of Greater Harare.

Ruwa is the youngest of the component towns of Greater Harare having only developed during the post independence era. Like Norton it was developed in order to provide additional industrial capacity and thus relieve pressure on the existing industrial areas elsewhere in Greater Harare. In addition to industrial areas, Ruwa includes a mix of LD, MD and HD housing. Currently, there is no informal settlement. Land has been reserved for construction of a town centre, but this has yet to be realized.

Ruwa is divided into nine wards. Low and medium density housing is confined to Wards 7, 8 and 9, which collectively cover 84% of the overall extent of Ruwa. Ward 7 is dominated by LD housing, whilst Wards 8 and 9 comprise a mix of LD and MD housing, and Ward 9 also includes a substantial HD portion. The remaining Wards 1 to 6 comprise a contiguous portion of HD development extending as an irregular strip to the south of the Harare-Marondera road. The industrial area is located in the northeastern corner of Ward 7, immediately to the south of the Marondera road and railway. Part of the northeastern portion of ward 9 has also been reserved for heavy industry but has not yet been developed.

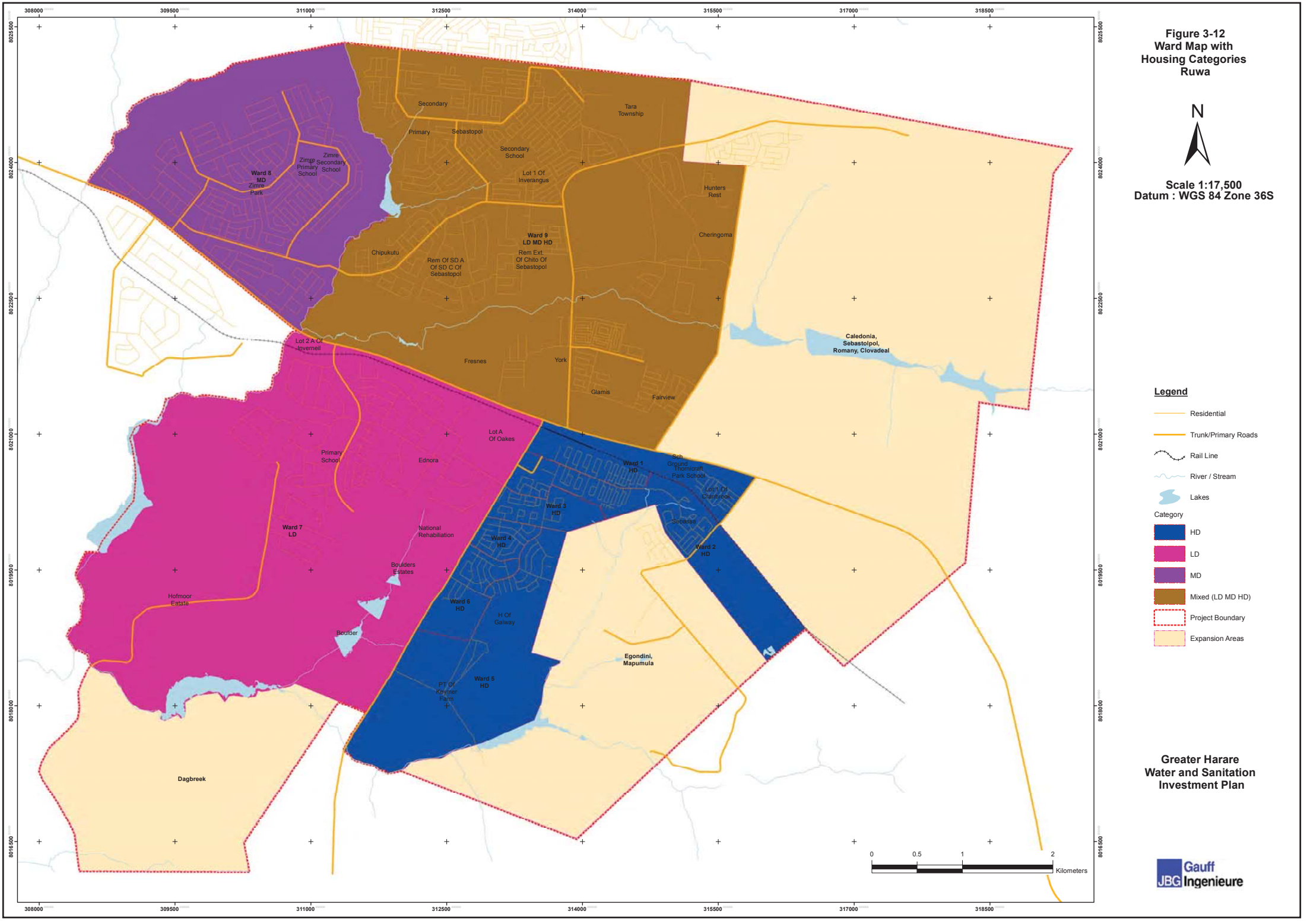


Figure 3-12
Ward Map with
Housing Categories
Ruwa
N
Scale 1:17,500
Datum : WGS 84 Zone 36S
Legend
Residential
Trunk/Primary Roads
Rail Line
River / Stream
Lakes
Category
HD
LD
MD
Mixed (LD MD HD)
Project Boundary
Expansion Areas
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure
0
0.5
1
2
Kilometers
Ward 8
MD
Zimre
Park
Zimre
Primary
School
Zimre
Secondary
School
Secondary
Primary
Sebastopol
Secondary
School
Tara
Township
Lot 1 Of
Inverangus
Hunters
Rest
Cheringoma
Ward 9
LD MD HD
Rem Ext.
Of Chito Of
Sebastopol
Chipukutu
Rem Of SD A
Of SD C Of
Sebastopol
Caledonia,
Sebastolpol,
Romany, Clovadeal
Lot 2 A Of
Invernell
Fresnes
York
Glamis
Fairview
Lot A
Of Oakes
Primary
School
Ednora
Ward 1
HD
Sch
Ground
Thomicraft
Park School
Lot 1 Of
Clanbrook
Ward 3
HD
Ward 7
LD
National
Rehabiliation
Ward 4
HD
Sebasta
Ward 2
HD
Boulders
Estates
Hofmoor
Estate
Ward 6
HD
H Of
Galway
Boulder
Egondini,
Mapumula
PT Of
Keymer
Farm
Ward 5
HD
Dagbreek
308000
309500
311000
312500
314000
315500
317000
318500
8025500
8024000
8022500
8021000
8019500
8018000
8016500

The distribution of population in 2012 by housing types was 26.5% LD, 13.7% MD and 59.8% HD – there were no informal settlements. The combined proportion of LD and MD housing (40.2%) was considerably higher than that of the other urban entities of Greater Harare (range is 2.9% for Chitungwiza to 34% for Epworth). Moreover, LD and MD accounted for about only one third of the total identified opportunities for future expansion in Ruwa. As such the combined proportion of LD and MD housing is expected to gradually decrease from 40.2% in 2012, to 35% in 2020 and 30% in 2030. The balance is expected to be taken up by HD housing, which is projected to rise in proportion from 59.8% in 2012, to 65% in 2020, and to 70% in 2030. No development of informal settlement is envisaged.

Using these figures, the future estimated populations broken down by housing types for the years 2020 and 2030 are shown in Table 3-12. This suggests that the LD population will grow from 14,950 in 2012 by 10,967 people, to give a 2020 population of 25,917, and by a further 9,077 people to give a 2030 population of 34,994. Similarly, MD residents are expected to grow from 7,718 in 2012, by 5,804 people to give a 2020 population of 13,522, and by an additional 3,976 people to give a 2030 population of 17,498.

The major growth will be in terms of HD, the population of which is expected to increase from 33,665 in 2012 to 73,243 in 2020 to 122,479 in 2030, the corresponding levels of growth being 39,578 from 2012-2020 and by 49,235 from 2020-2030.

Table 3-12: Estimated Future Populations for Ruwa by Residential Type

Residential Type	LD	MD	HD	INF	Total
			Estimated Proportion (%)		
2012	26.5%	13.7%	59.8%	0%	100%
2020	23.0%	12.0%	65.0%	0%	100%
2030	20.0%	10.0%	70.0%	0%	100%
			Estimated Population		
2012	14,950	7,718	33,665	0	56,333
2020	25,917	13,522	73,243	0	112,682
2030	34,994	17,498	122,479	0	174,970
			Estimated Population Growth		
2012-20	10,967	5,804	39,578	0	56,349
2020-30	9,077	3,976	49,235	0	62,288
2012-30	20,044	9,780	88,813	0	118,637
			Opportunities for Growth		
Existing 9 wards	9,240	14,000	54,000	0	77,240
Adjacent areas	11,000	0	35,000	0	46,000
Ruwa total	20,240	14,000	89,000	0	123,240

To cater for the future development of Ruwa it is envisaged that additional land will be incorporated to the northeast (Ward 9 Extension - Tarisa, Sebastopol, Romany, Clovadael B and Liddesdale Farms of Goromonzi Ward 25); to the southeast (Ward 5 Extension –

Galway Estate) and to the south (Ward 7 Extension - Dagbreek, Mariandi and Mandalay Farms of Goromonzi Ward 24). It is expected that Ward 9 Extension will comprise a mixture of LD and HD housing, whilst Ward 5 Extension and Ward 7 Extension will be restricted to HD housing.

Nine areas of possible expansion were identified within the extent of the current 9 wards of Ruwa, three for LD housing (Wards 7, 8 and 9), one for MD (Ward 9) and five for HD (Wards 1, 2, 5, 7 and 9) (Table 3-12). Collectively, there is opportunity to accommodate a further 9,240 LD, 14,000 MD and 54,000 HD residents.

For LD housing, it is assumed that all existing opportunities within Wards 7, 8 and 9 (9,240 people) are developed by 2020, with the balance of the expected population (1,727 people) being absorbed in Ward 9 Extension. For the subsequent interval to 2030 it is assumed that all LD growth will occur in Ward 9 Extension (9,077 people).

For MD the projected development in Ward 9 of 2,000 MD stands (14,000 people) should be more than sufficient to cater for the expected MD growth through to 2030 (9,780 people).

For HD housing, the expected growth of 39,578 people to 2020 could feasibly be accommodated within the existing wards, although some growth is forecast to also occur within Ward 9 Extension during this period. For the subsequent interval from 2020 to 2030 it is expected that HD growth will occur in Wards 5, 7 and 9, and in the adjacent areas of Ward 5 Extension, Ward 7 Extension and Ward 9 Extension.

Resulting estimated ward populations for 2020 and 2030 broken down by housing types are shown in Appendix 3-5.

Figure 3-13
Future Town
Development Map
Ruwa
N
Dutam : WGS 84 Zone 36S
Scale 1:17,500
Legend
Expansion Areas
Ward No.
Landuse
Agriculture
Commercial
Grasslands/Pastures
Industrial
Institutional
Mining/Quarrying
Park/Playground And Other Recreational Spaces
Proposed Development/Expansion Areas
Residential
Residential
Trunk/Primary Roads
Project Boundary
Rail Line
River / Stream
Lakes
Ward 8
MD
Zimre Park
Zimre Primary School
Zimre Secondary School
Secondary
Primary
Sebastopol
Secondary School
Tara Township
Lot 1 Of Inverangus
Hunters Rest
Cheringoma
Chipukutu
Ward 9
LD MD HD
Rem Ext Of Chito Of Sebastopol
Rem Of SD A Of SD C Of Sebastopol
Caledonia, Sebastolpol, Romany, Clovadeal
Lot 2 A Of Invernell
Fresnes
York
Glamis
Fairview
Primary School
Ednora
Lot A Of Oakes
Ward 1
HD
Sch Ground
Thornicraft Park School
Lot 1 Of Cranbrook
Ward 3
HD
Ward 7
LD
National Rehabilitation
Ward 4
HD
Sebassa
Ward 2
HD
Boulders Estates
Hofmoor Estate
Ward 6
HD
H Of Galway
Boulder
Egondini, Mapumula
Ward 5
HD
PT Of Keymer Farm
Dagbreek
0
0.5
1
2
Kilometers
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

CHAPTER 04: EXISTING WATER AND SANITATION SITUATION

4 EXISTING WATER AND SANITATION SITUATION

4.1 Harare

4.1.1 Water Supply

The Harare water supply scheme consists of two water treatment works - Morton Jaffray WTW with a nominal design capacity of 614,000 m^3/day and Prince Edward WTW with a nominal design capacity of 90,000 m^3/day. The scheme also has 16 treated water pumping stations, 27 reservoir sites 5,400 km of transmission and distribution pipelines and over 200,000 service connections. The schematic in Figure 4-1 Shows the general configuration of the water supply scheme, while the map in Figure 4-2 shows the spatial location of the main facilities in the scheme

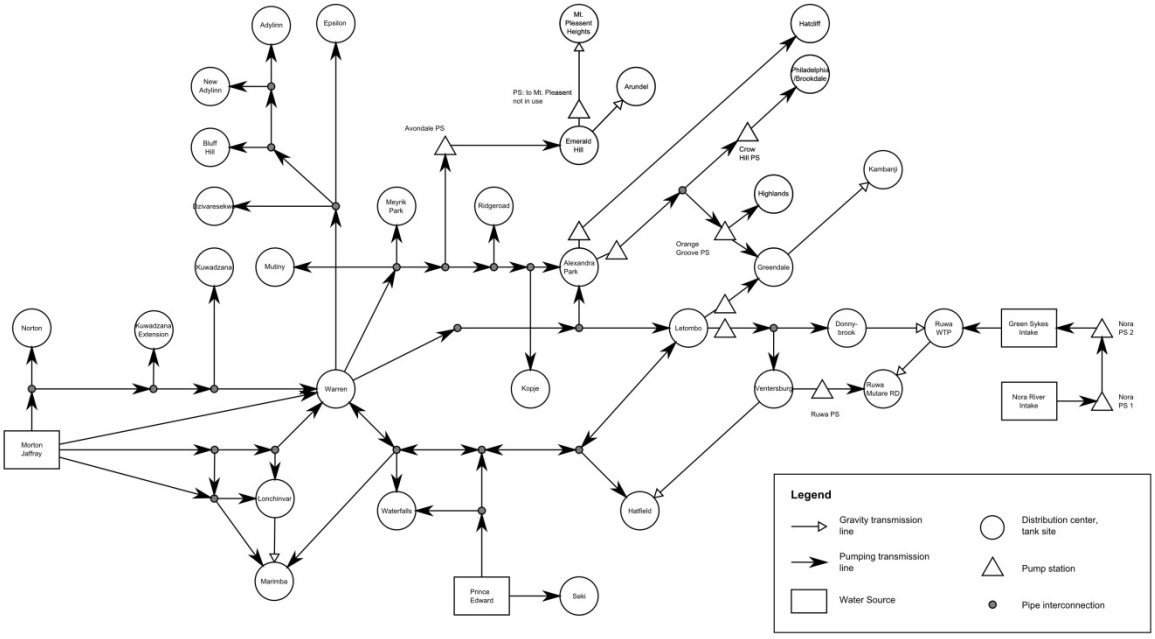


Figure 4-1: Harare Water Supply Scheme Schematic

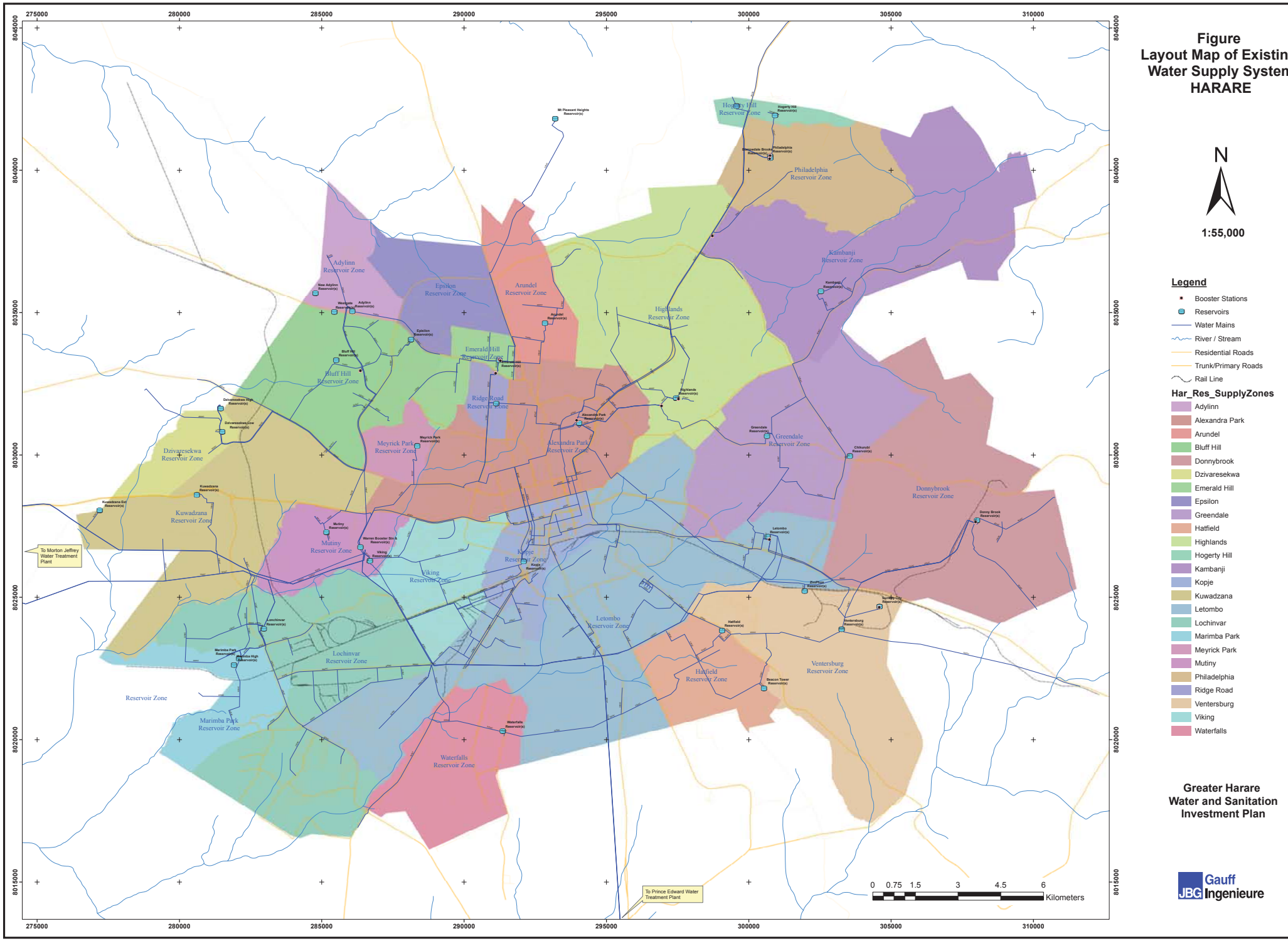


Figure
Layout Map of Existing Water Supply System HARARE

N

1:55,000

Legend

- Booster Stations
- Reservoirs
- Water Mains
- River / Stream
- Residential Roads
- Trunk/Primary Roads
- Rail Line

Har_Res_SupplyZones

- Adylinn
- Alexandra Park
- Arundel
- Bluff Hill
- Donnybrook
- Dzivaresekwa
- Emerald Hill
- Epsilon
- Greendale
- Hatfield
- Highlands
- Hogerty Hill
- Kambanji
- Kopje
- Kuwadzana
- Letombo
- Lochinvar
- Marimba Park
- Meyrick Park
- Mutiny
- Philadelphia
- Ridge Road
- Ventersburg
- Viking
- Waterfalls

Greater Harare Water and Sanitation Investment Plan

JBG Gauff Ingenieure

4.1.1.1 Water Resources

Harare is supplied with raw water from Harava Dam, Seke Dam, Lake Chivero and Lake Manyame. Morton Jaffray WTW is supplied by Lake Chivero and Lake Manyame whilst Prince Edward WTW is supplied by Harava and Seke Dams. All the raw water dams are located in the Upper Manyame Catchment area, along the Manyame River.

The total estimated 4% yield of the Chivero-Manyamewith allowance for upstream and downstream commitments is 159,376 Ml/year - approximately 436 Ml/day (Latest ZINWA assessment). Allowing for upstream commitments only, the 4% risk yield is 174,448 Ml/year (478 Ml/d). The 10% risk yield with upstream commitments only is estimated to be 231,117 Ml/year (478 Ml/d). The safe yield of the dams is clearly much lower than current average demand, let alone projected demand. This is risky for a large city such as Harare. There is need to develop water production facilities in other catchments.

The two upstream dams, Harava and Seke with a combined capacity of 12.5 million m3, which is a relatively small storage capacity provide water for treatment at Prince Edward WTW. They are normally only used for water supply purposes after the rain season when the dams contain sufficient water of a reasonable quality. It is important to note that the Prince Edward WTW was intended as a peak load facility to be operated during the hot season.

Morton Jaffray Water Treatment Works has three number intake works namely; the old intake tower (intake No.1) constructed in 1952 and draws water at five water levels; three being the City of Harare intakes and the other two an irrigation intake and the river outlet pipe respectively. Each of the COH intakes is connected to a common ND 1100 water main which transports raw water to the distribution chamber at the head of the water treatment works. Another intake tower was constructed in 1976 in order to resolve the issue of abstraction levels in the old intake tower as well as to have a better location for abstracting better quality raw water. The new intake tower was built to avoid the weed in the bay around the old intake and to change the design of the intake and install telescopic intakes.

Raw water from the intake works enters the treatment works from the northeast via a 3 m x 3 m tunnel. It is directed initially to a mixing chamber before being fed into the treatment works.

The third supply is from Lake Manyame and is via a 3 m x 3 m rectangular 15.4 km long tunnel. The tunnel is approximately 45 m into the ground at the works and raw water is pumped from a riser shaft.

The mechanical and electrical components of the intake structures are in bad condition and will need to be rehabilitated or replaced.

4.1.1.2 Water Treatment Works

The City of Harare operates two water treatment facilities namely: Morton Affray WTW located adjacent located adjacent to the Harare - Bulawayo Highway about 40 km west of Harare and Prince Edward Water Treatment Works located approximately 22 km South of Harare. They are both conventional surface water treatment facilities.

<u>Morton Jaffray WTW</u>

Morton Jaffray Water Treatment Works (WTW) consists of three units constructed in phases - Unit 1 constructed in 1954 with a design capacity of 160,000 m^3/day and fed from

Lake Chivero by gravity, Unit 2 constructed in 1976 with a design capacity of 227,000 m^3/day fed from both Lake Chivero and Lake Manyame by gravity, and Unit 3 constructed in 1994 with a design capacity of 227,000 m^3/day and fed from both Lake Chivero and Lake Manyame by gravity. The total design capacity is, therefore 614,000 m^3/day, however the estimated current total water production is reported to be around 500,000 m^3/day to 550,000 m^3/day[1].

Water Treatment Components

The table below shows a summary of the components of the treatment units

Table 4-1: Components of the MJ WTW

Component	Description
Unit 1	
Chemical storage, preparation and dosing	Raw water is dosed with aluminium sulphate which is prepared in four concrete tanks equipped with a stirrer. These concrete tanks are badly corroded and refurbishment is greatly recommended preferably using an HDPE membrane liner. For pH adjustment, the water is dosed with lime slurry prepared from two circular steel tanks. The corresponding stirrers and dosing pumps need to be replaced. In order to reduce the organic matter content of the raw water, Powdered Activated Carbon (PAC) is also dosed and is prepared in two concrete tanks with stirrers which were recently been rehabilitated and new stirrers installed. However, dosing pumps and corresponding pipework does not exist. Sodium silicate is dosed as a flocculation aid after being prepared from two recently rehabilitated concrete tanks with new stirrers. Stirrers have not yet been commissioned. As part of the disinfection process, gaseous chlorine is dosed. The chlorination system for treated water disinfection was rehabilitated under the “UNICEF “project in 2009/2010. Two new chlorinators were installed.
Clarifiers	Clarifiers No. 1 and No. 2 are circular with separate upstream flocculation chambers equipped with flocculators for moderate mixing purposes and bottom scrapers for sludge removal. For both clarifiers, flocculators are not operational. The motors and stirrers would have to be replaced. The scraper bridge drives are not working, making sludge removal very difficult. This can only be achieved by emptying the tanks and removing sludge manually. Clarifier No. 3 is a circular clarifier of the Accelerator type with an integrated flocculator. This clarifier is completely out of operation as the electromechanical equipment (motor, stirrer, valves, and pipe-work) is worn out and would have to be replaced.Clarifiers No. 4, No. 5 and No. 6 are vertical flow clarifiers (overall depth: 12m) of the PATTERSON CANDY type with 8 sludge pockets each. Clarifier No. 7 is a DegremontPulsator type clarifier, which receives its raw water by means of a separate gravity main from Lake Chivero. The vacuum system that creates the pulsations for sludge blanket formation is not working. A number of raw water diversion plates at the bottom of the rectangular clarifier are broken. Raw water inlet and

[1] The production volumes are based on calculation from original pump discharge and hours run as the flow meters are not working

Component	Description
	clarified water outlet valves will need to be checked on their operational status including desludge valves.
Rapid Gravity Sand Filters	Unit 1 comprises a total of 26 No. rapid gravity sand filters: 12 PATTERSON filters (installed between 1952 and 1954) and 14 DEGREMONT filters (installed in 1966). Inlet and outlet baffle gates of the 12 “Patterson “type filters are completely corroded and need complete replacement. The float type filter outflow regulation system is completely worn out, and no longer operational. All valves (filtered water outlet, backwash water inlet, and air inlet) need to be replaced as many of these are heavily leaking. The new valves will need to be equipped with pneumatic actuators complete with corresponding air compressors. The two existing backwash air blowers are very old, but still operational. Inlet plates of the 14 “Degremont” filters are heavily corroded. A number of the A.C. filter floor slabs are cracked and need repairing. The “Degremont” siphon type outflow control system is not working. All valves (filtered water outlet, backwash water inlet, and air inlet) will need to be replaced. The new valves will need to be equipped with pneumatic actuators complete with corresponding air compressors. Only one air blower is operational for filter backwashing. A second air blower will need to be installed including all corresponding pipework and fittings.The existing air pipework is leaking and requires repair or replacement. Two very old backwash water pumps (installed in 1954) are serving both, the “Paterson” and “Degremont” filters. A number of valves and pump starters will need to be replaced as the electrical control board is now in a bad state.
Units 2 & 3	
Raw Water Pumping Station/ Raw Water Tower	The underground raw water pumping station receives water by gravity flow from Lake Manyame via a rectangular tunnel, approximately 3m x 3m and 15.4 km long. The underground raw water pumping station is approximately 45 m below the ground, and comprises a total of 5 WEIR pumps; 3 pumps installed in 1985 and 2 pumps installed in 1993. Raw water is pumped up a raw water tower approximately 40m above ground and then falls down by gravity into the 1800 mm Ø main leading to the raw water mixing chamber where it is mixed with Lake Chivero raw water. Due to the 40 m falling height it is expected that the water from Lake Manyame is supersaturated with dissolved oxygen, which later on is released in the Pulsator type clarifiers, thus reducing the floc formation process due to flotation effects.
Chemical Storage, Preparation and Dosing	In order to reduce the organic matter content of the raw water, Powdered Activated Carbon (PAC) is dosed into the raw water mixing chamber by one PAC dosing pump capable of dosing 25 % of the total PAC demand leaving 75 % being dosed manually by pouring the content of 25 kg bags of PAC directly into the mixing chamber. For pH correction Sulphuric Acid (H2SO4, 98%) is dosed into the same mixing chamber above in order to reduce the raw water pH from a maximum range of 8.5 to 8.7 down to 6.8 to 7.0 which is the optimum pH range for subsequent coagulation with aluminium sulphate.

Component	Description
	Sulphuric acid is stored in a 60 ton storage capacity tank, which lasts on average 4 days only and is dosed by a single pump. Aluminium Sulphate is dosed at the inlet point of the six distribution channels to the six Pulsator type clarifiers of Unit 2 and 3. Due to the required high aluminium dosing rates of 60 to 80 mg/l, a daily amount of approximately 40 tons of aluminium sulphate is required. There are three aluminium sulphate solution tanks approximately 600 m3 in capacity each. Granular aluminium sulphate is being dosed. Two concrete tanks, originally foreseen for sodium silicate preparation are now used for alum solution preparation and from these preparation tanks alum is pumped to two alum dosing tanks, out of which alum is dosed by means of two centrifugal pumps (GRUNDFOS). In order to allow for some alum solution reserve volume, it is now common practice to store surplus prepared alum solution in the above 600 m3 alum solution tanks. Sodium Silicate is dosed as a flocculation aid by means of two separate dosing plants, one for Unit 2 and one for Unit 3.Each plant comprises two concrete preparation and dosing tanks, each tank is equipped with a stirrer. Lime dosing for final pH-adjustment is through a lime dosing station, comprising 4 No. lime slurry hoppers and 4 No. lime dosing pumps. As part of the disinfection process, gaseous chlorine is dosed
Pulsator Type Sludge Blanket Clarifiers	Unit 2 comprises 3 Pulsator type Clarifiers commissioned in 1976 and Unit 3 again comprises 3 Pulsator type Clarifiers commissioned in 1994. All clarifiers are of the same type and size. Pre-treated water is distributed by a distribution chamber with weirs discharging partially treated water to individual channels, where coagulation and some kind of pre-flocculation take place. Each clarifier inlet channel has a “Venturi” flume for flow measurement purposes. However, in one of the six channels this flume has been taken out, which leads to overloading of this individual channel and thus of the corresponding downstream clarifier. The “Pulsator” type clarification process is considered as not being the optimum clarification process for algae containing raw water as the formation of a sludge blanket over a large rectangular surface area is rather difficult under operational circumstances, where chemical dosing rates cannot be accurately monitored and where frequent power failures occur, leading to a complete breakdown of these sludge blankets. Compared to the vertical clarifiers (No.4, No.5 and No.6 of Unit 1), the solids and algae removal rate of Unit 2 and Unit 3 clarifiers is less than the removal rates observed for Unit 1 clarifiers. Therefore, due to the difficult sludge blanket formation only a limited sludge abstraction via sludge concentrators located at one side of the clarifiers, a lot of sludge is accumulated at the bottom of the clarifiers. This leads to frequent emptying and cleaning of the clarifiers (roughly, every 3 to 4 months) and thus a significant loss of water.

Component	Description
	The Pulsator system comprises the air pump, the corresponding motor, the starters and the vacuum release device. The vacuum systems are subject to frequent failures and thus have to be monitored very carefully and are being repaired rather frequently.
Rapid Gravity Sand Filters	Unit 2 comprises 18 Degremont V-type rapid gravity sand filters and Unit 3 comprises 18 rapid gravity sand filters of the same type. Filter regulation is of the syphon type outflow regulation. This system is longer operational. New pneumatically actuated solenoid valves were installed in 2009/2010 in all four mains per filter (i.e. in Φ400 mm filtered water outlet, Φ 600 mm backwash water outlet, Φ 500 mm backwash water inlet and Φ 300 mm air inlet) for both, Unit 2 and Unit 3 sand filters,. However, Unit 3, compressed airlines are inadequate to meet the pressure required to operate the valve actuators. Filter backwash is by 5 No. backwash water pumps of which, 3 are dedicated to Unit 2 and 2 are dedicated to Unit 3.5 No. air blowers are also operational of which 2 are dedicated to Unit 2 and 2 are dedicated to Unit 3 with one stand-by air blower serving both Unit 2 and Unit 3.

Rapid Gravity Sand Filters

Pulsator Clarifiers

High Lift Pump Station

The treated water pump station comprises of 14 pump-sets. Pump-sets 1-3 are fed from an ND 800 mm suction pipe with a positive suction. Pump-sets 4-14 are fed from a concrete clear water duct with a capacity of 455 Ml/d with a positive suction.

Pump-sets 1 - 3 were commissioned in 1954 as treated water pumps for the old treatment works. Due to continual operating problems during the last 5 to 10 years the pumps (W. H. Allen, Sons & Co, Size 20"/18") are scheduled to be replaced by Worthington Pumps with the same characteristics. When operating with two pumps in parallel only a minor rise in flow is achieved and the usual duty is with one pump operating and two as standby. Maximum discharge is 25 m^3/min for one pump. The pumps discharge into a ND 750 mm transmission main to Lochinvar Reservoir. A performance curve for the new 12 UZDL 25 Worthington pumps is available. The duty point for each pump-sets is 19.0 m^3/min against a 172 m head with an efficiency of 85%. The speed is 1450 rpm.

Pump-sets 4 - 6 were installed in 1960 for the transfer of treated water from the water treatment works to Warren Control Pump station through a ND 975 pumping main. These pumps are now being replaced with new Worthington pumps with the same characteristics.

The pumping station is connected to the old ND 1300 pumping main due to the replacement of the old and damaged pipes along the pipeline route to Warren Control. A performance curve for the new 12 LNC 29"A Pleuger Worthington pump is available. The duty point for two pumps in parallel is 75 m^3/min against a 154.3 m head with an efficiency of 85%. The speed is 1480 rpm.

Pump-sets 7 - 10 were commissioned in 1976 and the pump Model is 20" SDS METS. They consists of an A pump rated 600 kWin series with a B pump rated 1,300 kW. They discharge into a 1300 mm Ø transmission main to Warren Control Pump Station.

Pump-sets 11 - 14 were installed in 1994 and the pump Model is 16-LN-35E. Each pump set consists of two identical pumps connected in series with a duty point of 53 m^3/min against a of 90 m head. The speed is 1482 rpm and the efficiency 88%. They discharge into another ND 1300 transmission main to Warren Control Pump station.

The three old pipes (ND 750, ND 975 and ND 1300) and the new ND 1300 pipeline from the treated water pump station have flow recorders installed in separate chambers out of the main pump station.

Backwash Water Treatment and Recycling Plant

A backwash water treatment plant was installed approximately 10 years ago to treat dirty backwash water and recycle treated dirty backwash water to the head of the works. At nominal plant design capacity and depending on filter backwashing frequencies, the plant could easily result in a water savings of around 12,000 to 15,000 m^3/d. However, due to lack of funding for the final completion of the works by ODIS Filtering Ltd., of Israel, the plant was never commissioned.

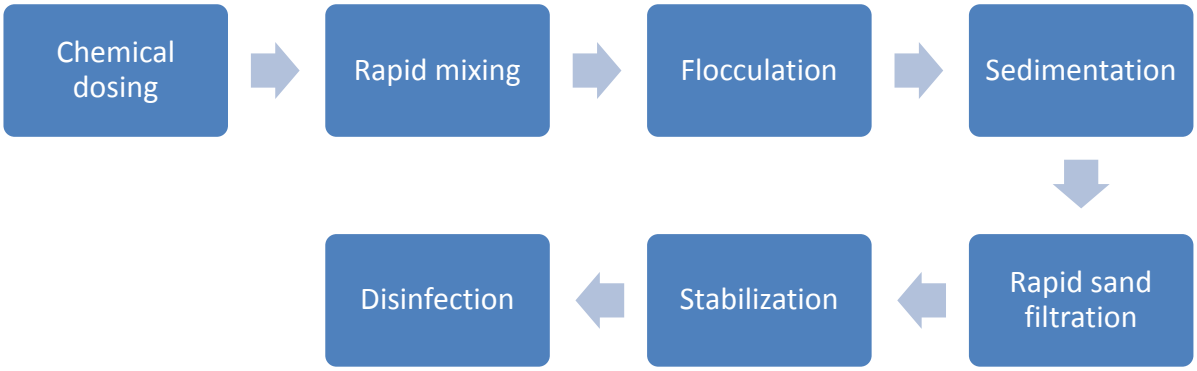
The plant comprises the following treatment processes:

- Polymer supported solid-liquid separation, (SOLIQUATOR),
- Pressure filtration of the liquid phase of the SOLIQUATOR with the filtered water to Unit 3,
- High rate settling for the solid phase of the SOLIQUATOR with the settled water returned to the SOLIQUATOR,
- Polymer supported belt press thickening of the settled solids of the high rate settlers with the supernatant returned to the SOLIQUATOR,
- Polymer supported filter press dewatering of the sludge from the belt press with the supernatant returned to the SOLIQUATOR.

<u>Prince Edward WTW</u>

Raw water for PE-WTW is taken from Seke and Harava Dams with a combined volume of 12.5 million m^3. The design capacity of PE-WTW is 90,000 m^3/d. it was built as a peak load station intended to be operated during the hot months prior to the start of the rainy season.

Prince Edward Water Treatment Works (WTW) is a conventional surface water treatment works which consist of the following unit processes:



Low lift Pump Station

The low lift pump station consist of 4 pumps and abstracts raw water from Seke Dam (formerly Prince Edward Dam). The pumps have been in operation for the past 40 years. These pumps will be replaced under the UWSSRP Phase 1.

Low Lift Pump Station

Water Treatment Components

The table below shows a summary of the components of the treatment units

Table 4-2: Components of the MJ WTW

Component	Description
Chemical Dosing	Aluminium Sulphate is dosed at the inlet point of the distribution channel to 28 No. clarifiers where rapid mixing and flocculation is achieved. The channel is 28.6 m long by 2.4 m wide and 2 m deep and has asbestos deflectors that facilitate mixing and flocculation and ensures the homogeneity of the coagulant and promotes flocculation.

Component	Description
	The coagulant is mixed in three alum make-up tanks and the solution gravitates to three number mixing tanks before being pumped to the dosing point. According to the plant operators, the average Aluminium Sulphate dosage rate is almost the same throughout the year, approximately 27.5 to 35 mg/l. In order to reduce the organic matter content of the raw water during dry periods and following the first rains, Powdered Activated Carbon (PAC) is dosed into the raw water by means of manually dosing one 25 kg bag for 2 hrs. For pH correction, lime is dosed after being prepared in two octagonal tanks with mixers. Dosing is done down-stream of the rapid sand filters. Sodium Silicate is dosed as a flocculation aid between September and December at a rate of 0.5 mg/l. As part of the disinfection process, gaseous chlorine is dosed. In addition it is dosed to kill algae, due to algal bloom in the supplying dams.
Clarifiers	There are 28 No. vertical flow clarifiers all approximately 18m x 9m x 9m with a surface loading rate of 1.5m/hr. The clarifiers receive coagulated water from a central circular distribution chamber that is connected to the flocculation channel. Clear water collection troughs are made of asbestos cement and consequently are very difficult to clean and as such these must be replaced with steel troughs with V-notch weirs for optimum and even distribution of clarified water. Treated water is collected by several troughs installed at the top of the tanks and flows to rapid sand filters. The clarification treatment performance appears to be good. The manually operated desludging valves are all in good operational status. The abstracted clarifier sludge is transferred to sludge lagoons by means of two sludge pumps, installed in the old 1929 low lift pump station. Out of these two pumps only one is operational and is very old. Therefore, two properly designed sludge pumps will need to be installed including corresponding pipework and valves.
Rapid Sand Filters	There are sixteen DegremontAquazur type rapid gravity sand filters constructed in banks of eight either side of the filter gallery and observation deck with the following dimensions: 11.8m x 4.25m. The operators advised that under normal circumstances the filtration rate is around 5m/hr. The water depth on the sand filter surface is controlled by siphons, of which vacuum strength is regulated by floats so that the water level is constant. However, this control mechanism is no longer operational and when the filter resistance reaches 1.5 m, washing of the filter layer using pumped water and pressurized air takes place. The backwash sequence is; air only followed by air and water and then water only until the water is clear. The filter floors comprise partly cracked precast concrete slabs with Degremont D20 type filter nozzles. Each filter is operated via three valves i.e. filtered water outlet, backwash water inlet and air inlet valves. The valves are fitted with pneumatic actuators which needs a complete overhaul.

High Lift Pump Station

Three pumps are installed in the high lift pump station. Some pumps were replaced recently under the EU project. All the other installations are approximately 40 years old. Presently only one pump is operational and it is reported that even the characteristics of the newly installed pump motors might not be adequate for the corresponding pump. However, new pumps will be installed under the UWSSRP Phase 1. The pump station has a drainage pump that is very old.

4.1.1.3 Transmission and Storage

Booster Stations

The water distribution network of the City of Harare consists of 16 booster stations for the conveyance of treated water. Based on the designated duty pumps in these stations, the pumping capacity ranges from 720 m3/day to 362,880 m3/day as minimum.

Out of the 16 booster stations, 6 are lift stations with 4 water towers at Donnybrook, Highlands, Greendale and Waterfalls with 2 being reservoirs near Kuwadzana and Dzivaresekwa.

There are also 2 private pump stations at Donnybrook for Lafarge Cement Factory and at Philadelphia for a military camp.

With the proposed Kunzwi WTP and Kunzwi Booster Station, a number of these booster stations will not be required in the long term planning to 2030.

A summary of these booster stations is provided in the table overleaf. Modetailed assessment of the booster stations is presented in Appendix 4.1.

Table 4-3: Booster Stations - Harare

Ref.	Pumping Station	Function of PS	Capacity[(1)] (m3/d)	Head (m)	Year of Constr. (year)
(a)	Alexandra Park	transmission	50,000	45	1971
(b)	Avondale	transmission	325	55	1959
(c)	Bluff Hill	transmission	13,055	55	1960
(d)	Crow hill	transmission	9,160	37	1971-72
(e)	Emerald Hill	lift station	460	27	?
(f)	Greendale	lift station	?	?	1979-80
(g)	Hatfield	removed	-	-	-
(h)	Hogerty Hill	transmission	3,260	30	1978-79
(j)	Kuwadzana	transmission	4,750	90	1995
(k)	Letombo	transmission	64,800	98	?
(l)	Mabvuku	lift station	1,700	22	1955-56
(m)	Marimba Park	lift station	?	?	?
(n)	Orange Grove	transmission	15,650	35	1969-70
(o)	Pockets Hill	lift station	?	?	?
(p)	Warren Control	transmission	?	125	?
(q)	Waterfalls	lift station	?	?	?

Transmission Mains

The City of Harare and surrounding areas are supplied by transmission pipelines from Morton Jaffray and Prince Edward Water Treatment Works. Two ND 1300 pipelines, a ND 750 and a ND 975 pipeline convey water from Morton Jaffray WTW pumping station to

Warren Control ground reservoir. DN 750 main conveys water from Morton Jaffray to Lochinvar reservoir.

Prince Edward Treatment Works supplies treated water through a ND 975 pipeline to the City of Harare and Chitungwiza.

The main supply point of the city's water distribution system is the Warren Control pumping station from where most of the city is supplied with treated water. From Warren Control, water is conveyed to 24 reservoirs by four transmission mains. These transmission mains also feed directly into the distribution system of the City. The four transmission mains are:

- The ND 800 main, supplying the north-west of the City (North-West Main);
- The ND 750 main supplying the Alexandra Park reservoir site (Alexandra Main);
- The ND 975 main supplying the Letombo system reservoirs (Letombo Main);
- The 1000 mm main supplying the south of the City and feeding the Letombo reservoir (Highfield Main).

These four transmission mains constitute the backbone of the supply system of the city. They are supported by additional primary mains which form a looped system incorporating the main pumping stations and reservoirs of the water distribution system. The main components of this system are:

- Warren Control pumping station;
- Letombo reservoirs and pumping station;
- Alexandra Park reservoirs and pumping station;
- Orange Grove pumping station;
- Greendale reservoirs;
- Highlands reservoirs and pumping station.

From Warren Control pumping station treated water gets pumped through the Letombo Mains and Highfield Mains to the Letombo reservoirs. The Letombo reservoir site/ pumping station operates as the main supply point of the eastern part of Harare. From there, treated water gets transferred by pumping to the reservoirs at Greendale, Ventersburg and Donnybrook. These reservoirs command the eastern areas of Harare. Greendale reservoir gets fed by a second supply source, the Orange Grove pumping station. This pumping station is supplied by two gravity mains - a ND 450 and a ND 375 from Alexandra Park reservoirs.

From Warren Control pumping station the Alexandra Park reservoirs are fed by two transmission mains, the ND 750 Alexandra Main and a ND 600 pipe branching off the ND 975 Letombo Main. From Alexandra Park the Highlands reservoirs are fed by pumping through a ND 525 main which gets supported by a ND 300 pumping main from Orange Grove pumping station. The north-east of the city gets supplied from Highlands reservoirs.

The north-west of the city is supplied by the ND 800 North-West Main from Warren Control. The reservoirs of Dzivaresekwa, Bluff Hill, Epsilon and Adylinn get supplied by this main.

The south-western areas of the city are supplied off the transmission mains from Morton-Jaffray to Warren Control by pumping. In addition, the reservoirs at Lochinvar and Marimba are directly fed from this transmission main.

Figure 4-3 below illustrates the main transmission network in Harare. The condition assessment of the transmission mains is presented in Appendix 4.1.

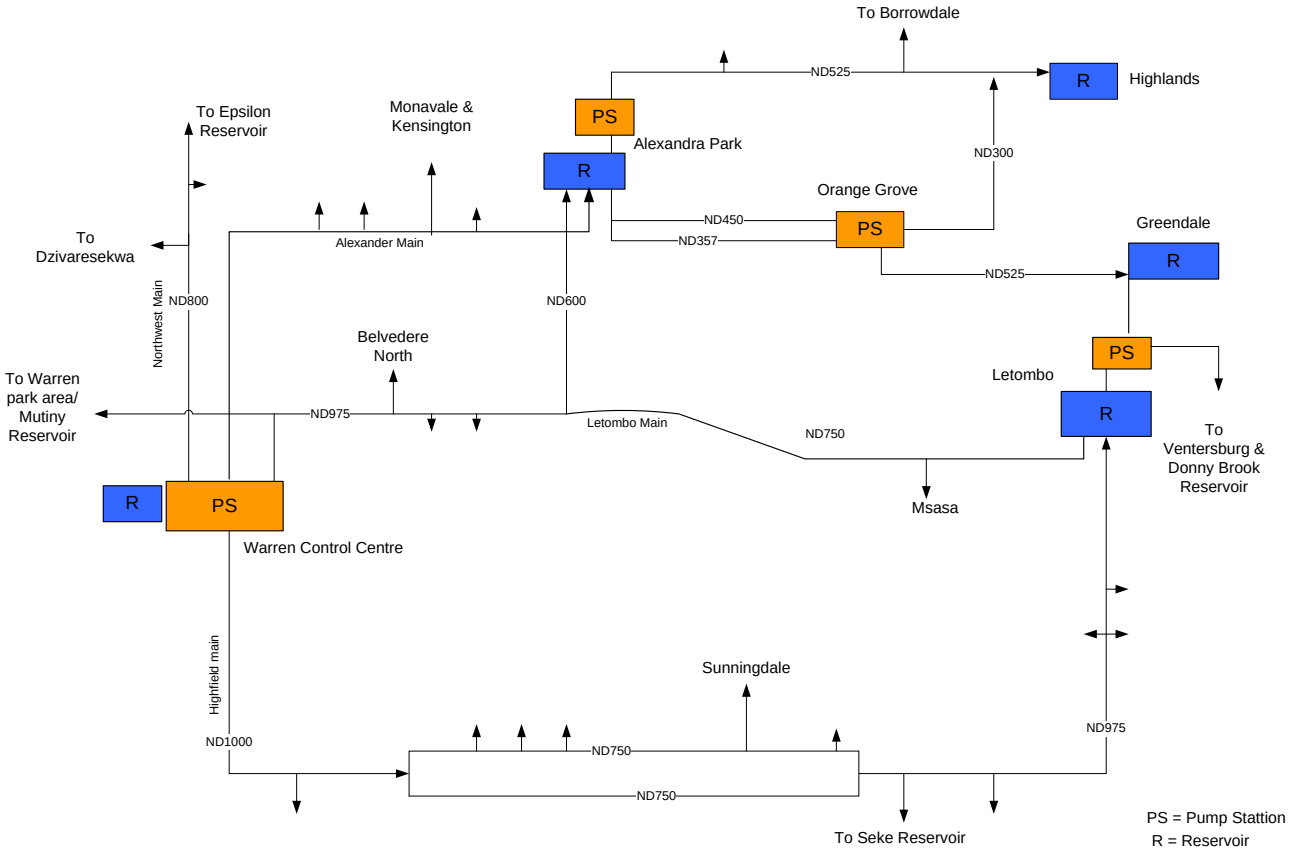


Figure 4-3: Configuration of the Main Water Transmission Network - Harare

Storage Reservoirs

The water supply system in Harare has 27 treated water reservoir sites. The reservoirs are dotted all around the city between 1,460 m and 1,600 m amsl. The main reservoirs in terms of capacity are Letombo, Alexandra Park, Lochinvar, Greendale and Highlands which together have a storage capacity of approximately 553,740 m^3. This is about 70% of the total storage capacity of the water supply system. The table below shows the main characteristics of the reservoirs.

Table 4-4: Reservoir Characteristics - Harare

ReservoirSite	Volume(m3)	T.W.L(m)
Adylinn	1,140	1519.02
Alexandra Park	111,950	1538.37
Arundel	7,580	1532.82
Bluff Hill	5,680	1506.06
Donnybrook	36,180	1602.02
Dzivaresekwa	5,680	1481.50
Emerald Hill	25,750	1552.39
Epsilon	4,090	1518.86
Greendale	70,770	1583.76
Hatfield	13,630	1521.30
Highlands	61,740	1568.55
Hogerty Hill	1,140	1600.07
Kambanji	5,680	1538.75

ReservoirSite	Volume(m3)	T.W.L(m)
Kopje	7,960	1527.27
Kuwadzana		
Letombo	236,400	1539.51
Lochinvar	72,880	1475.58** 1478.05
Marimba Park	34,400	1463.45
Meyrick Park	2,280	1517.65
Mutiny	11,400	1520.45
Philadelphia	7,580	1574.40
Ridge Road	3,410	1531.31
Ventersburg	22,800	1559.50
Viking	27,260	1516.73
Waterfalls	5,680	1467.13
Total Volume	783,060	

4.1.1.4 Distribution Network

The primary and secondary distribution network is made up of AC, steel and PVC pipes. The total network length (excluding transmission pipes above ND 600) is 5,200 km. Steel pipes are the oldest. Installation of PVC pipes only started in the 80s. PVC pipes now account for 22% of the network.Deterioration of the steel pipes is a major source of leakage. Much of the old steel reticulation in the centre of the city was replaced with PVC pipes in the last few years.

Table 4-5: Primary and Secondary Network Pipe Lengths - Harare

Diameter	Material			Total
	AC	ST	PVC	
ND 50	450,000	7,970		457,970
ND 63			190,780	190,780
ND 75	686,100	30,000		716,100
ND 90			270,000	270,000
ND 100	1,107,080	29,000		1,136,080
ND 110			300,000	300,000
ND 125	750			750
ND 150	890,000	48,000		938,000
ND 160			150,000	150,000
ND 225	312,900	12,485		325,385
ND 250	30,900	8,650	98,700	138,250
ND 300	140,455	20,840	140,000	301,295
ND 350	1,500	14,830		16,330
ND 375	30,000	21,380		51,380
ND 400	8,000	9,800		17,800
ND 450	60,620	18,970		79,590
ND 500	8,000	16,900		24,900
ND 525	5,000	18,000		23,000
ND 575		3,000		3,000
ND 600		16,400		16,400
Total	**3,731,305**	**276,225**	**1,149,480**	**5,157,010**

The distribution system is supplied by both pumping and gravity. There are areas that are supplied exclusively by pumping or gravity and others that are supplied by a combination of both.Most of the areas are supplied by pumping. Off-takes on transmission mains feed directly into the distribution system. These off-takes are equipped with 33 pressure reducing valves (PRVs) in order to reduce excessive pressure levels in the distribution network.

District Metering System

The City of Harare used to have a comprehensive metering system in operation. Bulk water meters and flow meters were installed to measure weekly flows at outlets/inlets of reservoirs and pumping stations as well as flows in main supply pipes transferring water into individual supply areas of the city. There were 145 district meters installed in the water supply system. Out of 145 meters, 11 bulk meters used to be read by the Chitungwiza Council. The remaining 134 meters were under the control of the water workshop of the COH. The district metering system is no longer functional because (a) the meters are not working, and (b) there have been interconnections among district metering areas that are not metered. We recommend that the old district metering system be restored after a comprehensive NRW study.

Areas outside the City Boundaries

Harare provides treated water to consumers outside the city boundaries. These areas include neighbouring municipalities and government facilities such as, Chitungwiza, Epworth, Ruwa, Norton, Domboshava, Inkomo Barracks, Chikurubi Complex (within the City boundaries), Cranbourne Barracks (within the City boundaries)

Pilot Area Investigations

The purpose of the pilot area investigations was to assess the condition of the water distribution and sewerage networks and recommend rehabilitation investment measures for the entire system using statistical methods.

The pilot areas were selected in liaison with the Harare Water following the selection criteria specified in the ToR of the Zim-Fund financed study. It was chosen to be conveniently small, but characteristically representative of the entire network so that extrapolations to the entire network could be done with reasonable levels of confidence.

Two pilot areas - one representing the high density housing category the other representing the medium density housing category - were chosen for the investigations.Highfield was chosen because it is one of the oldest high density suburbs and is densely populated, while Cranborne was chosen because it is one of the oldest medium density suburbs and isfairly representative of most medium density suburbs.

The AC pipes in the study areas appear to be in good condition despite the age – not very surprising considering that AC pipes have a lifespan of 50-70 years. Even though AC pipes undergo gradual degradation in the form of corrosion (i.e., internal calcium leaching due to conveyed water (lower Langelier index = more leaching) and/or external leaching due to groundwater), the council has not reported enough pipe failures to suggest that the pipes need replacement. The exposed pipes from the replaced pipes did indicate that the pipes were in fair condition except for those cracked pipes from presumably too high pressures as shown in the photo below.

Exposed Asbestos Cement (AC) pipe

Generally, all the valves are in a bad shape; they are rusty and leaking.Valve chambers are generally in a very poor condition, damaged and filled with stones as shown in the photos below.

Valve Chamber

Furthermore, there are no covers and those that do have, have been vandalised. Therefore, the conclusion based on the above is that, all network appurtenant fittings and structures must be replaced.

Significant amount of water is lost after the meter resulting in unnecessary water use/ wastage. If metered, these wastages lead to increased water bills, which may not be paid by the consumers. If unmetered, these wastages result in high NRW levels, as flat rate billing considers only a limited average amount of water usage. Wastage can be reduced and water conservation measures be implemented through rehabilitation of household installations and household education and awareness programs. Even though Household investments are normally not part of project funding, a provision in the investment plan for public awareness campaigns aimed at sensitizing consumers on the motivation and financial benefits associated with investing in internal plumbing repairs is made. It is further recommended that council should make it a policy to fix leaking taps and pass on the costs to the consumers as a way to minimise water losses.

As can be seen from the photos below, the service connections are heavily corroded and incrusted. This was expected, given that these connections have been in service for over 30 years. Most of the leakages in the network occur on these lines.

It is therefore recommend that, all house connections be replaced including the saddles. It is further recommend that, the replacement of service lines should be of HDPE. HDPE house connections have proved to be durable and reliable. HDPE pipes have a smooth internal surface that does not corrode or tuberculate and maintains its flow capability over time. HDPE service connection pipes have a cost benefit associated with their longevity. The polyethylene pipe industry conservatively estimates the service life for HDPE pipes to be 50-100 years. This translates to savings in replacement costs for a long period.

Incrusted house connections

4.1.2 Sewerage

4.1.2.1 Catchment areas

Harare is divided into Six catchment areas according to the drainage patterns of the city. The existing catchment areas are; Firle Mukuvisi Catchment Area, Crowborough Catchment Area, Marlborough Catchment Area, Budiriro Catchment Area, Hatcliff Catchment Area and Donnybrook ponds catchment area.

Firle or Mukuvisi Catchment Area

Firle or Mukuvisi Catchment Area is a large drainage area which encompasses the low density suburbs of Chisipite, Lewisham, Highland, Newlands, Oval Park, Runnivale, Borrowdale West, Pomona, Vainona,Groombridge, Little Norfolk, Mount Pleasant, North Wood, Gunhill, Worms Hill, Greendale, Dawn Hill, Oval Park, Rhodesville, Masasa, Mukuvisi Park, Beverly, Mukuvisi, Mukuvisi Park, Gleenglove, Beverly West, Amby, Bingley, Athlone, Cranborne Park, Queensdale, Arcadia, Braeside, Chadcombe, Masasa Park, Park Meadows, Hatfield, Graniteside, St Martins, Sunningdale, New Prospect Park, City Centre, the Avenues, Mbare, part of Southerton, Ardbennie, Prospect, Park Town, Malvern, Midlands, Waterfalls, Induna, Grobbie Park, Mbare West, Glen View, Glen Norah, Highfield and Willowvale.

The collector mains carrying influent flows from this catchment area ranges from 150 mm Ø to 1400 mm Ø mains.

Table 4-6: Systems Description ofFirle Catchment Area

Suburbs covered	System Description
Chisipite and Lewisam	Wastewater from these areas is pumped via a ND200 AC to a Transition Chamber in Highlands. The influent gravitates from the Transition Chamber via the ND 375 RC main into a ND 450 RC

Suburbs covered	System Description
	pipe which subsequently discharges into the ND 750 RC main. The ND 750 main discharges into a ND 900 AC main which also discharges into one of the ND 1400 twin collector main. The ND 1400 collector main discharges into the Firle WWTW.
Highland, part of Newlands, Oval Park and Runnivale	Wastewater from these areas discharge into a ND 450 RC pipe which subsequently discharges into the ND 750 RC main. The ND 750 main discharges into a ND 900 AC main which also discharges into one of the ND 1400 twin collector main. The ND 1400 collector main discharges into the Firle WWTW.
Borrowdale West, Pomona, Vainona,Groombridge, Little Norfolk, Mount Pleasant and North Wood	Wastewater from these areas is pumped via a ND 300 AC to a Transition Chamber in Gunhill. The influent gravitates from the Transition Chamber via the ND 450 RC main. The ND 450 RC main discharges into the ND 675 RC main. The ND 675 main discharge into one of the ND 1400 twin collector main. The ND 1400 collector main discharges into the Firle WWTW.
Gunhill and part of Newlands	The influent from these areas gravitate from the Transition Chamber via the 450 mm Ø RC main. The 450 mm Ø RC main discharges into the 675 mm Ø RC main. The 675 mm Ø main discharge into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
Worms Hill, Greendale, Dawn Hill, Oval Park and Rhodesville	Wastewater from these areas discharge a 315 mm Ø PVC main which subsequently discharge into the 450 mm Ø RC main. The 450 mm Ø RC main discharges into the 675 mm Ø RC main. The 675 mm Ø main discharge into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
Masasa, Mukuvisi Park, Beverly, Mukuvisi, Mukuvisi Park, Gleenglove, Beverly West, Amby, Bingley and Athlone	Wastewater from these areas discharge a 375 mm Ø RC main which subsequently discharge into the 525 mm Ø RC main and then into a 600 mm Ø RC main. The 600 mm Ø RC main discharges into the 750 mm Ø RC main. The 750 mm Ø main discharge into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
Cranborne Park, Queensdale, Arcadia and Braeside	Wastewater from these area discharge a 675 mm Ø RC main. The 675 mm Ø main discharge into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
Chadcombe, Masasa Park, Park Meadows and Hatfield	Wastewater from these areas discharge a 375 mm Ø RC main which subsequently discharge into the 525 mm Ø RC main. The 525 mm Ø main discharge into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
Graniteside, St Martins, Sunningdale and New	Wastewater from these areas discharge into two directions. Graniteside drains directly into the 1400 mm Ø collector main

Suburbs covered	System Description
Prospect Park	discharges into the Firle WWTW 1400 mm while Sunningdale, St Martins and New Prospects area drains into the 675 mm Ø main, which also discharges into one of the 1400 mm Ø twin collector main. The 1400 mm Ø collector main discharges into the Firle WWTW.
City Centre and the Avenues	Wastewater from these areas discharge into two mains. The 525 mm Ø RC main collecting wastewater from the town centre and the 750 mm Ø RC main collecting the wastewater from the avenues. The 525 mm Ø RC main discharges into a 750 mm Ø RC main which in turn discharges into the 1400 mm Ø RC collector main to Firle WWTW. The 750 mm also discharges into another twin 1400 mm Ø RC collector main to the Firle WWTW.
Mbare	Wastewater from this area discharges into the 1400 mm Ø RC collector main to the Firle WWTW.
Part of Southerton	Wastewater from these area is discharges a 375 mm Ø RC main which subsequently discharge into the 600 mm Ø RC main. The 600 mm Ø main discharge into one of the 1400 mm Ø twin collector main which in turn discharges into the Firle WWTW.
Ardbennie	Wastewater from this area discharges into two mains directions, the North Eastern part discharges into a 375 mm Ø RC main which in turn discharge into the 1400 mm Ø RC collector main. The other parts other parts of the suburb discharges into the 1400 mm Ø RC collector main to the Firle WWTW.
Prospect and Park Town	Wastewater from these areas discharge into a 300 mm Ø RC main which in turn discharge into the 1400 mm Ø RC collector main to the Firle WWTW.
Malvern, Midlands, Waterfalls, Induna, Grobbie Park and Mbare West	Wastewater from these areas discharge into the 1400 mm Ø RC collector main to the Firle WWTW
Glen View	Wastewater from this area discharges into a 300 mm Ø AC main which in turn discharge into a 375 mm Ø AC main. The 375 mm Ø AC main in turn discharges into the 450 mm Ø AC collector main. The influent from the 450 mm Ø AC main discharges into the 675 mm Ø AC collector main to the Firle WWTW.
Glen Norah	Wastewater from this area discharges into two mains directions, the North part discharges into a 300 mm Ø AC. The Southern part discharges into 450 mm Ø RC main. Both mains discharges into the 1400 mm Ø RC collector main to the Firle WWTW.
Highfield	Wastewater from this area discharges into two 375 mm Ø RC mains. Both mains merge downstream a 375 mm Ø RC before joining the 1400 mm Ø RC collector main to the Firle WWTW.
Willowvale	Wastewater from this area discharges into a 450 mm Ø RC main which in turn discharge into a 525 mm Ø RC main. The 525 mm Ø

Suburbs covered	System Description
	RC main in turn discharges into the 675 mm Ø RC collector main which discharges into the Firle WWTW.

Crowborough Catchment Area

Sunrise, Sunridge, Avondale West, Sherwood Park, Sentosa, Mayfield Park, Gotsword Hills, Meyrick Park, Strathaven, St Andrews Park, Mablereigh, Monavale, Avondale, Kensington, Alexandra Park, Belvedere North, Milton Park, Lincoln Green, Belvedere South, Ridge View, Workingston, Rugare, Lochinvar, Kambuzuma, New Marimba, Marimba, Mufakose, Crowborough, Crowborough North, Kwadzana, Kwadzana Phase 3, Kwadzana Phase 4 Ext, Glaudina, Dzivaresekwa, Dzivaresekwa Ext, Tynwald North and Sanganayi Park, Bluff Hill, Bluff Park, New Bluff Hill Park, Tynwald, Tynwald South, Nkwisi Park, Westlea, Ashdown Park, Warren Park and Warren Park D and part of the Town Centre.

Table 4-7: Systems Description ofCrowboroughCatchment Area

Suburbs covered	System Description
Sunrise, Sunridge, Avondale West, Sherwood Park, Sentosa, Mayfield Park, Gotsword Hills, Meyrick Park, Strathaven, St Andrews Park, Mablereigh and Monavale	Wastewater from these areas discharge into two mains; a 315 mm Ø PVC and 525 mm Ø RC mains. The mains join downstream into a 900 mm Ø RC main also discharges into the Crowborough WWTW.
Avondale, Kensington and Alexandra Park	Wastewater from these areas discharge into two mains 315 mm Ø PVC mains. The mains join downstream into a 450 mm Ø RC main also discharges into one of the 900 mm Ø twin collector main. The 900 mm Ø collector main discharges into the Crowborough WWTW.
Belvedere North, Milton Park and Lincoln Green	Wastewater from these areas discharge into a 450 mm Ø RC main. The 450 mm Ø RC main discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Belvedere South, Ridge View and Workingston	Wastewater from these areas discharge into a 315 mm Ø PVC main which in turn discharge into a 450 mm Ø RC main. The 450 mm Ø RC main discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Rugare	Wastewater from this area discharge into a 450 mm Ø RC main. The 450 mm Ø RC main discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Lochinvar and Kambuzuma	Wastewater from these areas discharge into a 300 mm Ø PVC main. The 300 mm Ø PVC main discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.

Suburbs covered	System Description
New Marimba and Marimba	Wastewater from these areas discharge into a 300 mm Ø AC main. The 300 mm Ø AC main discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Mufakose	Wastewater from this area discharges into a 315 mm Ø PVC and 600 mm Ø RC mains. The 315 mm Ø PVC main discharges directly into Crowborough WWTW. The 600 mm Ø RC discharges into the 900 mm Ø RC which in turn discharge into the Crowborough WWTW.
Crowborough and Crowborough North	Wastewater from these areas discharge into a 300 mm Ø AC main. The 300 mm Ø AC main discharges into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Kwadzana, Kwadzana Phase 3, Kwadzana Phase 4 Ext, Glaudina, Dzivaresekwa, Dzivaresekwa Ext, Tynwald North and Sanganayi Park, Bluff Hill, Bluff Park and New Bluff Hill Park	Wastewater from these areas discharge into a 600 mm Ø AC main which in turn discharges into the Crowborough WWTW.
Tynwald, Tynwald South, Nkwisi Park, Westlea, Ashdown Park and Warren Park D	Wastewater from these areas discharge into a 450 mm Ø RC main. The 450 mm Ø RC main discharges into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Warren Park	Wastewater from these areas discharge into a 900 mm Ø RC twin main which discharge into the Crowborough WWTW.
Mufakose	A sewer draining Mufakose enters Crowborough WWTW at a low level and is pumped to the head of the works.

Budiriro Catchment Area

Budiriro Catchment Area comprise of the high density areas of Budiriro 1, 2, 3, 4 and 5.

Table 4-8: Systems Description ofBudiriroCatchment Area

Suburbs covered	System Description
Budiriro 1, 2 and 3	Wastewater from these areas discharge into two mains 375 mm Ø RC main which in turn discharges into a 450 mm Ø RC main. The 450 mm Ø RC main discharges into a 675 mm Ø collector main. The 675 mm Ø collector main discharges into the Firle WWTW
Budiriro 4 and 5	Wastewater from these areas discharge into a 450 mm Ø RC to Budiriro Pump Station. From here, the influent is pumped to Firle WWTW via a 675 mm Ø RC

Suburbs covered	System Description
	collector main.

Marlborough Catchment Area

Marlborough Catchment Area consists of the low density of Marlborough, New Marlborough, Adylinn, Emerald Hill, Ashrrittle and Avonlea. The collector mains carrying sewage from this catchment area ranges from 300 mm Ø to 450 mm Ø mains. The table below gives detailed sewerage system description in the contributing suburbs within the Marlborough Catchment Area.

Table 4-9: Systems Description in each Suburb in Marlborough Catchment Area

Suburbs covered	System Description
Avonlea, Ashrrittle and Emerald Hill	Wastewater from these areas discharge into the Marlborough Pump Station where it is pumped via 375 mm Ø RC main into the Firle wastewater pipe network. In case of power outages, wastewater from these areas gravitates to the Marlborough WWTW.
Adylinn and Marlborough	Wastewater from these areas discharge into a 450 mm Ø RC main which discharge into the Marlborough WWTW
New Marlborough	Wastewater from these areas discharge into a 300 mm Ø AC main which discharge into the Marlborough WWTW

Hatcliff Catchment Area

Hatcliff Catchment Area encompasses low density areas of Philadelphia, Borrowdale Brook, and Hogertt Hill part of Carrick Creach. The catchment also consist of the High density area of Hatcliff.The collector mains carrying influent flows from this catchment area ranges from 250 mm Ø to 450 mm Ø mains. The table below gives detailed sewerage system description in the contributing suburbs within the Hatcliff Catchment Area.

Table 4-10: Systems Description of HatcliffCatchment Area

Suburbs covered	System Description
Hogert Hill, Borrowdale Brook, Philadelphia and part of Carrick Creagh	Wastewater from these areas is pumped through a series of Booster Pump Stations into a Transition Chamber in Hatcliff. From here, the wastewater gravitates via a 300 mm Ø AC main and then into a 450 mm Ø AC main to the Hatcliff WWTW.
Hatcliff	Wastewater from this discharges into a 300 mm Ø AC main and then into a 450 mm Ø AC main to the Hatcliff WWTW.

4.1.2.2 Condition Assessment of Trunk Sewers

The condition of the critical sewer mains conveying waste water from different suburbs in Harare were assessed with the help of Harare Water Staff. The following are the critical sections inspected during the site visit:

- the 1400 mm Ø RC twin mains collecting most of the influent in the Firle or Mukuvisi Catchment;
- the 600 mm Ø AC main collecting most of the influent on the eastern part of the Crowborough Catchment;
- the 900 mm Ø RC twin mains collecting most of the influent on the western part of the Crowborough Catchment.

The 1400 mm Ø RC twin mains colleting waste water in the Mukuvisi Catchment. Assessment of these mains was carried by visual inspection via manholes. The main seem to be in good condition. However, the benching indicated some corrosion. The mains will require rehabilitation in a long term (2030). The photos below show the condition of the manholes on the 1400 mm Ø RC twin mains.

Manholes

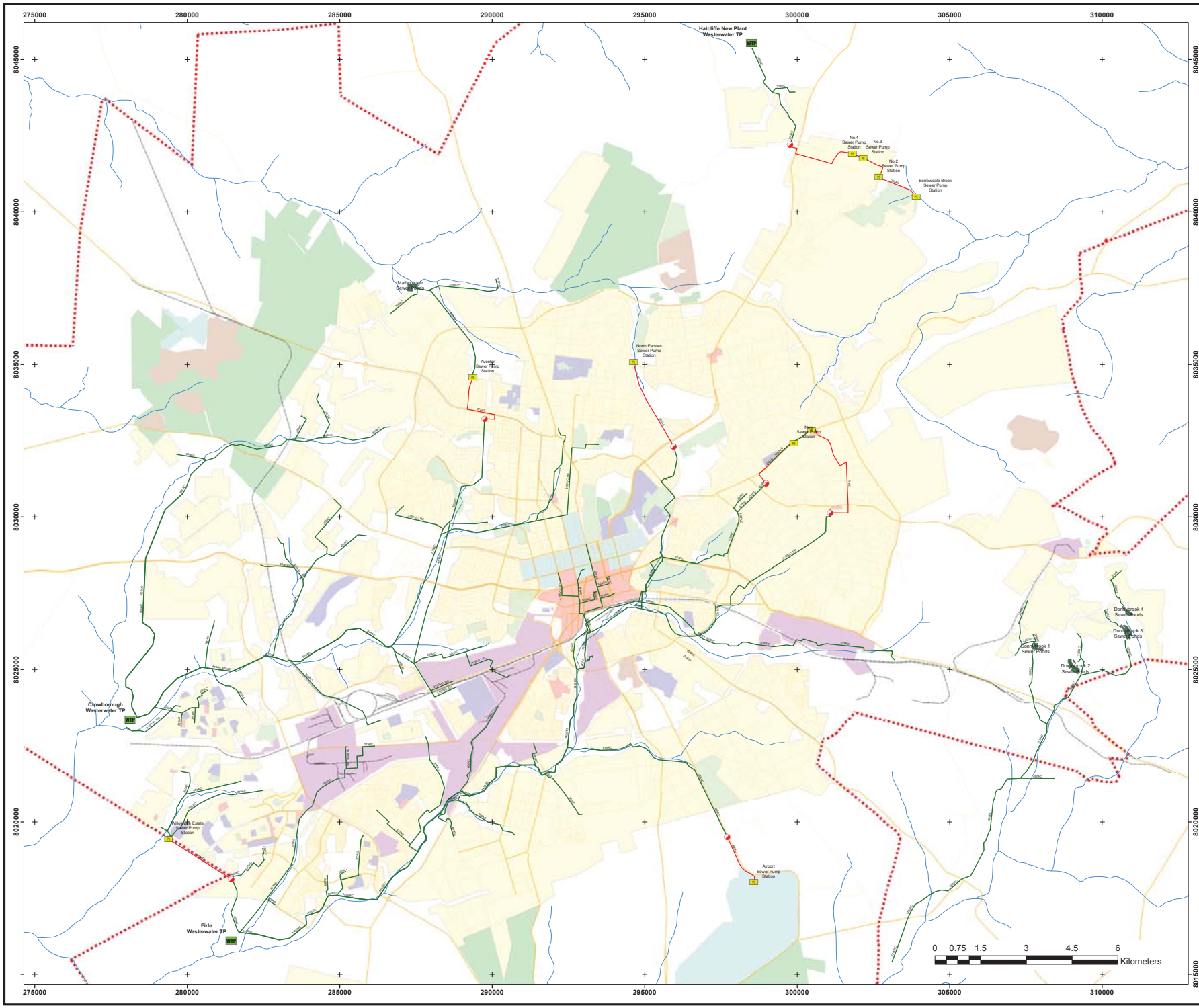
The ND 600 main collects waste water from the eastern section of the Crowborough Catchment Area such as Kwadzana, Glaudina, Dzivaresekwa, Tynwald North Sanganayi Park and Bluff Hill. Assessment of this main was carried out by visual inspection of the manholes and on specific sections of the pipe. The pipe is currently surging and has collapsed at the downstream end. The entire section of main mustbe replaced and upgraded. The photos below show the condition of the manholes and collapsed sections on the 600 mmØ AC main.

Collapsed section of the 600 mm Ø AC and state of Manholes on the main

The 900 mm Ø RC twin mains collects the influent from the western part of Crowborough Catchment. Assessment of these mains was carried out by visual inspection of the manholes and the pipe bridge upstream of the Crowborough WWTW. The steel pipes on the pipe bridge are severely corroded and damaged, and all the influent from one of the 900 mm Ø is surcharging into the stream. Consequently, about 5,000 m of the 900 mm Ø does not convey any waste water and is in effect, abandoned. Part of the influent on the 900 mm Ø RC main discharges into the main. The steel pipes pipe bridge and the 5,000 m length of the 900 mm Ø RC downstream of the pipe bridge that is currently abandoned due to the influent surcharging into the stream needs to be replace and upgraded. The figure below shows the condition of the manholes and damaged pipes on Pipe Bridge.

Condition of manhole and surcharging pipe on Pipe Bridge

Figure
Layout Map of Existing Sewerage System HARARE



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Legend

- Transition Chambers
- Har_SewerPumpStations
- Har_SewerTreatmentPlants
- Har_SewerPonds
- Gravity Main
- Pumping Main
- River Crossing
- River / Stream
- Residential Roads
- Trunk/Primary Roads
- Rail Line
- Project Boundary
- Agriculture
- Business
- CBD
- Industrial
- Institutional
- Mining/Quarrying
- Recreational
- Residential

Greater Harare Water and Sanitation Investment Plan

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4.1.2.3 Wastewater treatment facilities

The City of Harare operates a number of wastewater treatment facilities. These includeFirle WWTW, Crowborough WWTW, Donnybrook Stabilisation Ponds, Hatcliffe WWTW and Marlborough Stabilisation Ponds.

Firle WWTW

Firle sewage treatment works comprises a total of 5 individual wastewater treatment streams with a nominal overall design treatment capacity of 144,000m^3/day. Units 1 and 2 were commissioned around 1970, and have a nominal design treatment capacity of 18,000 m^3/d each. The two units comprise the following;

- A common intake works comprising two parallel screen channels equipped with two sets of manually raked coarse and medium screens and corresponding Venturi Flumes,
- Six parallel baffled type vertical flow grit chambers with corresponding air-lift type grit removal system including compressor and air-lift pipework,
- Each unit has 6 No. circular sedimentation tanks, of the Dortmund tank design, without any sludge scraping device,
- Each unit has 4 No. trickling filters 38m in diameter and 4m high, filled with granite rocks,
- Each unit has 4 No. circular humus tanks (Final Sedimentations Tanks).

Unit 3 is a modified activated sludge process biological reactor commonly known as a BNR with a 5 stage configuration for biological nutrient removal of nitrogen and phosphorous, and was commissioned in 1982 and has a nominal design treatment capacity of 18,000 m^3/d. Unit 3 comprises;

- A 5 stage biological reactor that includes denitrification and phosphorous removal and treatment of carbonaceous load,
- Three number humus tanks.

Unit 4 is also a modified activated sludge process biological reactor with a 3-stage configuration for the biological nutrient removal of nitrogen and phosphorous, instead of the 5-stage concept as unit 3.

In addition to the above units,Firle WWTW has 3 No. ponds in series serving all units for additional effluent treatment in order to meet the corresponding standards for land and/or crop irrigation. However, currently, treated effluent from units 3, 4 and 5 is directly discharged into Mukuvisi River.

FirleWWTW has two separate effluent pump stations:

- Existing Effluent Pump Station (EEPS) with a total of six pumps, all of which are not working,
- New Effluent Pump Station with a total of four pumps, two of which are operational.

Treated effluent from Unit 1 & 2 is discharge on adjacent farms owned by the City of Harare for further purification.

Crowborough WWTW

CrowboroughWWTW comprises a total of 3 individual wastewater treatment streams with a nominal overall design treatment capacity of 54,000 m3/day.Units 1 and 2 were commissioned in 1959 and 1972 respectively, and have a nominal design treatment capacity of 18,000 m^3/day each. The two units comprise the following;

- A common intake works comprising two parallel screen channels equipped with two sets of manually raked coarse and medium screens and corresponding Venturi Flumes;
- Six parallel baffled type vertical flow grit chambers with corresponding air-lift type grit removal system including compressor and air-lift pipework;
- Each unit has 6 No. circular sedimentation tanks, of the Dortmund tank design, without any sludge scraping device;
- Each unit has 4 No. trickling filters 38m in diameter and 4m high, filled with granite rocks;
- Each unit has 4 No. circular humus tanks (Final Sedimentations Tanks).

Unit 3 is a modified activated sludge process biological reactor commonly known as a BNR with a 5 stage configuration for biological nutrient removal of nitrogen and phosphorous, and was commissioned in 1982 and has a nominal design treatment capacity of 18,000 m^3/d. Unit 3 comprises;

- A 5 stage biological reactor that includes denitrification and phosphorous removal and treatment of carbonaceous load,
- Three number humus tanks.

In addition to the above units Crowboroughhas 3 No. ponds in series serving unit 1 and 2 for additional effluent treatment in order to meet the corresponding standards for land and/or crop irrigation. However, currently, treated effluent from units 3 is directly discharged into Marimba River.

CrowboroughWWTW has one effluent pump station with a total of six pumps, all of which are not working. Treated effluent from Unit 1 & 2 is discharged on to the adjacent farms owned by the City of Harare for further purification.

Hatcliffe WWTW

Hatcliffe sewage treatment works comprises one wastewater treatment stream with a nominal overall design treatment capacity of 5,000 m3/day.The treatment process includes preliminary pre-treatment and biological treatment using a BNRtecnology.

Marlborough Ponds

Marlborough sewage treatment works is a pond system with a nominal overall design treatment capacity of 2,000 m^3/day. The treatment process comprises 3 primary stabilisation ponds and 2 secondary stabilisation ponds.

4.1.3 On-Going Works

The notable on-going projects in Harare are the Urban Water Supply and Sanitation Rehabilitation Project (UWSSRP) – Phase 1 and the projects that are being financed by a loan from China Exim Bank.

4.1.3.1 UWSSRP – Phase 1 Works

These works under the Urban Water Supply and Sanitation Rehabilitation Project (UWSSRP) are designed to reinstate existing water production and wastewater treatment plants. The works are summarised in the following table.

Table 4-11: Ongoing Works Under UWSSRP - Phase 1

Location	Scope of Works
Morton Jaffray Water Treatment Works	Unit 1: Installation of proper flow meters in the raw water main from Lake Chivero to raw water inlet chamber and raw water main from Lake Chivero to Clarifier No. 7, Aluminium Sulphate solution transfer pumps, Aluminium Sulphate solution dosing pumps, Replacement of existing lime slurry preparation and dosing facilities, Rehabilitation of the Chlorine Dosing System, Replacement of pump sets No. 1 to 3, including all related motors, starters, pipework, valves and fittings and electrical control boards, Installation of an electric powered chlorine cylinder lifting system.
Morton Jaffray Water Treatment Works	Units 2 & 3: Installation of proper flow meters in raw water ND 2200 main from Lake Manyame to raw water mixing chamber and the raw water ND 1390 main from Lake Manyame to raw water mixing chamber, Aluminium Sulphate solution transfer pumps, Rehabilitation of the lime slurry preparation and dosing facilities, Installation of sodium silicate dosing pumps, Replacement of sand to 16 rapid gravity sand filters, Refurbishment to filter under-drainage system, Replacement of broken nozzles, Replacement of all gallery pipework and valves, Installation of an additional air compressor for the operation of pneumatically actuated valves, Refurbishment of the Pulsator system of 3No. Clarifiers, including air pump, motor, starters and vacuum release devices, Replacement of lateral pipes to 1No. Clarifier, Replacement of baffles to 3No. Clarifiers, Replacement of pump sets No. 4 to 6, including all related motors, starters, pipework, valves and fittings and electrical control boards, Replacement of pump sets No. 7 to 10, including all related motors, starters, pipework, valves and fittings and electrical control boards, Supplying spare parts for pump sets No. 11 to 14, Rehabilitation of Unit 2 & 3 Buildings
Prince Edward Water Treatment Works	Rehabilitation of the raw water pump-station, Rehabilitation of Flash Mixing and Flocculation Tank, Rehabilitation of Clarifiers, Rehabilitation of Rapid Gravity Sand Filters,Rehabilitation of High lift Clear Water Pump station, Rehabilitation of Chemical Building and General Site Works
Firle Sewage Treatment Works	Rehabilitation of Biological Trickling Filters, including, Rehabilitation of Pond System (Firle 1&2, Rehabilitation of Effluent Pumping Station,Rehabilitation of Effluent Pumping Main,
Crowborough Sewage Treatment Works	o Rehabilitation of Biological Trickling Filters, Rehabilitation of Pond System,
Donnybrook Stabilisation Ponds	Rehabilitation of Pond System, Repair of inlet, outlet structures, including installation of aluminium gates, valves and other metal fittings to distribution and collection chambers.
Little Marimba Trunk Sewer	Rehabilitation of damaged sections along the trunk sewer

Location	Scope of Works
Supply of Goods	Supply of Laboratory Equipment, Shop Tools and Equipment andSpare Parts.

4.1.3.2 China Exim Bank Loan

The works that will be financed by the China Exim Bank loan and executed by CMEC are summarised in the table below.

Table 4-12: Chinese Loan Scope of Works

Item	Scope of works
Morton Jaffray WTW	
Rehabilitation of Plant No. 1	Chivero Intake, mixing Chamber, Alexander and accelerator clarifiers, Degremont filters, Patterson filters for No.1 works, Materials and installation
Equipment for Plant No. 2 & 3	No. 2 & 3 Plant clarifiers, Aluminium sulphate dosing system for No. 1, 2 & 3, Silica and acid dosing systems for No. 1, 2 & 3, No. 2 & 3 Plant clarifiers, Lime dosing systems for No. 1, 2 & 3, Activated carbon dosing systems for No. 1, 2 & 3, Chlorination systems for No. 1, 2 & 3, Degremont filters, Wash water pumps, Clean water pumps, electric valves, Installation materials
Dosing Equipment for Clarifier No. 7	Aluminium sulphate dosing system, Silica dosing system, Activated carbon dosing system, Installation materials,
Other Equipment and Materials	Dewatering Pumps, Fire Hoses, Chlorine, Acid Storage Tanks, Clear Water Meters,
Construction of facilities	Chemical storage warehouse
Wash Water Pump station 2	Standby generator sets for Darwendale Pump station and No 1& 2 Plant
Installation Materials	Pipes and fittings, Electrical cable and material
Additional Materials, Supply and Installation for MJ	Butterfly valves No 7 to 10 pumps, NRV on No 1 &pumps 3, Interconnector valves for between New/old 7 to 10 and 11 to 14 pumps, Dewatering pumps, Motors, Turbine pumps, Darwendale intake, clarifier inlet valves and pipes.
Miscellaneous	Central Control Room and Redecoration, Lights for Workshop and Roads in plant (without poles).
Firle WWTW	
Biological Filters	Screw conveyoring machine, Completing electrics and wiring,

Item	Scope of works
	Supply 2 and install 1 Mufakose Mechanical screens, Replace accelerator clarifier equipment, supply and install flow meters
Supply and install items for Mufakose sump	Raw sewage pumps, Vertical pump, Pipes and fittings, Electrical cable and material/installations
Plant Facility	Supply ACSR conductors, Supply and Install Raw sewage pump, Transformers, and portable submersible pump, Dewatering pump station, pipes and fittings and Electricals.
Crowborough WWTW	
Existing Effluent Pump Station	Sewage pumps, Dewater pump set and motor, Replace accelerator clarifier equipment, flow meter recorder, screen board ,transformer, replace all electrical system for Pump station , Valves.
New Effluent Pump Station 2	Flow meter, Sewage pump and motor starters, valves, Supply and install Transformer, Fans, pipes, steel grating and guard rails, All electrical systems.
Installation Materials	Pipes, fittings, electrical cable and material and lights for workshop and roads.
Plant Facility	Supply and install Generator, Transformers, Breakers for transformers and Portable sub pump for dewatering effluent pump station.
Clear Water Pump Stations	
Alex Park Pump Station	Install Pipe delivery work, Control panel, Electric chain block, pipes and fittings, Electrical cables and material
New Alex Pump Station	Installation of Pump, Motor and Lighting system
Letombo Pump Station	Supply Motors, bolts, Gaskets, Valves, Fans and install Pipe works/ fittings
Warren Control Booster Pump Station	Supply and install Pumps, Motors, Valves, Pipes and fittings, all Electrical works. Spares for motor and Pump bearing, Centre control room.
Sewerage Reticulation	
Borrowdale Brooke Pump Station 1-4	Install 12 Pump sets, Electrical connection to control room, New cables, Switches, Lighting, Materials and installation, Pipes and fittings.

Item	Scope of works
Workshop Tools and Maintenance Equipment	
Plant Workshop	Supply Welding, Cutting, Shaping, Hydraulic, Radial Drilling, Universal Radial, Horizontal Milling, Pressing, Impact Drilling and Manual Pipe threading Machine. A Diesel Generator, Bearing heater, Clamp meter, Digital Camera, Bearing analyser and detector, Megger, Vibration meter, Balancer, High voltage tester. Replace Accelerator clarifier equipment, Multimeter, Sewer drain cleaning, Power cable detector and Tractor drawn mower.
Garage Tools	Supply Sockets, Allan keys, Joints, Pliers, Vehicle hoists, Trolley jacks, Tyre changer, Air Compressor (stationery and compressor), Breakdown recovery trucks, Lathe and Milling Machine
Laboratory Equipment	
Lab Equipment for Clear Water Plant	Supply Heat magnetic Stir, Ultraviolet spectrometer, Biochemistry incubator, Stationery turbidimeter, Ion chromatograph, Replace Accelerator Clarifier equipment, electronic balance, BOD incubator, Viscosity meter, Gas chromatograph, Chlorine detector, Colorimeter, PH meter, Atom spectrometer, Muffle furnace, Conductivity meter, Bottom sampler, 3-way taps, E-Collilert Complete, Autoclave, Binocular microscope, Electric centrifugal machine, Distillation unit, Liquid chromatograph, Dry oven
Lab Equipment For Sewage Water Plant	Liquid chromatograph, PH meter, Gas chromatograph, Binocular microscope, Portable DO, Portable SS, Portable Hydrogen Sulphide meter, Table DO analyser, Stationery Hydrogen Sulphide meter, Muffle furnace, , Biochemistry incubator, Electric heater constant dryer, Electric balance, Physics balance, Disinfector, Magnetic Stir, Refrigerator, Vacuum pump, Desktop PC, Electric centrifugal machine, Medical cabinet, Glassware, COD tester, Nitrogen analyser, Ion selective meter and electrode, Ultraviolet spectrometer, Automatic liquid sampler, Medical cabinet Dragger gas analyser
Information and Communication Equipment	
Computer Hardware and	Supply Desktop computers, Laptops, printers, Copiers,

Item	Scope of works
Other Peripheral devices	Recording media
Network Equipment And Accessories	Supply Routers, Wireless network, Cisco switch core, distribution and access, Network tool kits, Network cables, Connectors , Projectors, UPS,
Workshop Equipment And Accessories	Supply Hard drives, Plotters, Scanners, Trimble and differential GPS, Memory chips, Dust blowers and Power Supply systems.
Software	Supply and install Land information Management systems, Perimeter access control and clocking system,

4.2 Chitungwiza

This section presents a summary of the existing water supply and sewerage infrastructure in Chitungwiza. More tailed information is presented in Appendix 4.2.

4.2.1 Water Supply

The Municipality of Chitungwiza receives bulk water from the City of Harare's water treatment facilities which are mainly; Morton Jaffray Water Treatment Works and Prince Edward Water Treatment Works. The transmission system is designed in such a way that water can be drawn from both Prince Edward WTW and Morton Jaffray WTW.

Overall, the city provides services to a population of 356,840 (2012 National Statistics). At present, the system has 55,669 connections, which are equipped with water meters most of which are not functional. The schematic layout of the system is presented in the following figure.

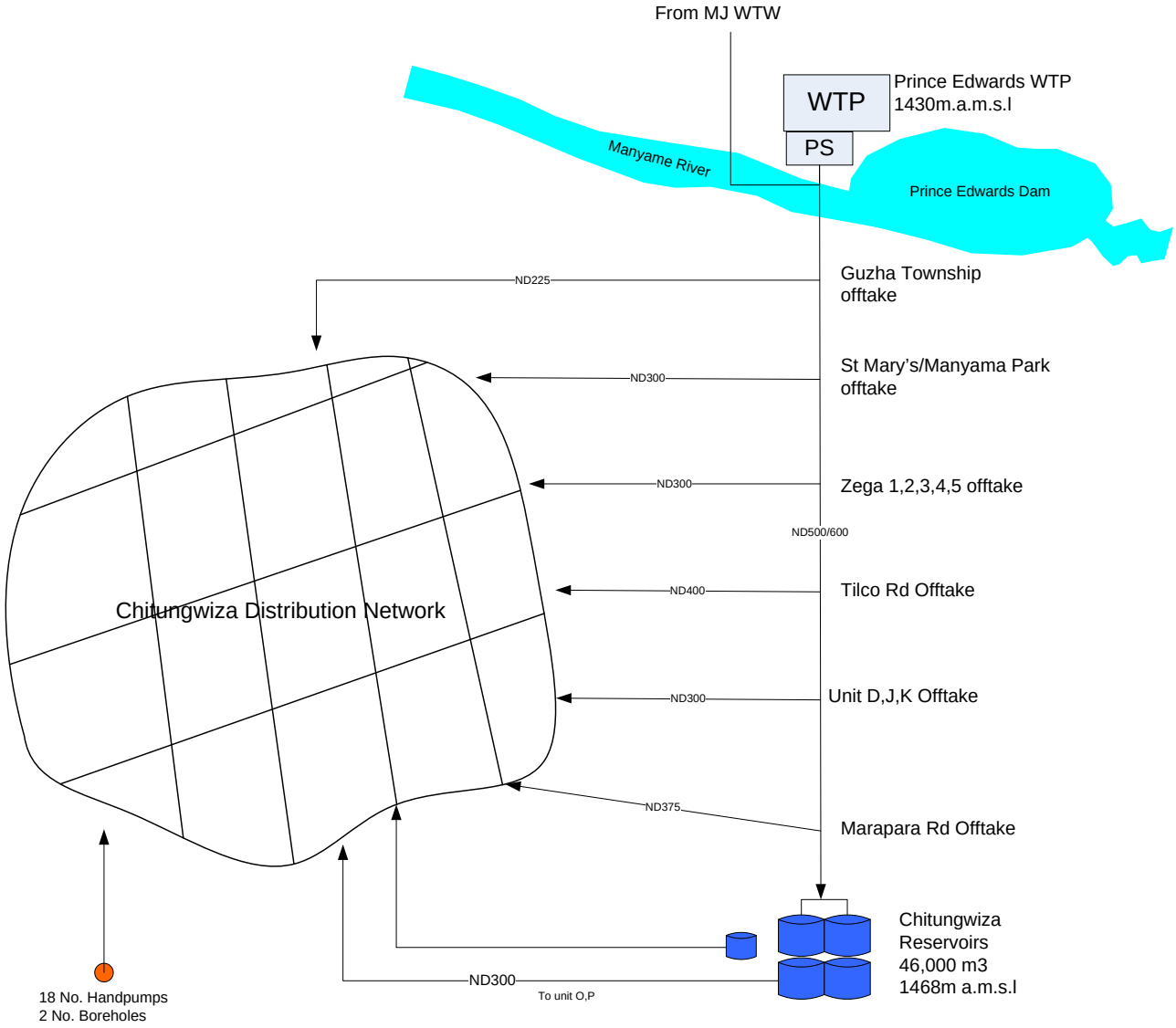
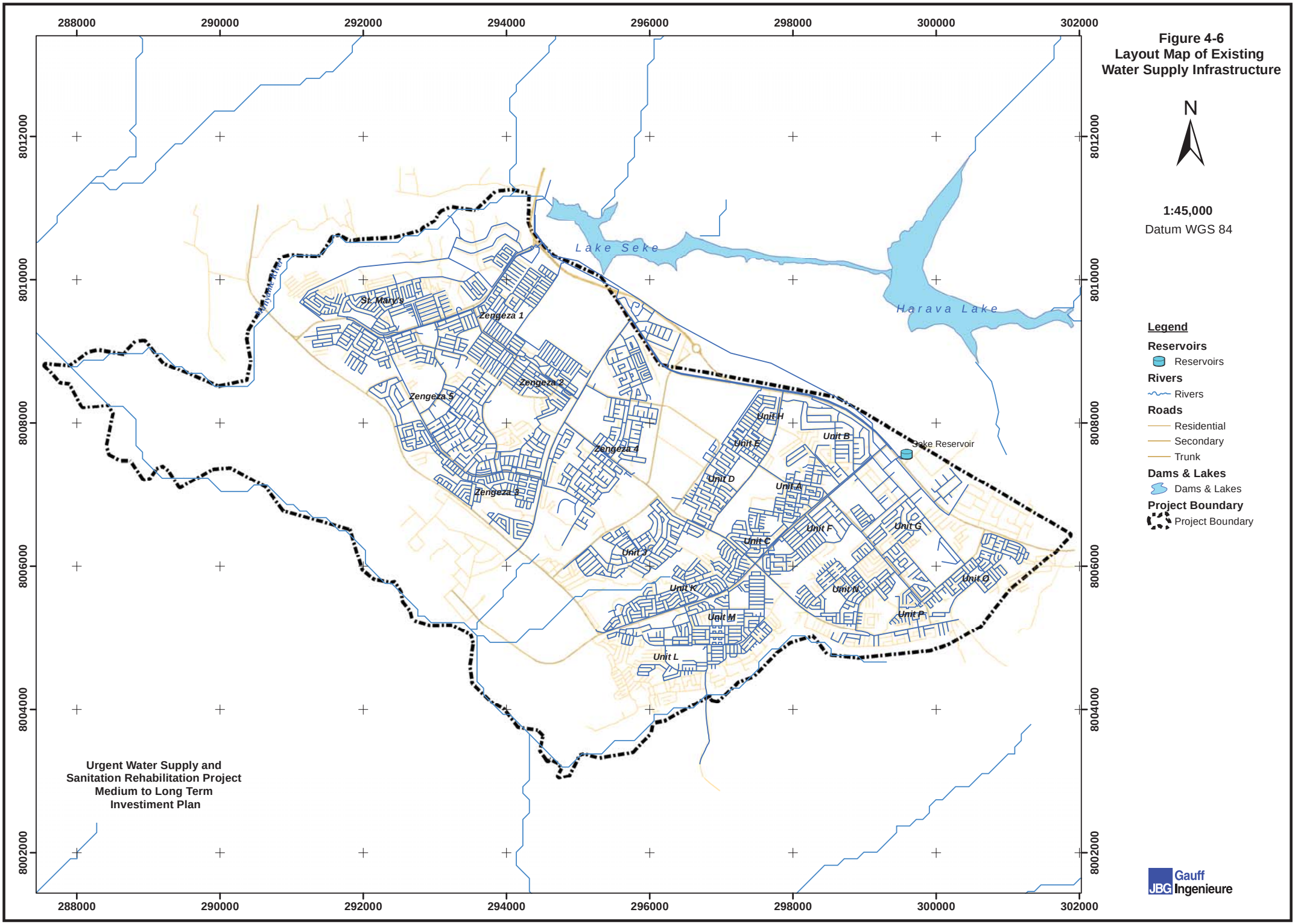


Figure 4-5: Principle layout of the water system of Chitungwiza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Harava Lake
St. Mary's
Zengeza 1
Zengeza 2
Zengeza 3
Zengeza 4
Zengeza 5
Unit A
Unit B
Unit C
Unit D
Unit E
Unit F
Unit G
Unit H
Unit J
Unit K
Unit L
Unit M
Unit N
Unit O
Unit P
Seke Reservoir
Urgent Water Supply and Sanitation Rehabilitation Project Medium to Long Term Investiment Plan
Figure 4-6
Layout Map of Existing Water Supply Infrastructure
N
1:45,000
Datum WGS 84
Legend
Reservoirs
Reservoirs
Rivers
Rivers
Roads
Residential
Secondary
Trunk
Dams & Lakes
Dams & Lakes
Project Boundary
Project Boundary
Gauff Ingenieure

4.2.1.1 Water Sources

Prince Edward Water Treatment Works (WTW) is located approximately 22 km South of Harare adjacent to Prince Edward Dam also known as Seke Dam. The Water Treatment Works has a reported maximum peak production of 90,000 m3/day. The current average daily water production is reported to vary between 50,000 to 55,000 m3/day.

During the rainy season when Prince Edward WTW is operating at full capacity, most of the supply to Chitungwiza is from Prince Edward WTW. Prince Edward WTW is supplied with raw water from the upstream Harava1, Harava2 and Seke Dams all along the Manyame River. During the dry season when Prince Edward WTW is not operating at full capacity due to insufficient water in the upstream dams, Chitungwiza is supplied from the Morton Jaffray WTW system.

4.2.1.2 Transmission System

The transmission main from Prince Edward WTW starts off as a ND 600 steel main followed by a ND 225 branch after the bridge feeding an area called Mayambara which is under Harava Rural District Council. The ND 600main continues before splitting into a 450mm diameter main and a ND 525 main before the Police Station. The ND 450 main feeds the reservoirs located on the northern part of Makoni Shopping Centre. The ND 525main also feeds the reservoirs and the reticulation network. The reservoirs can hydraulically be described as floating reservoirs.

The ND 600mm diameter main has off-takes feeding the following areas;

- ND225 off-take for Area 1 - Mayambara;
- ND300 off-take for Area 2 - St Mary`s &Manyame Park;
- ND300 off-take for Area 3 - Zengeza 1, 2, 3 & 5;
- Area 4- ND375 - off take for area 4-Tilcor, Zengeza 2, 3 & 4.

The ND525 main has off-takes feeding the following areas;

- ND 300 off-take for Area 5- Unit H,D,J, with interconnection to Unit K;
- ND375 off-take for Area 6- Unit A, C, F, M, L & K.

4.2.1.3 Storage Reservoirs

The reservoirs for Chitungwiza are located on the north eastern outskirts of the town north of Makoni Shopping Centre at the end of the network. The reservoir site has four ground reservoirs of equal capacity and an elevated tank. They have a total storage capacity of approximately 46, 000 m^3. A small booster pump station houses the pump sets used to transfer water to the elevated tank.

From a visual inspection, the tanks are in a good state with no cracks, scaling concrete or rusting rebar. They are in good working order but, largely redundant since they never fill up because of their location in the network and the limited water supply from Harare.

4.2.1.4 Distribution Network

The distribution network comprises of a combination of AC pipes in old sections of the town, Polyethylene and PVC pipes in newer sections of the city (15 years old).

The Municipality of Chitungwiza advised that, some sections in the distribution network continuously suffer from pipe bursts. This is attributed to the fact that pressure reducing valves are not working. The areas most vulnerable are; Unit N and Unit K.

No issues have been raised in the recently installed networks. The recently installed networks include the following areas:

- ND90 Polyethylene pipes in Zengeza;
- ND110 PVC pipes in St Mary's (Manyame Park);
- ND 90 PVC pipes in New Developments and infill areas;
- ND 75 PVC pipes in New Developments and infill areas.

It is worth noting that, there are control valves and bulk flow meters on all the branches, but most of them are not working. The branches come off the 525mmØ rising main to the storage reservoir resulting in low lying areas getting water ahead of the high level areas, hence the need to address the issue of control valves.

The oldest section of the distribution network was constructed between 1973 and 1978 and the network has been expanding based on the growth of the city.The layout of the network is structured in eight independent supply zones, with the last supply zone to Unit O formed as a loop so that water can be supplied from both the service reservoirs and also from Unit N.

The water supply to Chitungwiza is erratic and varies in terms of continuity of supply but has an approximate supply rate of 500m^3/hour. To manage supplies to the various suburbs, the municipality has a rationing criterion in which certain areas/zones get water on a particular day in a week. The table overleaf shows a summary of the water supply schedules for Chitungwiza.

The water supply to Chitungwiza is erratic and varies in terms of continuity of supply but has an approximate supply rate of 500 m^3/hour. To manage supplies to the various suburbs, the municipality has a rationing criterion in which certain areas/zones get water on a particular day in a week. The table overleaf shows a summary of the water supply schedules for Chitungwiza.

Table 4-13: Water service on daily basis

Supply Zones	Supply day
Area 1- Old St Mary's and Manyame Park	Monday
Area 2- Zengeza 1	Tuesday
Area 3- Industrial Area	continuous
Area 4- Unit H	Thursday
Area 5 – Unit A	Saturday

4.2.1.5 Pilot Area Investigations Findings and Recommendations – Water Distribution Network

All the network elements are over 30 years old. There have not been any major rehabilitation or replacement undertakings since the town was developed. In the oldest parts of town, water pipes and appurtenant structures date as far back as 1978.

Water pipes

St Marys is supplied by a ND225 main. The water distribution mains within the pilot zone are ND75 mm mains.

The AC pipes appear to be in good condition despite the age – not very surprising considering that AC pipes have a lifespan of 50-70 years. Even though AC pipes undergo gradual degradation in the form of corrosion (i.e., internal calcium leaching due to conveyed water (lower Langelier index = more leaching) and/or external leaching due to groundwater), the council has not reported enough pipe failures to suggest that the pipes need replacement. The exposed pipes from the replaced pipes did indicate that the pipes were in fair condition except for those blocked as a result of siltation.

Valves and fire hydrants

There were no hydrants in the pilot area. Isolation valves were found randomly installed on the distribution mains. Generally, all the valves are in a bad shape; they are rusty and leaky.

Valve chambers are generally in a very poor condition, damaged and filled with stones as shown in the photos below. Furthermore, there are no covers and those that do have, they have been vandalised.

Therefore, the conclusion based on the above is that, all network appurtenant fittings and structures must be replaced as most network leakages occur there.

Vandalised valve chamber

Significant amount of water is lost after the meter resulting in unnecessary water use/ wastage. If metered, these wastages lead to increased water bills, which may not be paid by the consumers. If unmetered, these wastages result in high NRW levels, as flat rate billing considers only a limited average amount of water usage. Wastage can be reduced and water conservation measures be implemented through rehabilitation of household installations and household education and awareness programs. Even though Household investments are normally not part of project funding, a provision in the investment plan for public awareness campaigns aimed at sensitizing consumers on the motivation and financial benefits associated with investing in internal plumbing repairs is made. It is further recommended that council should make it a policy to fix leaking taps and pass on the costs to the consumers as a way to minimise water losses.

Vandalised water meter *House connection*

Flow meter testing

Service connections are taken off the 75 mm tertiary mains using cast iron saddles. Each saddle serves 4 ND 20 service connections.

As can be seen from the photos below, the service connections are heavily corroded and incrusted. This was expected, given that these connections have been in service for over 30 years. Most of the leakages in the network occur on these lines.

It is therefore recommend that, all house connections be replaced including the saddles. It is further recommend that, the replacement of service lines should be of HDPE. HDPE house connections have proved to be durable and reliable. HDPE pipes have a smooth internal surface that does not corrode or tuberculate and maintains its flow capability over time. HDPE service connection pipes have a cost benefit associated with their longevity. The polyethylene pipe industry conservatively estimates the service life for HDPE pipes to be 50-100 years. This relates to savings in replacement costs for a long period.

Water testing meter

Encrusted pipes

4.2.2 Sewerage

The wastewater infrastructure in Chitungwiza consists of both on-site and off-site sanitation systems. Building and housing guidelines, by-laws and standards stipulate that Low density properties depending on soil conditions, are not connected to the sewerage system. They are provided with on-site septic tanks and soak-away pits. High and medium density properties, on the other hand, are all connected to the sewerage system. The sewerage system in Chitungwiza consists of laterals, collector mains, pump stations and trunk mains that collectively convey wastewater to Zengeza Sewage Treatment Works. Figure 4-7 shows the schematic layout of the sewerage system in Chitungwiza.

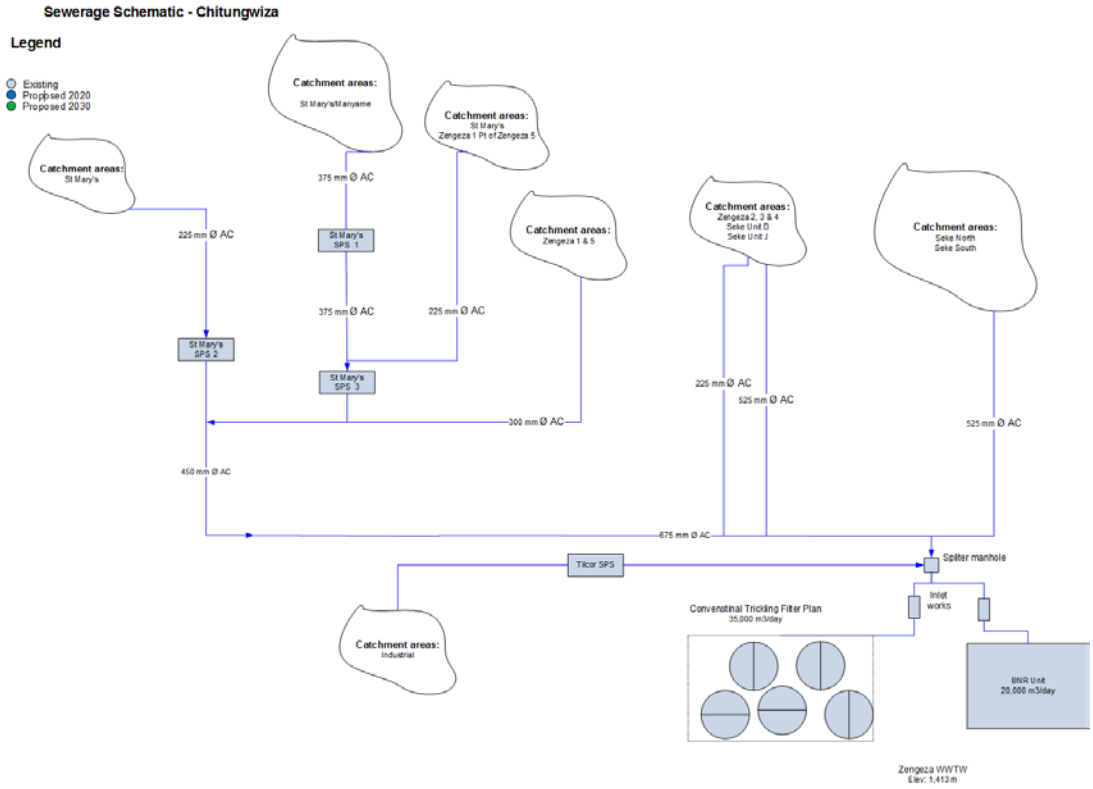


Figure 4-7: Schematic Layout of the Sewerage System of Chitungwiza

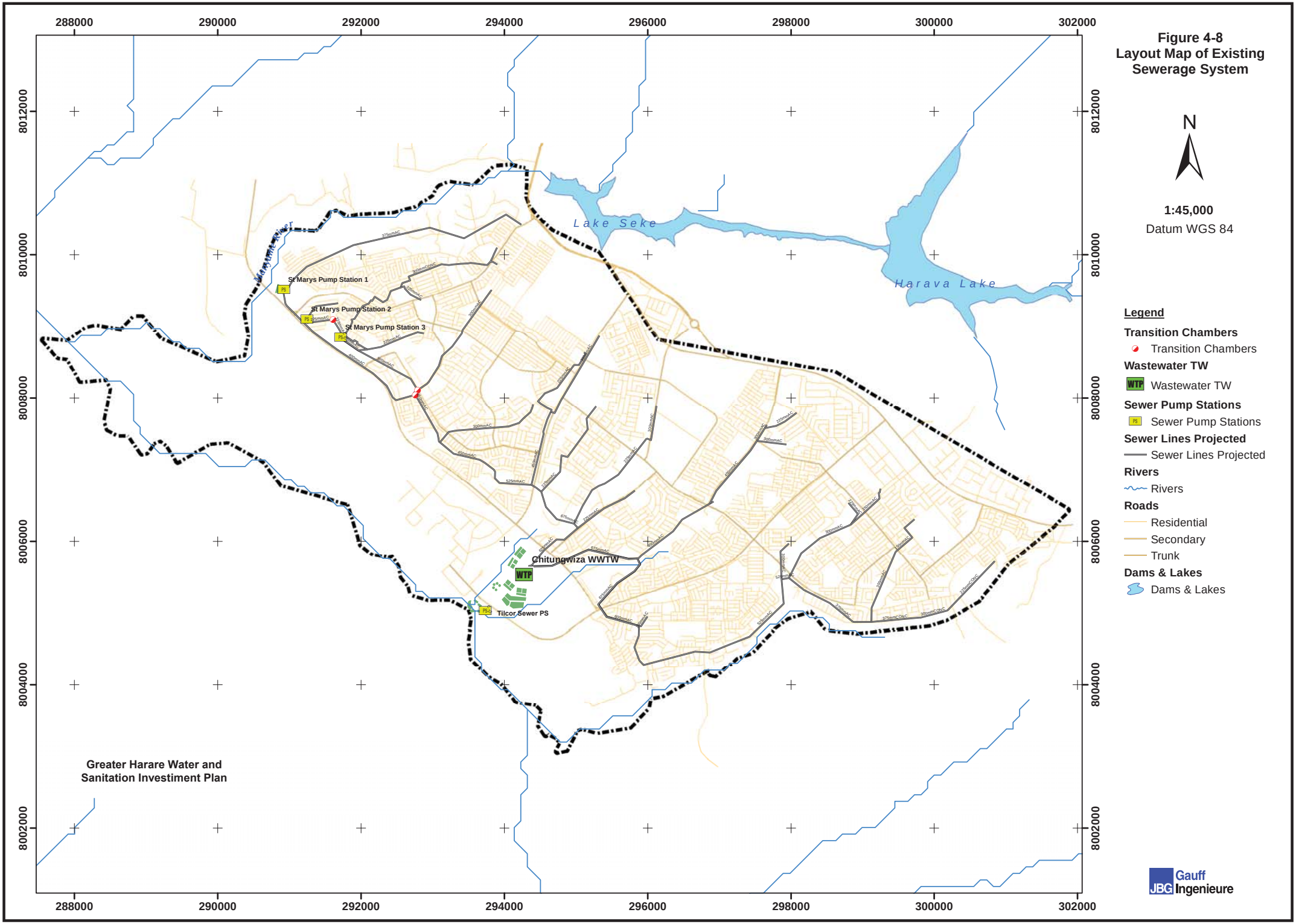


Figure 4-8
Layout Map of Existing Sewerage System

N

1:45,000
Datum WGS 84

Legend

Transition Chambers
- Transition Chambers

Wastewater TW
- Wastewater TW

Sewer Pump Stations
- Sewer Pump Stations

Sewer Lines Projected
- Sewer Lines Projected

Rivers
- Rivers

Roads
- Residential
- Secondary
- Trunk

Dams & Lakes
- Dams & Lakes

Gauff Ingenieure

4.2.2.1 Catchment Areas and Sewer Reticulation Network

Chitungwiza has currently seven catchment areas according to the drainage patterns of the city. The existing catchment areas are; Old St Mary's, St Mary's/Manyame Park, Zengeza 1 & 5, Zengeza 2, 3 & 4, Seke North & South and Industrial Catchment Areas. The following table summarises the characteristics of the catchment areas.

Table 4-14: Catchment Areas

Catchment Areas	**Suburbs covered**	**General characteristics**
Old St Mary's	Old St Mary's	Wastewater from this catchment area discharges into a ND 225 AC pipe which subsequently drains into Pump Station No. 2. Pump Station No 2 pumps waste water flow to Pump Station No. 3 where it is pumped to Zengeza Wastewater Treatment Works.
St Mary's Manyame Park	St Mary's/Manyame Park.	Wastewater from this catchment area discharges into a ND 375 AC pipe which subsequently drains into Pump Station No. 1. Pump Station No 1 pumps via a ND 400 AC pipe to Zengeza Wastewater Treatment Works.
New St Mary's	St Mary's, parts of Zengeza 1 and 5	Wastewater from this catchment area discharges into a ND 225 AC pipe which subsequently drains into Pump Station No. 3. Pump Station No 3 pumps via a ND 300 AC to Zengeza Wastewater Treatment Works.
Zengeza 1 & 5	Zengeza 2, part of Zengeza 1 & 5	Wastewater from this catchment area discharges into a ND 300 AC pipe which subsequently drains into the ND 450 AC to Zengeza Wastewater Treatment Works.
Zengeza	Zengeza 2, 3 and 4, Seke Unit D and J	Wastewater from this catchment area discharges into ND 225 and ND 450 AC pipes which subsequently drain into ND 675 AC collector main to Zengeza Wastewater Treatment Works.
Seke North and South	Seke North and South	Wastewater from this catchment area discharges into a ND 525 AC pipe which subsequently drains to Zengeza Wastewater Treatment Work.
Industrial	Industrial	Wastewater from this catchment area discharges into the Tilcor Pump Station which subsequently pumps wastewater flow to Zengeza Wastewater Treatment Works.

The sewer network comprises collector mains ranging in size from ND 100 to ND 525 and trunk/outfall sewers up to ND 825. Most of the drawings showing the layout plans and longitudinal profiles of the existing collector, sub-trunk and trunk sewers could not be

located. Due to lack of sufficient information, it was not possible to establish the exact length of the existing network and number of man-holes.

4.2.2.2 Pilot Area Investigations Findings and Recommendations – Sewerage Network

The sewer collection system in the pilot area comprises of ND 150 Vitrified Clay (VC) and AC material.

The sewer pipes are generally in good condition though; there is silt/solids accumulation due to insufficient sewage flow.The structural integrity of all inspected manholes is considered to be good. However, there seems to be insufficient flow in thesewers to flush away the solids (silt and human waste) as observed in the photos below.

Given the findings elaborated above, it is recommend that measures should be put in place for routine cleaning of sewer pipes and ensuring that there is sufficient flow in the sewers by improving water supply services. Phase 1 of the UWSSRP has provided sufficient sewer cleaning equipment that the councils will be using to address the problem of sewer blockages.

Investment should also be directed towards replacing those sewers that were reported by the council to have collapsed, including reconstructing the manholes that are damaged.

Sewer manholes blocked due to siltation in pipes

4.2.2.3 Wastewater Treatment Works (Zengeza)

Chitungwiza wastewater scheme comprises one treatment site: Zengeza Sewage Treatment Works comprising two treatment streams namely;

Modified Conventional Treatment Works; with a treatment capacity of 35,000 m^3/day, comprising;

- Inlet Workscomplete with a grit removal system
- Anaerobic ponds,
- Biological Filters, and
- Effluent Pump Stations.

Biological Nutrient RemovalTreatment Works; with a treatment capacity of 20,000 m^3/day, comprising;

- New Inlet Works complete with a grit system discharging grit to the existing Old Works grit removal system.
- Primary sedimentation tanks,

- Equalisation basin,
- BNR Tank comprising; an anaerobic basin, anoxic basin, and an aerobic basin,
- Final Sedimentation Tanks,
- Maturation Ponds,
- Sludge Thickeners,
- Sludge Digesters.

Modified Conventional Treatment Works Old Works

The modified conventional treatment works consist of the following process units;

Intake Works

The inlet works consist of two parallel screen channels, which were supposed to be isolated by penstocks which are completely corroded. According to the original design, the two screen channels would comprise a coarse screen (with approximately 60mm spacing between bars) and a medium screen (with approximately 30mm spacing between bars), manually raked. However, only the medium screens are in place at present, but are highly corroded and damaged.

Grit removal is supposed to take place in two parallel baffled grit chambers. The baffles (A.C. plates) are no longer in place and the weir penstocks are completely corroded and missing in some areas. The two grit removal chambers are nearly full with sand.

Rusting Air-lift pipework 150 mm in diameter discharges grit into a shallow grit separation box, with missing aluminium sluice gates.

Anaerobic Ponds

The pond system consists of 4 parallel sets of ponds, i.e. 3 ponds in series each. All ponds are concrete lined with a sloped floor and a sloped collection trough to allow for gravity flow of the settled sludge towards the scour valves (one per pond) for desludging.

Two ponds are interconnected by sluice gates in order to be able to take-out of operation one of the two ponds for maintenance (cleaning) purposes. A third pond can be by-passed by making use of a separation chamber, which was supposed to be equipped with sluice gates.

All the ponds are filled up with sand, sludge and weeds.

All gates, submerged steel plates (at the outlet of the ponds) and valves are corroded and some are missing.

The ponds are surrounded by 150 mm diameter A.C. pipes, which supply recycled effluent from the outlet of the biological trickling filters by means of the effluent pumping station back to the ponds for scum breaking purposes. The recycled effluent is distributed on top of the ponds by making use of numerous jet pipes (50 mm diameter). However, these jet pipes are heavily corroded and not operational.

Biological Trickling Filters

The works comprises a total number of 5 trickling filters, approximately 38 m, in diameter and 4.0 m deep. The filters are filled with granite rocks of average grain size of around 50

to 80mm from local quarries. The trickling filters were constructed between 1975 and 1980. They have, however, undergone major repair works to inlet columns and distributor arms, between 1997 and 1999.

The 450 mm diameter incoming pipes to the five trickling filters are partly broken and valves would be required to isolate individual trickling filters for maintenance purposes.

The concrete structures of the trickling filters do show cracks and leakages and thus have to be sealed.

Effluent Pumping

There are 2 no. Effluent Pump Stations. The old Pump Station was constructed in 1975 and comprises a total of 4 pumps. The new Pump Station was constructed in 1995 and comprises a total of 5 pumps, out of which 3 are treated effluent pumps to Imbwa farm and 2 are recirculation pumps to anaerobic ponds for scum breaking purposes.

Biological Nutrient RemovalTreatment Works;

The BNR Works constructed with financial support from Japan in 2000 ha a nominal capacity of 20,000 m^3/d. The plant was operated from the day of commissioning upto 2004 and consists of the following process units;

- New Inlet Works complete with a grit system discharging grit to the existing Old Works grit removal system.
- Primary sedimentation tanks,
- Equalisation basin,
- BNR Tank comprising; an anaerobic basin, anoxic basin, and an aerobic basin,
- Final Sedimentation Tanks,
- Maturation Ponds,
- Sludge Thickeners,
- Sludge Digesters.

4.3 Epworth

A summary of the existing situation in Epworth is presented here. More detail along with a narrative of the proposed investment measures is presented in Appendix 4.5.

4.3.1 Water Supply

4.3.1.1 Water Sources

Epworth has only one source of water which is the City of Harare via the Ventersberg Tanks. For the supply route from Morton Jaffray WTW to Ventersberg refer to the City of Harare Report.

4.3.1.2 Transmission System

Figure 4-9 below shows the transmission system for Epworth, in schematic form:

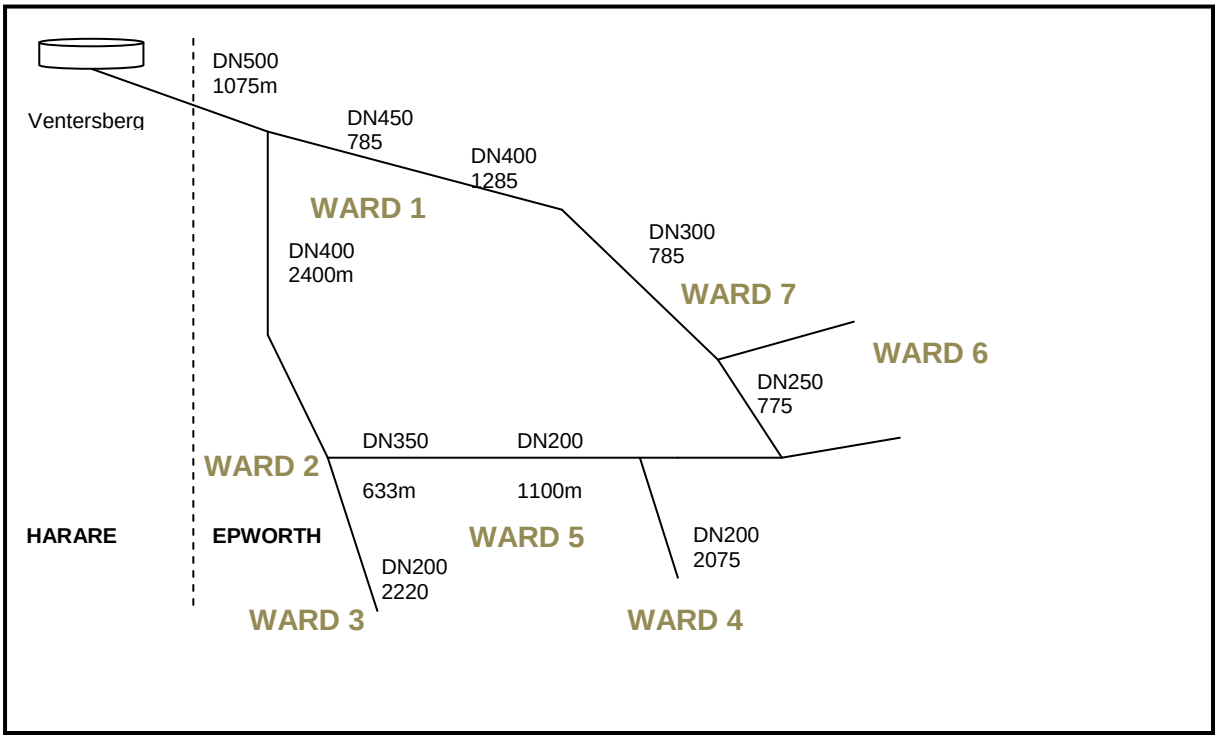


Figure 4-9: Epworth Transmission and Storage Schematic - Existing

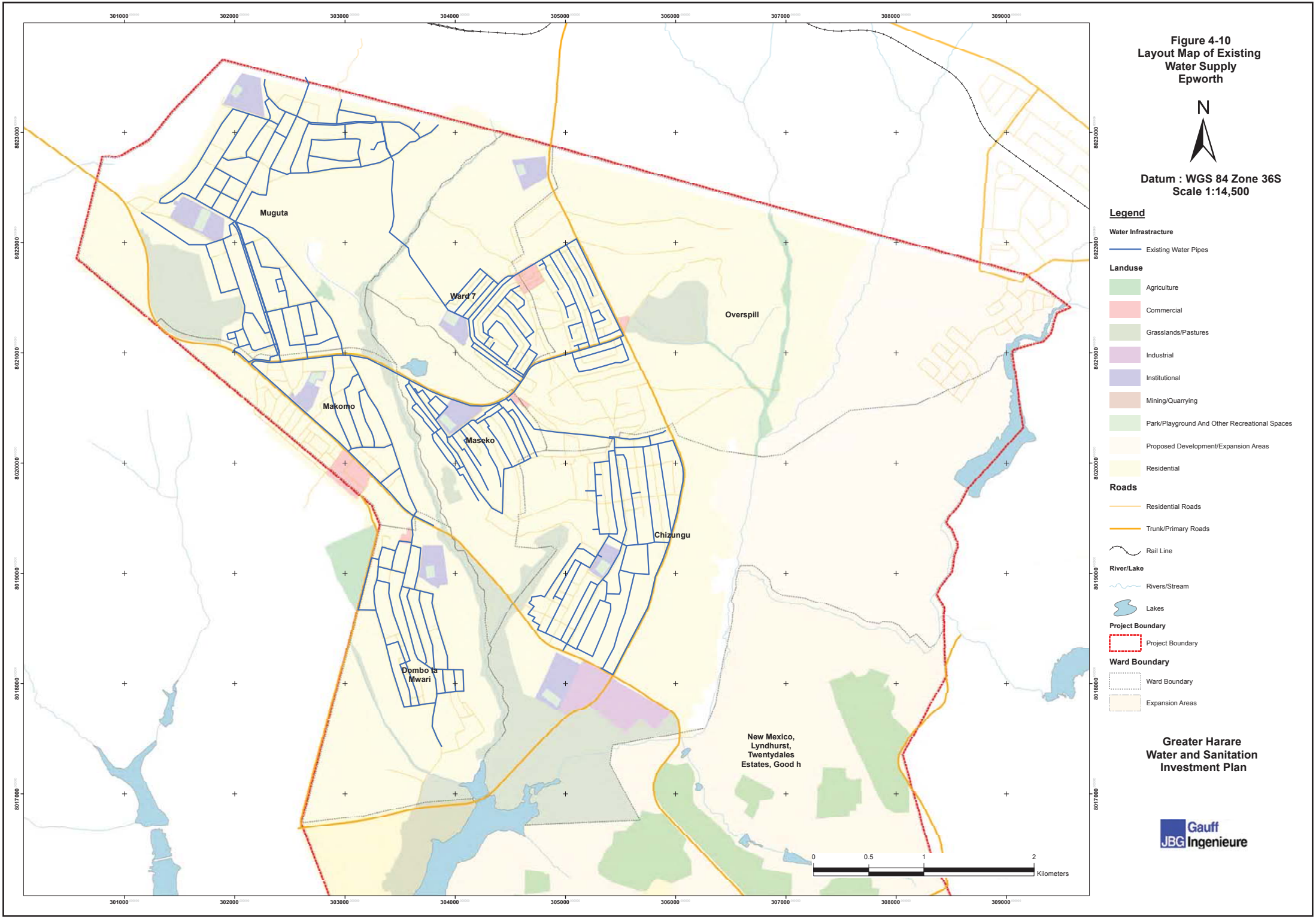


Figure 4-10
Layout Map of Existing Water Supply Epworth

N

Datum : WGS 84 Zone 36S
Scale 1:14,500

Legend

Water Infrastracture
- Existing Water Pipes

Landuse
- Agriculture
- Commercial
- Grasslands/Pastures
- Industrial
- Institutional
- Mining/Quarrying
- Park/Playground And Other Recreational Spaces
- Proposed Development/Expansion Areas
- Residential

Roads
- Residential Roads
- Trunk/Primary Roads
- Rail Line

River/Lake
- Rivers/Stream
- Lakes

Project Boundary
- Project Boundary

Ward Boundary
- Ward Boundary
- Expansion Areas

Greater Harare Water and Sanitation Investment Plan

Gauff JBG Ingenieure

Only one source of treated water is available to Epworth from the City of Harare's Ventersberg Tanks, directly into the supply network via a 1075m long DN500 supply line.

4.3.1.3 Distribution Network

Table 4-15: Demand Management Areas

DMA	Source of Supply	Comment
EXISTING TOWN AREAS		
Ward 1	DN500 from Ventersberg.	all other DMZs are supplied through ward 1
Ward 2	DN 400 from Ward 1	onward supply to wards 3 and 5 through ward 2
Ward 3	DN200 from Ward 2	
Ward 5	Existing DN350 on boundary of Wards 1 and 2 Future Supply may include supply through ward 2	In future ward 5 could be subdivided into northern and southern halves with separate supply each
Ward 4	DN200 from ward 6	Only a small area is currently developed. Major expansion expected in this ward
Ward 6	DN200 southern part of ring from ward 5 DN300 northern part of ring from Ward 7	Only a small area is currently developed. Major expansion in to Rockview is expected
Wards 7	DN400 from Ward 1	Only a small area of the ward has water network.

4.3.1.4 NRW assessment

- Bulk and Block Metering - Bulk and block metering is absent and new metering will be needed throughout as soon as water is restored.
- Distribution Networks - The distribution networks were reportedly in relatively good condition when water was last regularly supplied. The condition cannot be assessed now as water has been entirely absent for many years. Incidents of vandalism have been noted, especially at locations where public water points used to be provided.
- Consumer Metering - The Council reports that almost all consumers either have never had a meter or have a faulty meter.

4.3.1.5 Emergency Water Supplies

With the considerable water shortages that Epworth has been experiencing the Local Board has an ongoing programme to supply water through strategically located boreholes as follows:

- 6 No Boreholes with hand-pumps were installed in a joint programme with a church

Water Po

A once off testing of all boreholes was carried out and all were found to have high iron content but met requirements for potable water.

4.3.2 Sewerage

4.3.2.1 Sewage Sub Catchments

A small area of Epworth, within Wards 1, 2, 5 and 7 currently has a sewerage network. Ponds were constructed to collect and treat the sewage from the area but were quickly overbuilt and were never commissioned. Therefore the sewerage network was never commissioned either.

4.3.2.2 Sewer Reticulation System

The sewerage system covering most areas that have water supply has never been commissioned. As soon as water supply is restored there are many properties that do have water connections and demand for a sewage system will grow.

Discussions with the local board indicate that sewer pipes are likely to be in good condition whilst manholes will require sand removal and in about 50% of cases, reconstruction of the cover slab.

4.3.2.3 Sewage Treatment

Epworth has an existing pond set which was never commissioned and is now overbuilt and used as a sports field and so cannot now be commissioned.

Epworth Sewage Ponds

4.4 Norton

A summary of the existing situation in Norton is presented here. More detail along with a narrative of the proposed investment measures is presented in Appendix 4.4.

4.4.1 Water Supply

4.4.1.1 Water Sources

Norton currently obtains all of its water from Morton Jaffray WTW. A DN300 steel treated water supply line 4.3km long feeds the town's reservoirs on a hill to the east of the town from the WTW.

The existing supply has a capacity of between 8 and 10MLD, depending on the pumping pressure at the Morton Jaffray WTW. Modelling for Harare indicates that pressures at Morton Jaffray will be about 12.5bar at the discharge manifold once the refurbishment is complete. On this basis the existing line can supply around 8MLD to Norton. Current supplies are also around this figure.

4.4.1.2 Raw Water Pump Stations and Intakes and Transmission Mains

The town currently has no raw water supply of its own although a project has been underway for some time to develop one. This is discussed further below.

4.4.1.3 Norton WTW

The town currently has no water treatment works of its own although a project has been underway for some time to develop one. This is discussed further below.

4.4.1.4 Booster Pump Stations

The current system in Norton is entirely gravity fed. This makes for easy operation but supply pressures have been declining with increased demands and as more demand areas have been added to the system.

Transmission System

Figure 4-11below shows the transmission system for Norton, in schematic form:

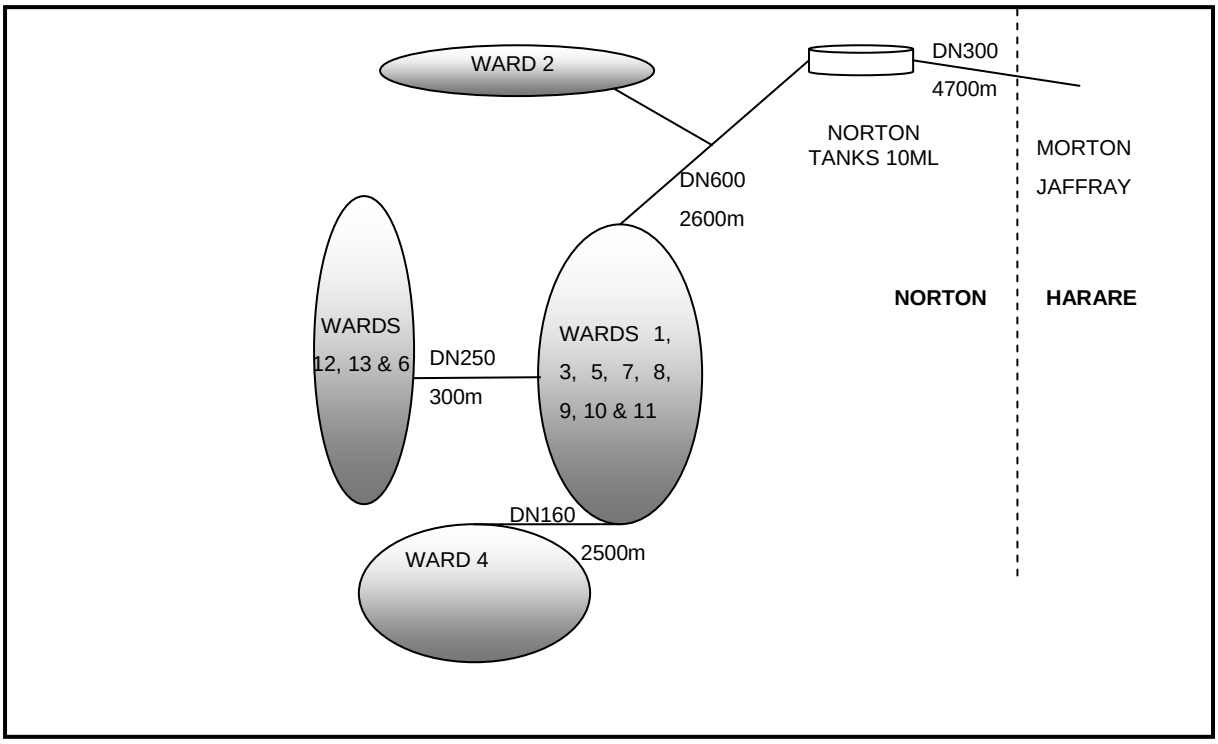


Figure 4-11: Norton Transmission and Storage Schematic - Existing

The sole treated water supply to the whole of Norton is a single DN600 AC pipeline from the Norton Tanks to a distribution centre at the Council Engineering Offices in Ward 3. A major concern with this line once it enters the town boundary it has no servitude and has been overbuilt in areas.

A tee off approximately half way along the line feeds Ward 2 which is a newly developed low density suburb.

At ward 3 the DN600 splits into the various parts of the distribution system for Wards 1 and 3 and with onward transmission to Wards5, 6, 7, 8, 9,10 and 11. These wards together make up the whole of the original town of Norton for which the water supply system was designed.

New expansion areas in Wards 12,13 and 6 have been attached to the distribution system for the old town and receive almost no water. Modelling confirms that the network simply does not have capacity to supply these areas.

Similarly Ward 4 is supplied through the distribution system of ward 3 and then via a 2.5km DN160 main which is entirely too small to supply the area.

Thus under the existing condition areas of the old town which used to have adequate supply now suffer from low pressures and short supply hours but do receive water, New development areas receive little or no water at very low pressures. As a result many people, especially in the new development areas now rely on shallow wells for their water supplies.

4.4.1.5 Storage Reservoirs

Norton has a single tank site with 2 x 5000m3 circular concrete tanks located on the site.

Reservoirs

GIZ Insta

4.4.1.6 Distribution Network

The following Zones are logically identified from the network layout. Currently poor valves mean that many of the zones are heavily interconnected and do not constitute demand management areas. A GIZ initiative currently underway aims to improve this.

Table 4-16: Demand Management Areas

DMA	Source of Supply	Comment
EXISTING TOWN AREAS		
Ward 1	Off-takes from existing DN600	
Ward 2	Off take half way along existing DN600	-
Ward 3	Off-takes from existing DN600	
Ward 4	Via 2500m long DN160 from Ward 3	Supply line is totally insufficient for demand
Ward 5	DN375 form Ward 3	Low pressures in ward
Ward 6	Supplied out of Ward 5 network	Investments plant to provide separate supply for Ward 6
Ward 7	DN225 from Ward 8	Low pressures in ward
Ward 8	DN300 from Ward 7	Low pressures in ward
Ward 9	DN225 from ward 8	Low pressures in ward
Ward 10	DN225 from Ward 9	Low pressures in ward
Ward 11	DN225 from Ward 9	Low pressures in ward
Ward 12	DN250 from Ward 10	Line and pressures are absolutely insufficient to supply Ward 12 in this

DMA	Source of Supply	Comment
		way.Ward 12 effectively receives no supply
Ward 13	DN225 from Ward 12	Ward 13 effectively receives no supply
New Supply Areas		
Chegutu Expansion	DN450 from Ward 4	This area has not commenced formal development. Network expansion into the area will be a long term goal.

4.4.1.7 NRW assessment

Bulk and block metering is absent for most of the town although a GIZ project is currently underway to address this.

The distribution network has certain parts which are known to be problematic and which will require significant rehabilitation. These tend to be the older areas of the town. The Council staff identified:

- DN300AC line in Wards 8 and 9 suffers regular burst despite low pressures.
- Western part of Ward 5 has GI pipes and very low supply pressures despite bing low lying.

The Council Reports that over 50% of consumer meters are faulty or inoperable.

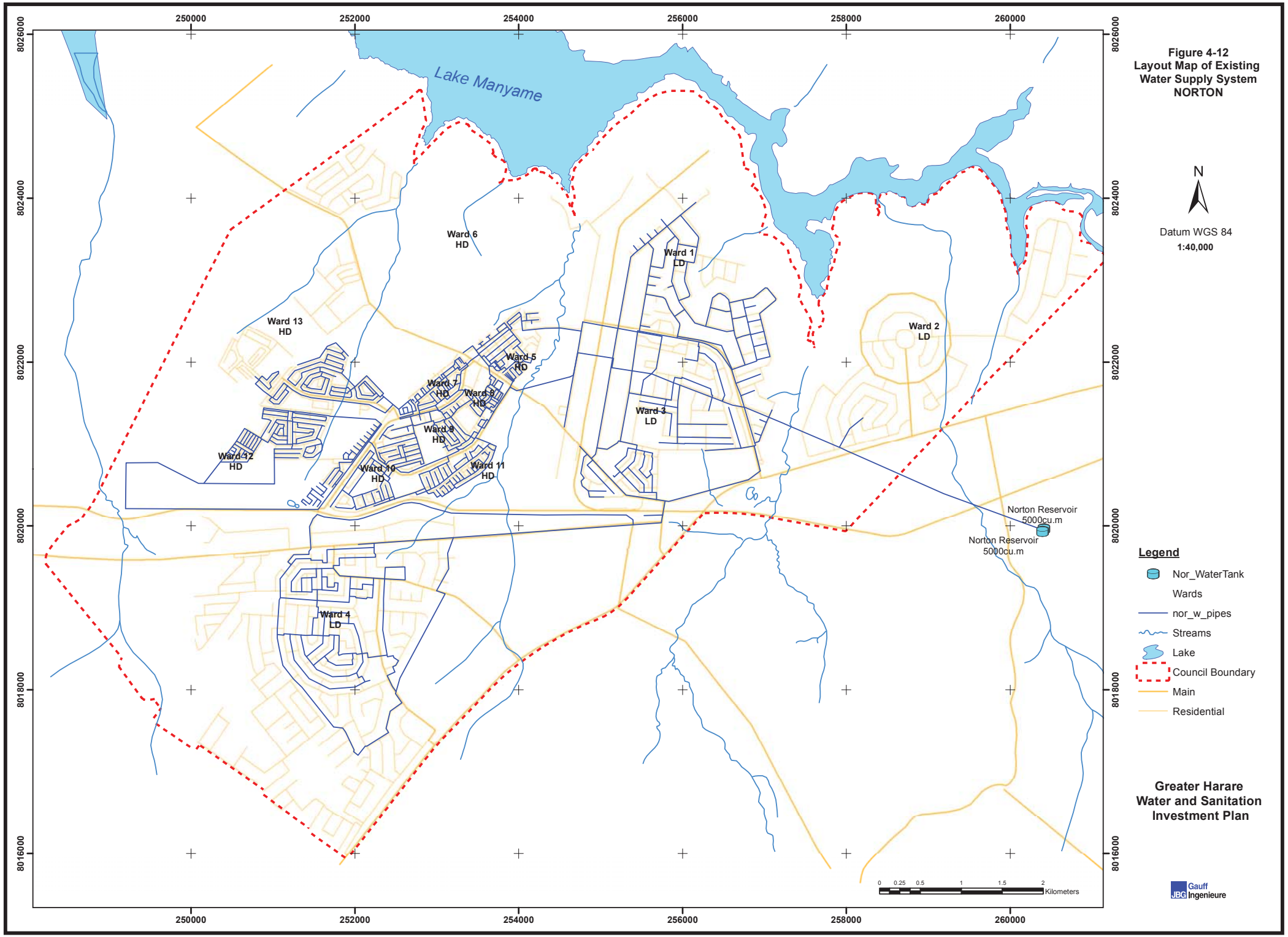
4.4.1.8 Emergency Water Supplies

With the considerable water shortages that Norton has been experiencing the Council has an ongoing programme to supply water through strategically located water points and boreholes provided mostly by NGOs. There currently 21 boreholes with hand pumps.

Council borehole with Handpump

Well mai… …he close proximity … …) to a pit latrine (background)

The Council arranges for the department of health to test the boreholes.


Lake Manyame
Ward 6 HD
Ward 1 LD
Ward 13 HD
Ward 2 LD
Ward 5 HD
Ward 7 HD
Ward 8 HD
Ward 3 LD
Ward 9 HD
Ward 12 HD
Ward 10 HD
Ward 11 HD
Norton Reservoir 5000cu.m
Norton Reservoir 5000cu.m
Ward 4 LD
250000
252000
254000
256000
258000
260000
8026000
8024000
8022000
8020000
8018000
8016000
N
Datum WGS 84
1:40,000
0 0.25 0.5 1 1.5 2 Kilometers
Legend
Nor_WaterTank
Wards
nor_w_pipes
Streams
Lake
Council Boundary
Main
Residential
Figure 4-12
Layout Map of Existing
Water Supply System
NORTON
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

4.4.2 Sewerage

4.4.2.1 Sewage Sub Catchments

Originally there was just one main sewerage catchment in Norton with two small sub-catchments supplied by small sewage pump stations. All wastewater was conveyed to the Town's wastewater treatment works on a single location near LakeManyame. Recent expansion in the town to the west has led to development outside of this sewage catchment and consideration must now be given to strategically planning the future sewerage catchments of the town.

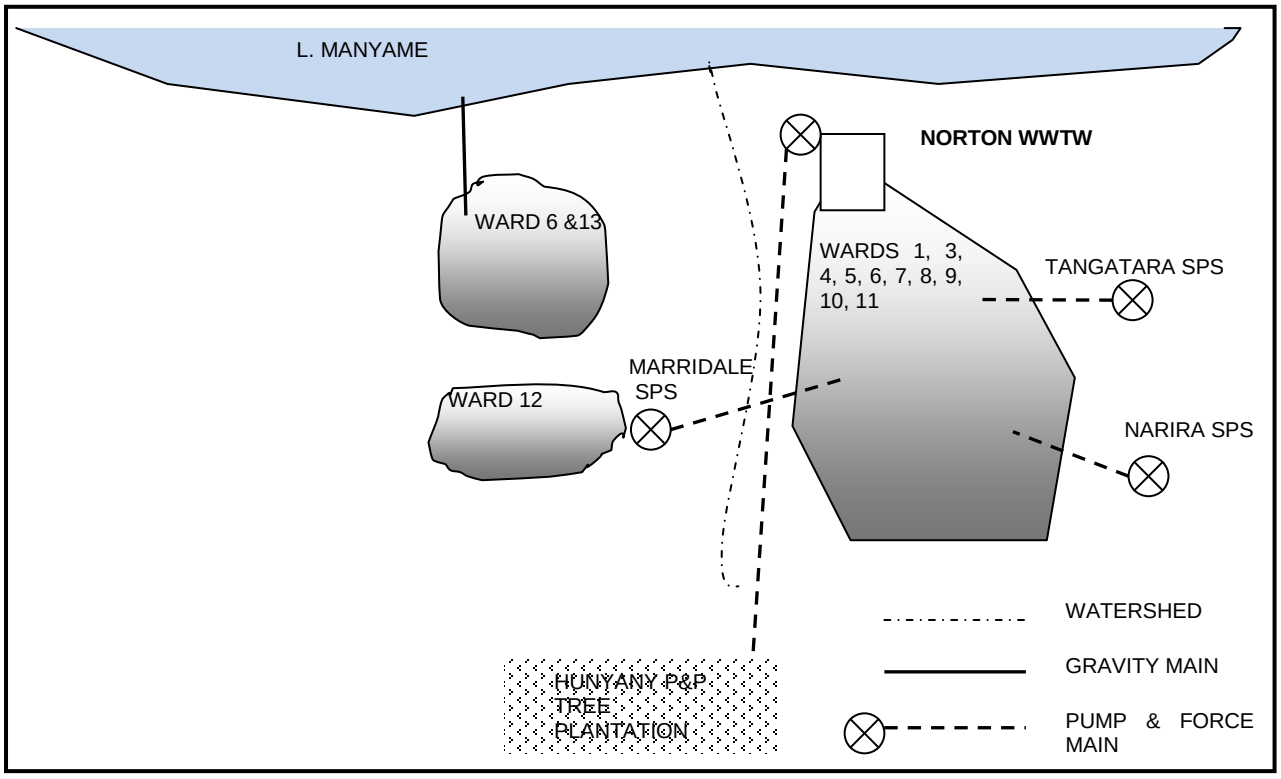


Figure 4-13: Norton Existing Sewerage Catchments Schematic

The schematic above shows the intended function of the Norton sewerage system. The main current concerns are that the Maridale SPS is not equipped with pumps and that Ward 6 and 13 have a sewerage system which is blanked off and has neither ponds nor pump station to discharge to.

A system is required which collects from all areas that are currently sewered and that the Council intends to provide with sewerage services in future. The proposed system of sewerage catchments for Norton is shown in the figure below.

4.4.2.2 Sewer Reticulation System

Norton's sewer system varies in age but is generally considered to be in reasonable condition with no areas reported as causing significant maintenance problems. However general rehabilitation works will be expected on the system including targeted line replacements and manhole rehabilitation and cover programmes. Older parts of town experience significant amount of infiltration flow during and just after the rainy season.

4.4.2.3 Transmission Sewers

The current sewage transmission system meets current hydraulic requirements and according tothe Council is reliable and does not present an undue maintenance burden. The system has been modelled assuming normalized water supplies to meet demands and in areas of existing development is adequate.

In Figure 4-13 above the proposed sewerage catchment development is presented. If this is followed then all existing sewers have the capacity needed for the long term duty.

For Norton, it is not planned that any expansion to the existing sewerage reticulation system will be carried out in the short term. Therefore there are no proposed short term measures to expand the main sewage transmission.

4.4.2.4 Sewage Pump Stations

There are three sewage pump stations in Norton as follows:

Tangatara SPS

Tangatara SPS handles flows from a few houses in the Twin Lakes Area of Norton. Peak flows are <10l/s. The station pumps into a 785m long AC force main 150mm diameter.

The SPS is not enclosed in a fenced area and its pump is considered by the Council to be unreliable as it is a temporary unit which is also used for many other duties. The 1AC force main suffers regular bursts and should be replaced.

There are no standby power facilities and the station overflows at times of power failure.

Details of the pumping equipment in the station were not available.

Tangatara SPS

Sewage Overflow from Burst Force Main

Narira SPS

Narira SPS handles flows from a few houses in the Narira Area of Norton. Peak flows are <10l/s. The station pumps into a 500m long AC force main 150mm diameter.

The SPS is enclosed in a fenced area and its pump and force main are reliable.

There are no standby power facilities and the station overflows at times of power failure. Large informal ponds have been dug to capture these overflows.

Details of the pumping equipment in the station were not available.

Narira SPS

The Maridale SPS was built by a private developer to handles flows from the development in Ward 12. Modelled flows are 35l/second. It is however intended that this station will be abandoned in the long term and will therefore only continue to operate in the short term.

Currently that station does not function because it has no pumps installed. No problems are reported with the Force Main which discharges to a manhole in Ward 9 from where sewage gravitates to the Norton WWTW.

The SPS is not enclosed in a fenced area and there are no standby power facilities.

As there is almost no water supplied to this area overflows of sewage are minimal but as soon as water returns these will be serious.

Maridale SPS Station

4.4.2.5 Sewage Treatment

Norton has two sewage treatment plants at the same location known as the 'Old Works' and the 'New Works'.

Norton Old Works

The Norton Old Works consists of a traditional treatment process with the following components:

- Intake works with coarse and fine bar screens, grit screening and flow measuring and flow diversion facilities.
- 2 No. Primary sewage clarifiers with bridge mounted scrapers
- 2No. Biological trickling filters

- 2No. Humus tanks with bridge mounted scrapers
- Holding ponds for treated wastewater awaiting pumping to disposal
- Disposal to a forest plantation owned by Hunyani Pulp and Paper but currently leased out.
- Drying beds for clarifier sludge.

In addition to the above, non treatment components include:

- A pump station with the following functions;
    - Pumping of primary effluent to trickling filters;
    - Pumping sludge to sludge drying beds;
    - Pumping of final wastewater to the holding ponds;
- High lift pump station at the ponds serving the new and old works
- 7.8km AC main to the forest plantation serving the new and old works.

Norton New Works

The Norton New Works consists of a traditional treatment process with the following components:

- Intake works with coarse and fine bar screens, grit screening and flow measuring and flow diversion facilities;
- 4 No. Primary sewage clarifiers of the 'Dortmund' upflow type, without scrapers. 2 of the four are generally finished but not yet commissioned;
- 3No. Biological trickling filters. Only one is commissioned and two are partly constructed;
- 6No. Humus tanks of the Dortmund type. Three are commissioned and the other three are generally finished but not commissioned;
- Sludge drying beds;
- A partly completed digester. Construction quality on this is poor and the potential to complete it dubious.
- Disposal system is the same as for the old works.

In addition to the above, non treatment components include:

- A pump station with the following functions;
    - Pumping of clarified wastewater to the filters;
    - Pumping primary effluent to trickling filter distribution box;
    - Pumping of final wastewater to the holding ponds;
    - Pumping sludge to sludge drying beds.

<u>Existing Works Capacity</u>

Calculations of the capacity of the new and old works have been carried out as part of the GIZ exercise which looked at, but eventually did not proceed with, rehabilitation of the

works. The following capacities were provided based on actual sewage characteristics at the plant inflow:

Old Works

Limiting component is the Biological Trickling Filters with 3.2MLD capacity. Clarifier capacity is 6.6MLD. Works nominal capacity is 3.2MLD.

New Works

Limiting component is the Primary Clarifiers with 2.2MLD capacity in the two existing clarifies which can be economically raised to 4.4MD by commissioning the other two units. Filter capacity of the one complete unit is 4.7MLD. Therefore completion of the other two units is not required. The large filter capacity of this plant arises from design at a time when Norton had significant industry producing high COD wastewater.

Combined Works Capacity

The combined nominal capacity of the works is around 7.2MLD.

Holding Ponds

The existing holding ponds have an allowable loading rate of around 300kg BOD per day, equivalent to a flow of 2.4MLD from treated sewage from the works. Thus with any flow above this the pond will be overloaded and will remain anaerobic throughout.

On-Going Works

Norton Water supply Project

When supply difficulties first arouse with the Morton Jaffray Supply Norton commenced a project to bring Raw Water from Lake Chivero to their own water treatment works, from where it was to be pumped to the hillside tanks. The project included the following components:

1. An intake on Lake Chivero based on the re-use of an existing intake tower. This tower has been identified as problematic because it has a fixed depth intake which cannot be moved to access the layers of best water and it is located within a bay that wind tends to fill will weed from other areas of the lake. City of Harare had previously abandoned the use of this intake due to wind blown weed choking the area of the dam in which it is located.
2. A raw water pump station and pipeline 3km long
3. A 20MLD FC Reactor type water treatment plant.
4. A treated water pump station and pipeline 1500m to the Norton tanks

Money for the project was provided intermittently and at the time it was suspended the main works were the partial completion of the FC reactor WTW. None of the pump stations or pipework had been completed.

A review of the project was carried out by GIZ with a view to a decision on whether it would be prudent to fund the completion of the works. GIZ concluded that the costs would be very high and that the raw water source quality was very low and therefore a risk to success and decided not to finance completion. The current review concurs with the GIZ findings and therefore we have recommended an increase in supplies to Norton from Morton Jaffray

WTW as a more efficient investment than the completion of Norton's independent water supply.

Partially Complete FC Reactor

GIZ Financing

GIZ are funding some Non Revenue Water activities in Norton including a current programme of valve replacement and bulk and block metering.

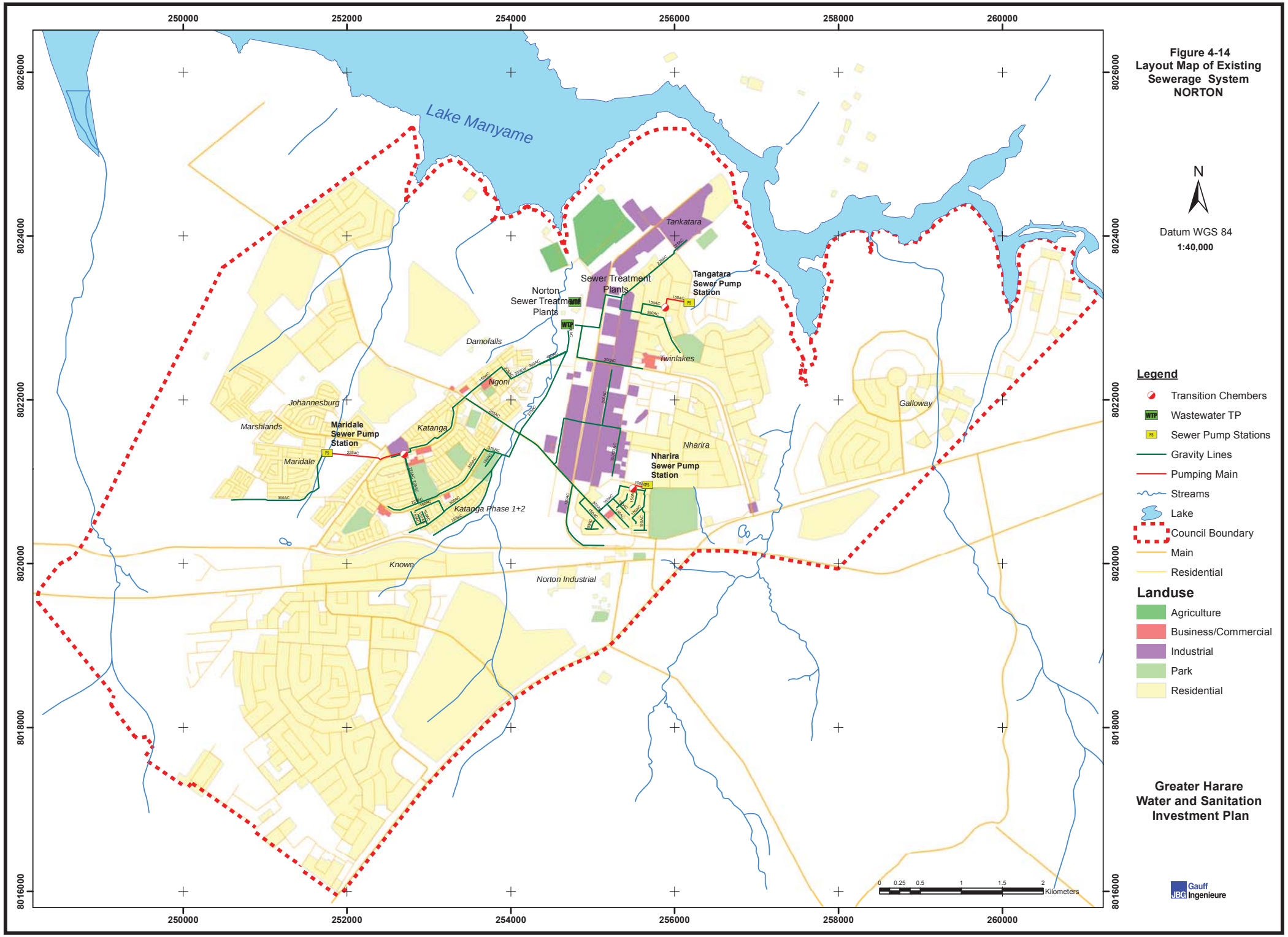


Figure 4-14
Layout Map of Existing Sewerage System
NORTON
N
Datum WGS 84
1:40,000
Lake Manyame
Tankatara
Sewer Treatment Plants
Tangatara Sewer Pump Station
Norton Sewer Treatment Plants
Damofalls
Twinlakes
Ngoni
Johannesburg
Marshlands
Maridale Sewer Pump Station
Maridale
Katanga
Katanga Phase 1+2
Nharira
Nharira Sewer Pump Station
Galloway
Knowe
Norton Industrial
Legend
Transition Chembers
Wastewater TP
Sewer Pump Stations
Gravity Lines
Pumping Main
Streams
Lake
Council Boundary
Main
Residential
Landuse
Agriculture
Business/Commercial
Industrial
Park
Residential
0 0.25 0.5 1 1.5 2 Kilometers
Greater Harare Water and Sanitation Investment Plan
Gauff Ingenieure
250000
252000
254000
256000
258000
260000
8026000
8024000
8022000
8020000
8018000
8016000

4.5 Ruwa

A summary of the existing situation in Ruwa is presented here. More detail along with a narrative of the proposed investment measures is presented in Appendix 4.5.

4.5.1 Water Supply

4.5.1.1 Water Sources

Ruwa currently obtains water from the following sources:

- Nora Dam via DN450 uPVC/ DN515AC supply line which feeds into Green Sykes dam on the outskirts of the town. This has been constructed as part of a 25 year Build Operate Transfer (BOT) scheme.
- City of Harare (treated water supply) via:
    - DN525 supply line from Donny Brook tanks to the ZIMRE estate and onwards into the supply network for Ruwa
    - DN350 supply line from the Ventersberg tanks which feeds the Mutare Road Ground Tanks via a booster station on the western outskirts of Ruwa.
- Green Sykes dam on the outskirts of the town which is connected to the WTW via DN515 AC supply line.

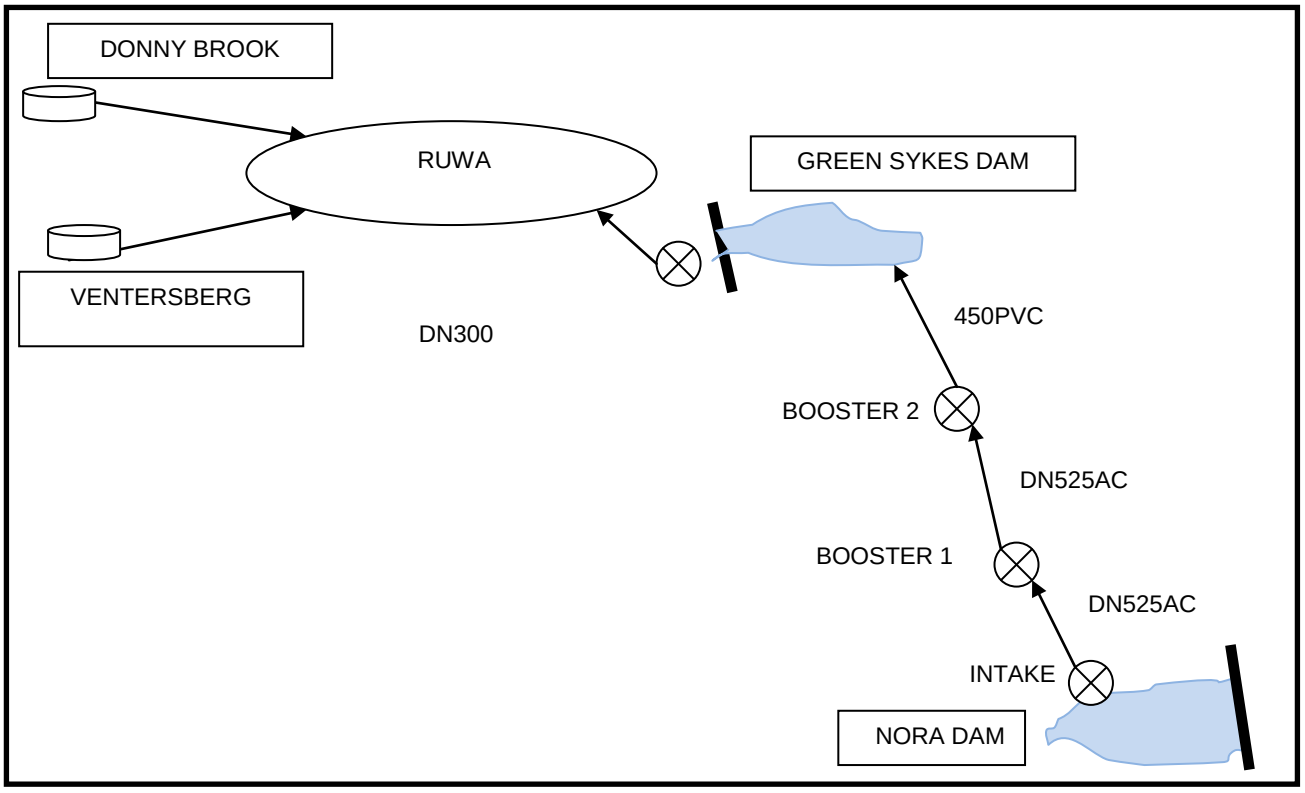


Figure 4-15: Ruwa Water Supplies

The supplies from City of Harare have become increasingly unreliable and are now virtually non- existent. Thus over the past ten years Ruwa has focused on its project to bring the town's water needs from Nora dam, some 15.5km southeast of the town. This project has been largely completed in 2014.

The ZINWA yield assessment for the 'Nora Pick up Weir' gives a 4% yield of around 10,000 ML per annum or 27MLD. Ruwa have installed a raw water system capable of transferring 21ML per day (24 hour pumping).

4.5.1.2 Ruwa WTW

The Ruwa WTW is of the 'FC Reactor' type. This is a proprietary design of 'Hydro Project Zimbabwe' of Bulawayo.

The FC reactor contains two functional units within a single vessel constructed of either steel of concrete.The base of the unit functions as an upward flow clari-flocculator and above this there is a filter which achieves filtration through a floating bed of hardened kaylite. Filtration is upwards and backwash is downwards and is achieved by opening a valve at the base of the unit. The system operates entirely under gravity and requires no circulation or backwash pumps.

The FC reactor plant is used in many locations throughout Zimbabwe and the Ruwa Engineering staff are very happy with the performance of the units installed.

There are two FC reactor units on the site:

1. The original 2.5MLD unit fabricated steel unit
2. A more recent 5MLD reinforced concrete unit

Works was commenced on a 4000m3 clear water reservoir at the site of the WTW but this has not been completed. The FC reactor units therefore drain directly into supply.

The works is generally in good condition although the following issues were identified:

1. Corrosion of the 2.5ML steel FC reactor vessel.
2. Chemical dosing arrangement is not functional and requires overhaul. Filter beds are losing hardened kaylite media which finds its way into supply and clogs supply meters.
3. Sludge drying bed construction is incomplete
4. Treated water reservoir is incomplete.

FC Reactor Units 2.5MLD (left) and 5MLD (right)

Broken Down Chemical Dosing

4.5.1.3 Booster Pump Stations

The system currently contains one booster pump station, split into two parts, located at the Mutare Road reservoir site.

The original part of the station pumps to the 180m3 elevated tank at that location whilst a new section of the pump station is under construction and will deliver to the new Damofalls Tanks and generally into supply.

4.5.1.4 Transmission System

Figure 4-16 below shows the transmission system for Ruwa, in schematic form:

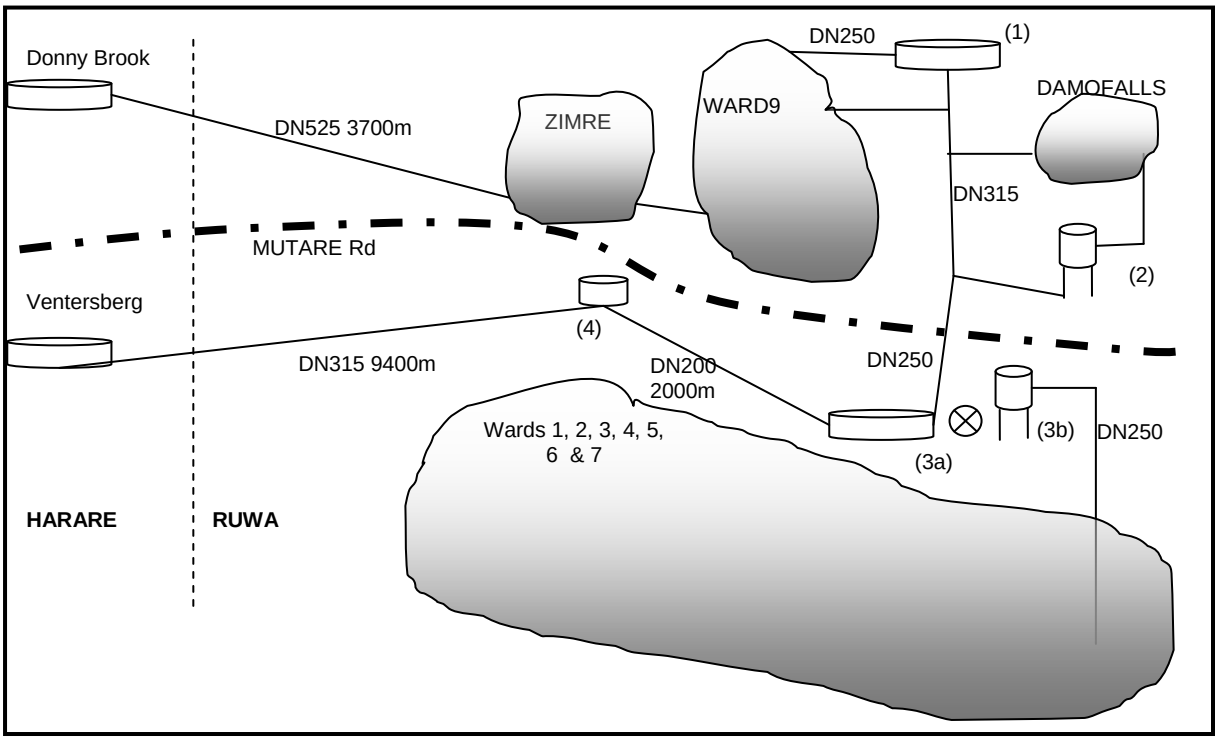


Figure 4-16: Ruwa Transmission and Storage Schematic - Existing

Three sources of treated water are available to Ruwa when all things are functioning normally. These are the two City of Harare reservoirs at Ventersberg and Donny Brook and the Ruwa WTW.

The City of Harare Supplies are as follows:

- The original supply to Ruwa was a DN315 line from Ventersberg through a booster at Sunway City and then Via a DN200 Line to Ruwa'sMutare Road Tanks.
- Later a DN525 was added to supply the ZIMRE area without any intervening storage.
- Currently no supply is received from Ventersberg and little from Donny Brook.
- There are no reported problems with the pipelines themselves.

The supply from Ruwa WTW Operates as Follows:

- At the water treatment works there are a number of connections directly into the supply network of the northern part of Ward 9.
- A DN315 AC line runs south with offtakes to Ward 9 and Damofalls before reducing to DN250 and terminating at the Mutare Road Ground Tanks

- From Mutare Road Ground Tanks a single DN250 goes into supply in the southern area of the town with multiple off-takes.

4.5.1.5 Storage Reservoirs

Existing storage reservoirs are located and supplied as shown in Figure 4-16 above. The following reservoirs exist in the town:

Table 4-17: Reservoir Storage - Ruwa

ID	Location	Capacity
1	Ruwa WTW	4000m3 under construction
2	New Damofalls	1000m3 elevated on 10m stand
3a	Mutare Road Ground	2000m3 Ground with - 3 x 50kW Pumps to (3b). - 3 x 50kW Pumps to (2) Not connected
3b	Mutare Road Elev.	180m3 steel – condition suspect
4	Sunway City	+-200m3

The above table covers the storage within the town only. Of great importance to Ruwa but belonging to Harare are the Donny Brook tanks which have a large diameter supply line to Ruwa and to a lesser extent the Ventersberg tanks which have a long DN300 supply line to Ruwa but which should also feed the growing Sunway City development. Little or no water is currently received through these lines.

4.5.1.6 Distribution Network

The following Zones are logically identified from the network layout. Currently poor valves etc. mean that many of the zones are heavily interconnected and do not constitute demand management areas.

Table 4-18: Demand Management Areas

DMA	Source of Supply	Comment
EXISTING TOWN AREAS		
ZIMRE Area	via DN525 from Harare Donny Brook Tanks.	Interconnected to ward 9 via DN250. This should be normally closed
Ward 9	Ruwa WTW via numerous offtakes from DN315 line running from Ruwa WTW to Mutare Road Tanks	Ward 9 should be subdivided into three DMAs covering; - the northern and southern parts of the ward west of the supply line and, - theDamofalls area east of

DMA	Source of Supply	Comment
		the supply line.
Ward 1	Mutare Road Tanks offtake from Existing DN250 running south from the tanks	
Ward 2	Mutare Road Tanks offtake from Existing DN250 running south from the tanks	
Ward 3	Mutare Road Tanks offtake from Existing DN250 running south from the tanks	
Wards 4 and 6	Mutare Road Tanks offtake from Existing DN250 running south from the tanks	
Ward 5	Mutare Road Tanks offtake from Proposed DN400/315 running south from the tanks.	This area is currently expanding
Ward 7 - North	Mutare Road Tanks with offtake from existing DN250 running south from the tanks	This is the existing developed area of Ward 7
Ward 7 - South	Ward 5	Mutare Road Tanks offtake from Proposed DN400/315 running south from the tanks.
EXPANSION AREAS (Current and Future)		
Tarisa Farm	Ruwa WTW via existing Dn250 line running east to west along the boundary between Tarisa Farm and Ward 9	This is a currently expanding area and will continue to expand eastwards up to 2030
Mara Farm	Ruwa WTW via new secondary network.	Expansion into Mara Farm area has commenced but only at small scale.
Athelney Farm	Mutare Road Tanks via new secondary network	Expansion into Athelney Farm area has not commenced.

4.5.1.7 NRW assessment

Bulk and block metering is absent for most of the town.

The Ruwa distribution networks are relatively new as Ruwa is a new settlement. As such major issues with dilapidated pipes and house connections are not generally reported.

However there has been a significant water supply deficit for many years which makes it almost impossible to assess the level of leakage in the tertiary distribution system.

The Council Reports that over 50% of consumer meters are faulty or inoperable.

4.5.1.8 Emergency Water Supplies

With the considerable water shortages that Ruwa has been experiencing the Council has an ongoing programme to supply water through strategically located water points and boreholes as follows:

- 5 electrically powered boreholes with typical yields <1 lps.
- 5 boreholes with hand pumps

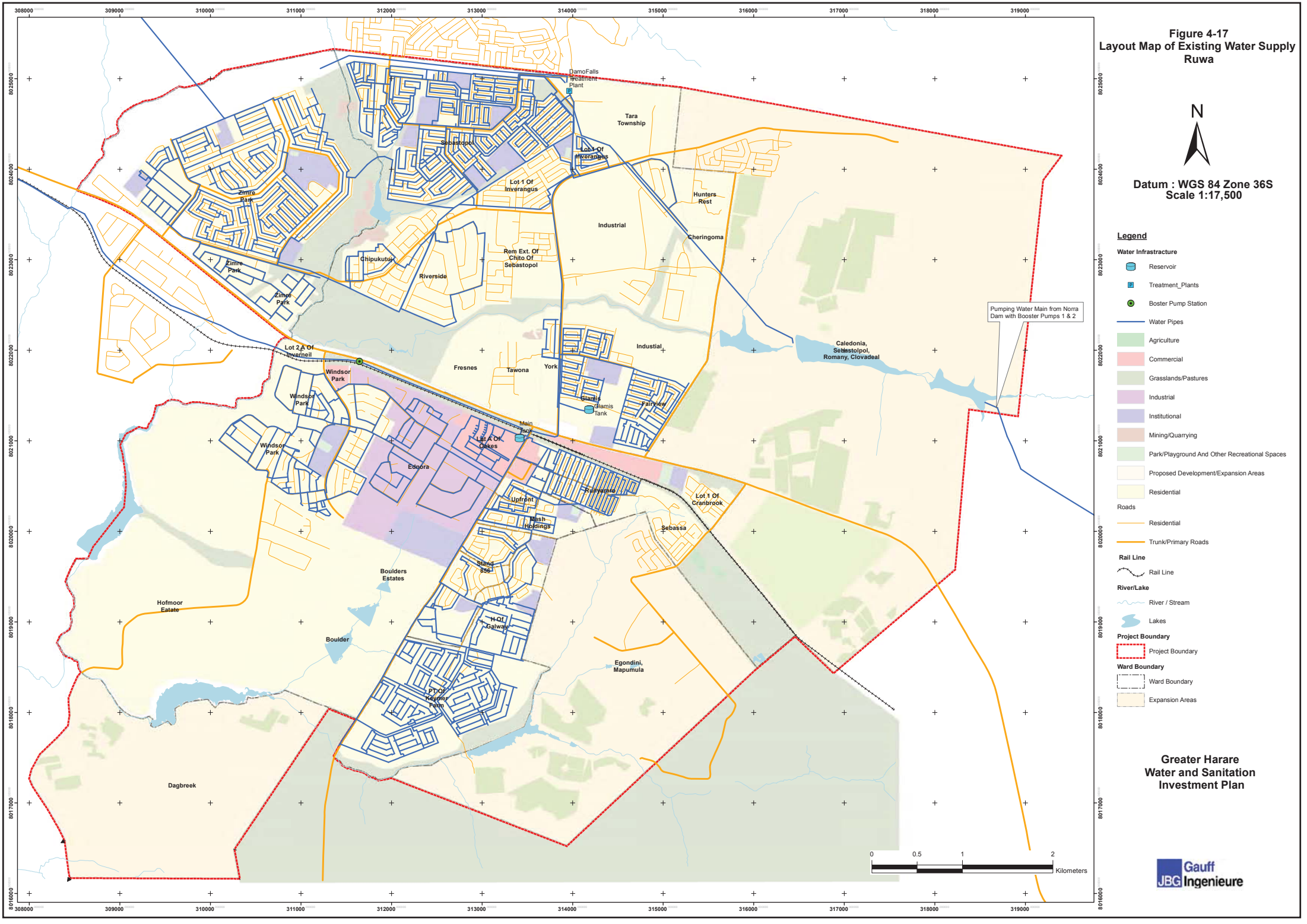


Figure 4-17
Layout Map of Existing Water Supply
Ruwa
N
Datum : WGS 84 Zone 36S
Scale 1:17,500
Legend
Water Infrastracture
Reservoir
Treatment_Plants
Boster Pump Station
Water Pipes
Agriculture
Commercial
Grasslands/Pastures
Industrial
Institutional
Mining/Quarrying
Park/Playground And Other Recreational Spaces
Proposed Development/Expansion Areas
Residential
Roads
Residential
Trunk/Primary Roads
Rail Line
Rail Line
River/Lake
River / Stream
Lakes
Project Boundary
Project Boundary
Ward Boundary
Ward Boundary
Expansion Areas
Pumping Water Main from Norra Dam with Booster Pumps 1 & 2
DamoFalls Treatment Plant
Tara Township
Sebastopol
Lot 1 Of Inverangus
Zimre Park
Hunters Rest
Industrial
Cheringoma
Rem Ext. Of Chito Of Sebastopol
Chipukutuk
Riverside
Caledonia, Sebastolpol, Romany, Clovadeal
Lot 2 A Of Inverneil
Windsor Park
Fresnes
Tawona
York
Industial
Glamis
Glamis Tank
Fairview
Main Tank
Lot A Of Oakes
Ednora
Runnymede
Upfront
Lot 1 Of Cranbrook
Mash Holdings
Sebassa
Stand 856
Boulders Estates
Hofmoor Estate
H Of Galway
Boulder
Egondini, Mapumula
PT Of Kaymor Farm
Dagbreek
0
0.5
1
2
Kilometers
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

4.5.2 Sewerage

4.5.2.1 Sewage Sub Catchments

Ruwa has a single sewage catchment served by the Adelaide Ponds. This is divided into four sub-catchments, each served by a single sewage pump station.

- Runyararo SPS Sub-catchment - This is a small area of Wards 1 and 2 which drains to the Runyararo SPS. This SPS has a short lift into a sewer line in the Ruwa Main SPS sub-catchment at Jun-93.
- Chiremba SPS Sub-catchment - This covers wards 4 and 6 and areas of Ward 5 which drain to the Chiremba SPS. This SPS has a short lift into a sewer line in the Ruwa Main SPS sub catchment at Jun-102.
- Ruwa Main SPS Sub-catchment - This covers the whole of Ruwa, including flows from the two above sub catchments with the balance of flow arriving all the way by gravity to the Ruwa Main SPS.
- Wards 5&7 Sub Catchment - The new developments in Wards 5 and 7, south of the Chiremba SPS cannot feed any of the existing sub catchments by gravity. It would appear that the developer intends to install a sewage pump station at the southernmost extent of this area (Jun-31 in mapping) and pump up to a manhole within the Ruwa Main SPS sub-catchment. This pump station has not yet been installed.

4.5.2.2 Sewer Reticulation System

Ruwa is a relatively new town and as such there are no significant problems reported with the sewer network. However, in the last decade water supplies have been short and flows therefore low and it is expected that a return to normal supply levels may show up areas where the existing system has deteriorated.

4.5.2.3 Transmission Sewers

The main sewer network for Ruwa has been modelled using the expected flows at the 2030 time horizon to identify sewer lines which may need to be augmented or upgraded to accommodate the expansion of the town. It should be noted that all of the current network appears adequate for normal flows with the current population.

4.5.2.4 Sewage Pump Stations

There are three sewage pump stations in Ruwa as follows:

Runyaro SPS

Runyaro SPS (Jun-87 in modelling). Peak modelled inflows were 18l/s and pumping head is not clear but <15m for the short lift to Jun-93 in the Ruwa Main SPS sub catchment.

The SPS has is enclosed within a fenced area and has an inlet works with coarse and fine bar screen and grit screening upstream of the pumps.

Pumping equipment consists of one submersible pump in a wet well.

The station is prone to overflows as a result of power failures but is mechanically reliable. Spills are into the Ruwa stream and thence into the Manyame No standby power is available at the station.

Chiremba SPS

Chiremba SPS (Jun-106 in modelling). Peak modelled inflows were 6l/s and pumping head is not clear but are estimated around 40m for the lift to Jun-103 in the Ruwa Main SPS sub catchment.

The SPS is enclosed within a fenced area and has an inlet works with coarse and fine bar screen and grit screening upstream of the pumps.

Pumping equipment normally consists of two submersible pumps but has been replaced by a single end suction pump after failure of the submersibles.

The station is prone to overflows as a result of power failures but is mechanically reliable. Spills are into the Ruwa stream and thence into the Manyame. The station has a relatively new standby generator.

Ruwa Main SPS

All sewage from Ruwa ends up at the main sewage pumps station. From here it should be pumped around 1250m to the Adleigh ponds located between Ruwa and Epworth.

The SPS is enclosed within a walled area and has an inlet works with coarse and fine bar screen and grit screening upstream of the pumps. There are three inlet works consisting of coarse and fine screens and grit screening. Two feed into old wet wells and are not used whilst the one feeding the current pump station is in good condition and is in use.

The station is currently inoperable with one pump failed, two motors failed and one panel failed. With no pumps running, all of Ruwa's sewage discharges untreated into the Manyame catchment.

Ruwa Stream Downstream of Ruwa Main SPS

4.5.2.5 Sewage Treatment

Ruwa currently uses the Adelaide stabilization ponds which are in an area which forms part of Epworth and which has been zoned by Epworth for development. Ruwa has no direct access to the ponds and discharge no effluent to them.

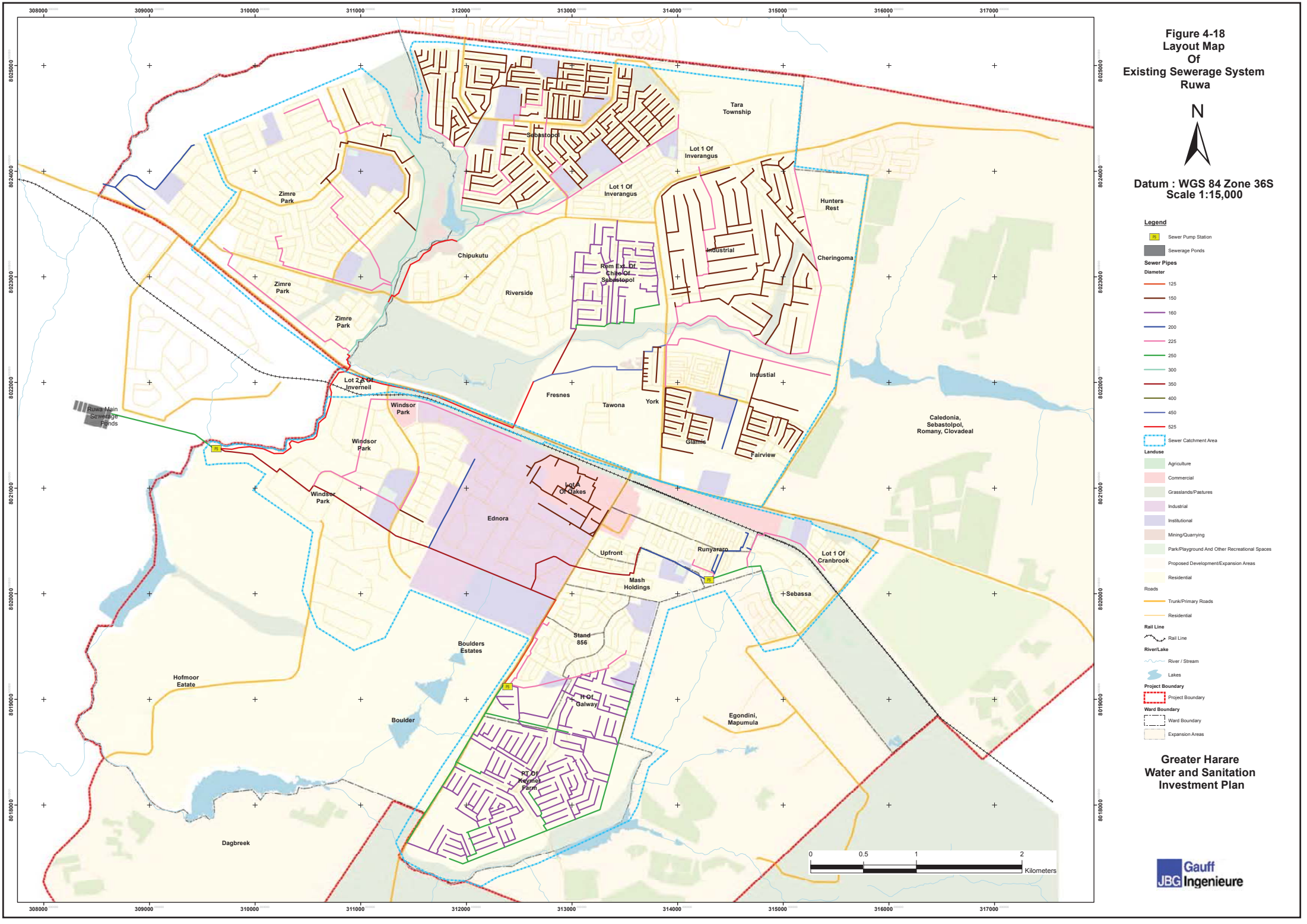


Figure 4-18
Layout Map
Of
Existing Sewerage System
Ruwa
N
Datum : WGS 84 Zone 36S
Scale 1:15,000
Legend
Sewer Pump Station
Sewerage Ponds
Sewer Pipes
Diameter
125
150
160
200
225
250
300
350
400
450
525
Sewer Catchment Area
Landuse
Agriculture
Commercial
Grasslands/Pastures
Industrial
Institutional
Mining/Quarrying
Park/Playground And Other Recreational Spaces
Proposed Development/Expansion Areas
Residential
Roads
Trunk/Primary Roads
Residential
Rail Line
Rail Line
River/Lake
River / Stream
Lakes
Project Boundary
Project Boundary
Ward Boundary
Ward Boundary
Expansion Areas
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure
Tara Township
Sebastopol
Lot 1 Of Inverangus
Lot 1 Of Inverangus
Hunters Rest
Industrial
Cheringoma
Zimre Park
Zimre Park
Zimre Park
Chipukutu
Riverside
Rem Ext. Of Chile Of Sebastopol
Industial
Lot 2 A Of Inverneil
Windsor Park
Windsor Park
Windsor Park
Fresnes
Tawona
York
Glamis
Fairview
Caledonia, Sebastolpol, Romany, Clovadeal
Ruwa Main Sewerage Ponds
Lot A Of Oakes
Ednora
Upfront
Runyararo
Lot 1 Of Cranbrook
Mash Holdings
Sebassa
Stand 856
Boulders Estates
Hofmoor Eatate
H Of Galway
Boulder
Egondini, Mapumula
PT Of Keymer Farm
Dagbreek
0
0.5
1
2
Kilometers
308000
309000
310000
311000
312000
313000
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315000
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317000
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CHAPTER 05: POPULATION, WATER DEMAND AND WASTEWATER FLOW PROJECTIONS

5 POPULATION, WATER DEMAND AND WASTEWATER FLOW PROJECTIONS

This chapter presents the methodology for projecting the water demand and wastewater flows. The projected flows are applied for each project town, and Greater Harare as a whole, to determine the medium and long-term water supply and sewerage infrastructure input/output requirements. The chapter also summarises the basic assumptions made concerning water usage, wastewater generation and water losses, which were already presented and approved in the Final Inception Report.

5.1 Key Planning Criteria

5.1.1 Service Levels

Domestic water consumption depends to a large extent on the service levels utilised by the users. These service levels depend on the affluence and income levels of the water users. The housing development standards in Zimbabwe categorise properties according to density and size of properties. There are generally three categories: High density with properties (stands) equal or smaller than 400 m^2, medium density with properties between 400 m^2 and 1,000 m^2, and low density areas with properties larger than 1,000 m^2.

The standard in Zimbabwe was to provide house connections for all urban properties with sewer connections for all medium and high density stands. Low density areas were to be on-site septic tanks with soakaways. There were some exceptions such as Epworth, which developed as an informal settlement although informal settlements were not allowed. In the last 15 years there have been a number of housing developments that have either not been provided with technical infrastructure services or have been provided with infrastructure but without water services. Residents have been forced to obtain their water from boreholes, wells and surface water whilst sanitation has been on-site septic tanks with soakaways (even on small stands), pit latrines or open defecation.

However, it should be noted that even though the National Water Policy emphasises that there is a duty to provide safe water and sanitation services to all, it recognises the challenges associated with such a commitment and hence acknowledges that the requirements for house connections and water borne sanitation may be relaxed during the recovery phase. Hence, the provision of waterborne sanitation systems will be strategically phased over the planning horizon. The use of low cost technologies for services provision during the recovery phase will be promoted as stipulated by the National Water Policy. In this regard, the population in peri-urban areas such as parts of Epworth and Harare South that are currently developing informally will initially be provided with low cost water supply systems based on water kiosks or house connections with flow restrictors.

Field visits and discussions with the councils were conducted to determine the proportions of population in each service level category. The results of these surveys are presented in the Appendix.

5.1.2 Per Capita Consumption

The current standards for specific water consumption in Zimbabwe are generally higher than the regional averages. However, the actual consumption is lower than the standard provisions due to water rationing induced by high network leakages and reduced water production. Infrastructure rehabilitation interventions are expected to restore production

facilities to design capacity and also arrest the leakage situation in the network. However, the specific water consumption is not expected to rise back to the old standards due to a number of factors such as: progressive block tariff system which penalises high water usage, improved public awareness on the need to conserve water, and state driven policies that promote principles of financial sustainability in the provision of water and sanitation services. In light of the foregoing, the specific consumption figures presented in the table below have been applied in the calculation of the domestic water demand.

Table 5-1: Proposed Specific Water Consumption Figures

Urban areas	At present	2020	2030
	l/cap/day	l/cap/day	l/cap/day
Low Density (LD) areas	300	250	200
Medium Density (MD) areas	200	175	150
High density (HD) areas	85	80	80
Informal*	40	40	40

*without in-house plumbing

These figures a comparable with actual measured consumption figures from the region – Lusaka, Zambia. Table 5-2 shows a summary of consumption figures measured in several DMAs and suburbs. The consumer category equivalents for Zimbabwe are as follows

- Low Cost (LC) → High Density (HD);
- Medium Cost (MC) → Medium Density (MD);
- High Cost (HC) → Low Density (LD).

Table 5-2: Actual Measured Consumption from the Region (Lusaka, Zambia)

Township	Consumer category	Metered domestic connections [no.]	Avg Consumption [m^3/month]	Avg consumption /Connection [m^3/month]	Monthly avg consumption / category [m^3/month]	Avg population / connection [no.]	per capita consumption [l/day]
Rhodespark	HC	985	64,931	66	58.89	6	327.16
Kabulonga & Sunningdale	HC	1,240	92,425	75			
Town/Kabelenga	HC	162	7,418	46			
Northmead	HC	827	40,781	49			
Chelston	MC	2,481	83,585	34	38.63	8	160.95
Avondale Southend	MC	1,384	73,508	53			
Kabwata	MC	1,357	43,301	32			
New Kabwata S/S	MC	1,165	53,520	46			
Emmasdale Bank Houses S/S	MC	596	22,637	38			
Chilenje South	MC	2,422	70,551	29			
Marapodi	LC	1,565	26,213	17	21.57	10	71.91
Matero ***	LC	6,413	106,797	17			
Garden	LC	786	24,469	31			
Chawama/Kuomboka	LC	671	14,599	22			

5.1.3 Institutional Consumption

Water consumption for institutions such as schools, hotels, hospitals, prisons, service camps and administrative offices is closely intertwined with domestic consumption. In essence, the water requirements for daily patrons and workers of these institutions are generally included in the total water requirements, if they come from within the enumeration area. An allowance (15% of domestic consumption) has been made for people that patronise and visit the institutions from areas outside the area of consideration (ward).

5.1.4 Industrial and Commercial Consumption

Industrial and commercial demand on the other hand depends on activities of the commercial or industrial establishment. Most of the commercial and industrial activities use water in their production processes in addition to the water used for cleaning and consumption by the workforce.

Studies have shown that the size of the property on which the industry is located, gives a good indication of the amount of water required by that industry. At this master-planning stage, detailed characteristics of the existing and future industries are not known and in the absence of such information, the industrial water requirements have been calculated on the basis of area. A unit consumption figure of 15 – 22.5 m^3/ha/day has been assumed.

The current industrial land area was calculated using a combination of information gathered during field investigations and recent satellite images.

5.1.5 Physical Water Losses

Physical water losses are inevitable no matter how well controlled and maintained a public water supply system is, but it can be minimised. Such losses occur at various stages of the water supply chain. In the distribution network, losses occur at the numerous pipe connections and fittings. This type of losses depends on the type of fittings and the nature of connections as well as workmanship. As the network gets older, the various elements begin to fail due to rusting or bursting, increasing the network losses considerably. This is normally exacerbated by high pressures in a network based on system operation and control. This type of losses can be mitigated by regular maintenance and routine rehabilitation. There has not been a specific attempt to quantify the physical losses in all the towns. Data on total NRW (physical and commercial losses) is generally reported by the councils without breaking it down into the two components. Without carrying out appropriate measurements in the field, it is virtually impossible to determine the current physical water losses. Furthermore, the erratic water supply situation especially in the satellite towns and the non-functional bulk and domestic water meters makes it very difficult to determine current physical losses.

Moving forward, it is reasonable to assume that system losses and especially technical losses will decrease significantly as the quality of the infrastructure improves and the level of operation is enhanced. For the purposes of the current estimates, it is assumed that physical losses will reduce to 25% by 2020[1] and eventually to 20% by 2030. The reduction to 20% of the average day gross water demand is in-line with what can be considered desirable within a system[2]. All utilities would like to eliminate physical water losses completely, however a more economically realistic and acceptable level is around 15% to 20%. The reduction in leakage rates will be achieved by implementing the activities outline in Table 2-2 overleaf. While we recognise the efforts being made by Harare Water to reduce the water losses in the network, we believe that significant water loss reduction will only occur after implementation of a targeted water loss reduction project.

[1] It has been assumed that Harare Water implements water loss reduction measures as a priority measure with immediate effect

[2] Mays, L.W. (2000). “Unaccounted-for Water” in Water Distribution Systems Handbook (p.p. 17.2 - 17.10). McGraw-Hill

Table 5-3: Water Loss Reduction Progression

Year	Rate	Activities promoting water loss reduction	Remark
2013	40%	• Emergency repairs • bulk meters not working • service meters not working • some properties not metered • old and dilapidated network	Present situation
2020	25%	• pipe repair and replacement programme completed • established NRW teams and training of staff • provision of tools and equipment to monitor, control and manage the network • universal metering implemented • bulk metering applied • distribution zones operational • water demand and pressure management introduced	Implementation of investment measures
2030	20%	• active leakage control, monitoring detection and repair is part of the operational ethos • functioning NRW teams • availability of latest tools and equipment to monitor, control and manage the network • on-going pipe replacement and repair programme • improved operation and maintenance activities	Continuous improvement of operation practices

5.1.6 Peak Factors

Water production and transmission facilities are usually designed to meet service requirements during the peak demand month. The peak month in Zimbabwe is October when demand is generally around 25% above average. Hence a peak season factor (Psf) of 1.25 was used.

Water distribution pipes are designed with peak hour hydraulic loading. The peak hour factor depends on the nature of commercial activities and the demographic characteristics of a town. Generally, the higher the population, the smoother the diurnal curve (the less the fluctuations in water consumption). Table 2.3 below shows peak hour factors for different population ranges. Given the population and demographic characteristics of the urban centres that make up Greater Harare, a peak hour factor of 1.5 is considered applicable for distribution network designs. However, as part of an investment master plan, network hydraulics of the supply networks in the various networks of Harare are not undertaken. This activity will be undertaken for supply areas selected for rehabilitation and/or expansion during the study and final design stage.

Table 5-4: Typical Peak Hour Factors

Population	Peak Hour Factor
<5,000	2.5
5,000 > 50,000	2
> 50,000	1.5

5.1.7 Wastewater Return Rates

The wastewater flows have been estimated as a function of the water demand. Studies have shown that the proportion of water that is returned as wastewater is highly dependent on the water consumption patterns. Properties such as those in low density areas with well-manicured and watered gardens will generate less wastewater (as a percentage of water consumed) than high density properties with no lawns. The table below shows the assumed water return for each service user category. Generally low density areas are on septic tanks except that where soil conditions are not suitable for soakaways, sewers are provided.

Table 5-5: Wastewater generation rates

Category	Wastewater generation rate
Low Density Areas (where connected to sewer)	50%
Medium Density Areas	70%
High Density Areas	85%
Institutional	80%
Commercial	80%
Industrial	70%

5.1.8 Service Coverage

Service coverage is a very important input parameter in the water demand and wastewater flow calculations. Field surveys and extensive discussions with the councils were used to determine the current water and sewerage service coverage for all the urban centres that make up greater Harare. Thematic maps showing the areas serviced were created and used to estimate the service coverage percentages used in the calculation of water demand and wastewater flows.

Water Service Coverage

The water service coverage considered factors such as the actual reticulation network coverage and the prevalence of boreholes.

The population living in areas where there is a water reticulation network were considered ‘covered’ even though the supply in those areas is erratic so that they could be included in the water demand calculations. This approach essentially determines the amount of water needed to service the population living in areas that already have a reticulation network. The mainly informal settlements that are not reticulated, such as large parts of Harare South and some parts of Epworth, are considered ‘not covered’ and are excluded from the current water demand. Given that the guiding principles outlined in the National Water Policy stipulate access to water services for all, the coverage proportion for these areas

have been increased over the planning period while keeping in mind that the service levels in the 'recovery period' will be basic (water kiosks and service connections with flow limiters).

In recent years, there has been a proliferation of private boreholes in the low density areas, mainly as a reaction to the unreliable municipal water supply. The properties with private boreholes are essentially not using municipal water even though they have a service connection. There are significant numbers of private boreholes in the northern low density suburbs of Greendale, Waterfalls, Mt Pleasant, Highlands, Hatfield Belvedere, Marlborough, Borrowdale, Alexander Park, Eastlea, Avondale, Vainona and Northwood. The table below shows the approximate numbers of registered private boreholes as reported in the Upper Manyame Sub-Catchment Council's Annual Report 2013.

Table 5-6: Borehole Numbers in Low Density Suburbs

Suburb	Ward No.	Appr. Number of borehole
Greendale	8	1,400 +
Waterfalls	23	1,200 +
Mt Pleasant	17	1,000 +
Highlands	8	1,000 +
Hatfield	22	8000 +
Belvedere	5	600 +
Marlborough	41	500 +
Borrowdale	17	400 +
Alexandra Park	7	400 +
Eastlea	2	400 +
Avondale	7	300 +
Vainona	17	400 +
Northwood	17	100+

These properties were considered 'not covered' in the service coverage proportion. The actual coverage proportions used for the Wards in which these suburbs fall, are shown in the detailed water demand calculation tables.

Sewerage Service Coverage

The sewerage coverage proportion considers the population living in areas that have municipal sewer reticulation systems. It excludes areas that are on septic tanks – majority of the northern low density suburbs. It also excludes the informal high density areas on pit latrines. Using sewer network data collected from the councils, we have defined the so called 'urban boundary' - the current extent of the municipal sewer network and areas where it would be economically and technically feasible to extend municipal sewerage services. The map in Figure 5-1 shows the current 'urban boundary' and the proposed extension of this boundary over the planning horizon.

The northern low density suburbs such as Vinona, Pomona, Borrowdale, Quinnington, Greystone Park, Helensvale and Glenwood are mainly on septic tanks and are not covered

by the municipal sewer reticulation system. The area around the CBD and the western high density suburbs are all covered by the municipal sewer reticulation system. There are two isolated sewer reticulation catchments in the high density areas of Tafara/Mabvuku and Hatcliffe.

Harare is developing rapidly southwards into Harare South ahead of water and waterborne sanitation services. Most parts of Harare south are not sewered and people are relying on pit latrines. The 'urban boundary' will gradually be extended into these areas over time as long as the property development is controlled and urban planning protocols are followed.

A sewer reticulation network was laid in parts of Epworth, but it was never commissioned. This network cannot be resuscitated because the pipes and manholes have been vandalised over time. Hence the whole of Epworth is considered to be un-sewered. Most people are relying on pit latrines. With the construction of the proposed wastewater treatment works in Harare South, the southern parts of Epworth can be provided with a sewer reticulation network.

Chitungwiza is mostly sewered except for informal settlements sprouting on the southern and eastern outskirts. The new high density housing developments in the Nyatsime area will be sewered in phases as shown on the map.

Most of Ruwa is on sewers despite the fact that the sewage is currently not being treated. The whole Ruwa catchment area will be connected to an outfall sewer that will lead to the new wastewater treatment works in Harare South. This will allow most of development areas in Ruwa to be sewered in phases as indicated on the urban boundary map. In the medium term, the urban sewer boundary will be extended westwards in to cover the new development areas in Ward 9 and southwards within Wards 7 and 5.

In Norton, the high density suburbs of Ngoni, Katanga and Damo Falls are all sewered. The majority of the low density suburbs such as Twinlakes, Galloway, Nharira and Knowe are on septic tanks. Sewers were also laid in Maridale and Johannesburg but they were never commissioned. These sewers have since been vandalised and cannot be reused. The people in these suburbs are relying on pit latrines. They make up part of the population without water borne sanitation services. The sewer network in these areas will be rebuilt in the medium term, extending the current sewer boundary westwards. In the long term, the urban sewer boundary will be extended to the new high density development area west of Knowe (Chegutu 14).

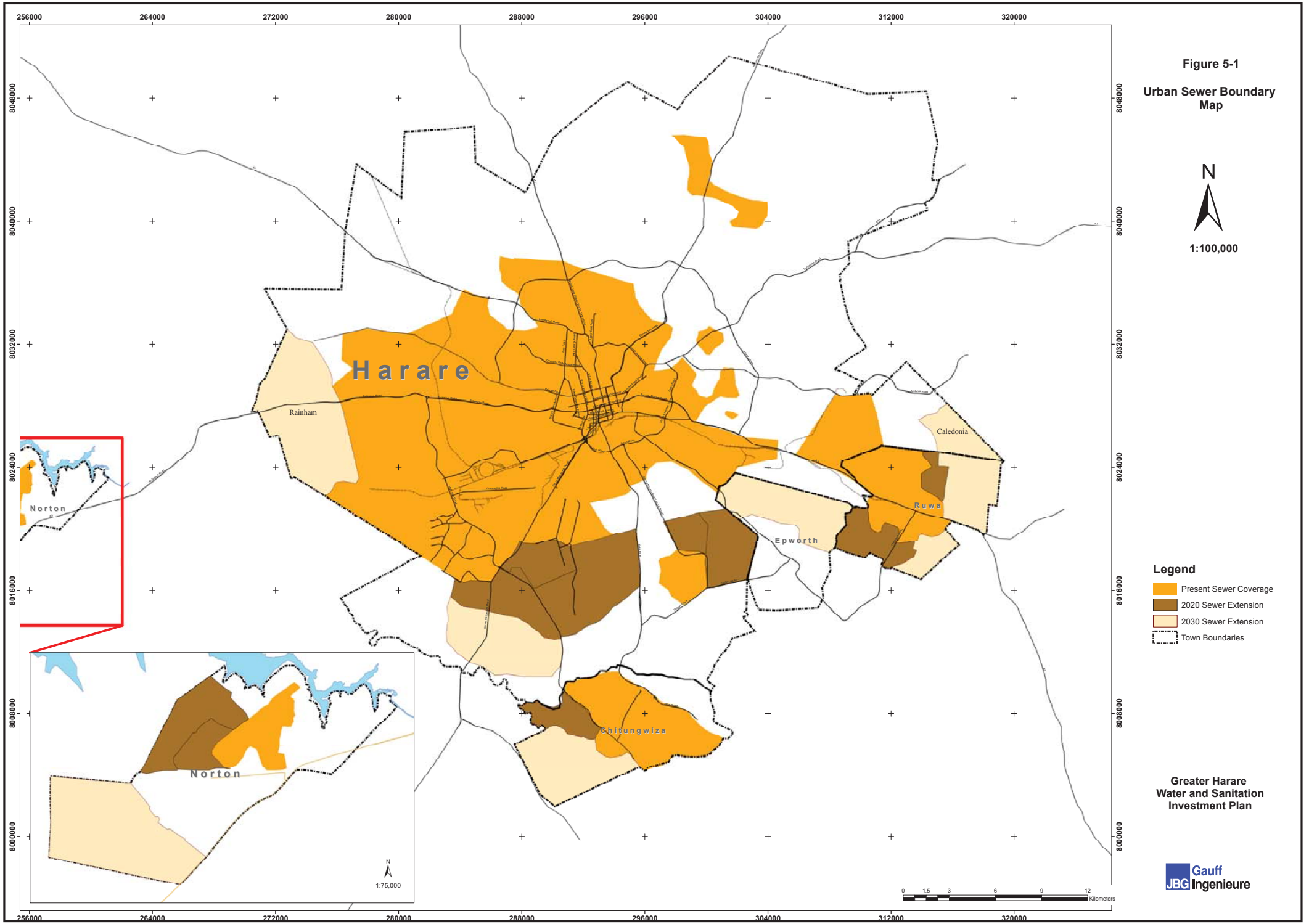

Figure 5-1

Urban Sewer Boundary Map

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1:100,000

Legend

- Present Sewer Coverage
- 2020 Sewer Extension
- 2030 Sewer Extension
- Town Boundaries

Greater Harare Water and Sanitation Investment Plan

JBG Gauff Ingenieure

5.2 Population in Service Level Categories

Water supply and sewerage schemes are sized and designed to meet the service requirements of a population. Hence the target population is a very important parameter in the calculation of water demand and wastewater flows. The base population and population projection methodology have been elaborated in Chapter 3. Domestic water consumption is largely driven by the level of affluence of the population and the service level type used to receive the services. Affluent people with house connections tend to use more water than poor people accessing services through yard taps or communal water points. It is important therefore to determine the population in each service level category before the domestic water consumption can be calculated.

As elaborate in Chapter 3, the population in each service level category was determined through a combination of consultations with the councils and spatial analysis of population and water distribution infrastructure. The tables below population distribution across service level categories in each project town. The capita water consumption for each of these service categories is

Table 5-7: Population in Service Category - Greater Harare

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	525,175	22%	573,677	21%	768,732	19%
MD	114,044	5%	136,959	5%	175,936	4%
HD (a)	1,438,903	61%	1,636,010	59%	2,470,054	60%
HD (b)	278,642	12%	413,784	15%	722,632	17%
Total	**2,356,764**	**100%**	**2,760,431**	**100%**	**4,137,354**	**100%**

Table 5-8: Population in Service Category - Harare

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	482,961	28%	512,319	26%	685,797	22%
MD	50,409	3%	56,924	3%	76,200	3%
HD	1,014,130	59%	1,126,709	57%	1,688,585	55%
Inf.	161,038	9%	266,956	14%	597,405	20%
Total	**1,708,538**	**100%**	**1,962,908**	**100%**	**3,047,987**	**100%**

Table 5-9: Population in Service Category - Chitungwiza

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	4,489	1%	4,858	1%	6,523	1%
MD	5,600	2%	6,061	2%	8,142	2%

HD (a)	330,017	92%	356,296	92%	485,125	94%
HD (b)	16,734	5%	18,984	5%	18,984	4%
Total	**356,840**	**100%**	**386,199**	**100%**	**518,774**	**100%**

Table 5-10: Population in Service Category - Epworth

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	14,880	9%	20,480	10%	20,480	8%
MD	42,100	25%	42,100	21%	42,100	17%
HD (a)	9,612	6%	13,612	7%	79,896	32%
HD (b)	100,870	60%	127,844	63%	106,243	43%
Total	**167,462**	**100%**	**204,036**	**100%**	**248,719**	**100%**

Table 5-11: Population in Service Category - Norton

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	16,112	24%	22,552	24%	35,019	24%
MD	-	0%	-	0%	-	0%
HD (a)	51,479	76%	72,054	76%	111,884	76%
HD (b)	-	0%	-	0%	-	0%
Total	67,591	100%	94,606	100%	146,903	100%

Table 5-12: Population in Service Category - Ruwa

Category	Present		2020		2030	
	Population	Prop (%)	Population	Prop (%)	Population	Prop (%)
LD	6,733	12%	12,396	11%	20,180	12%
MD	15,935	28%	27,065	24%	31,195	18%
HD	33,665	60%	73,221	65%	123,595	71%
Total	**56,333**	**100%**	**112,682**	**100%**	**174,970**	**100%**

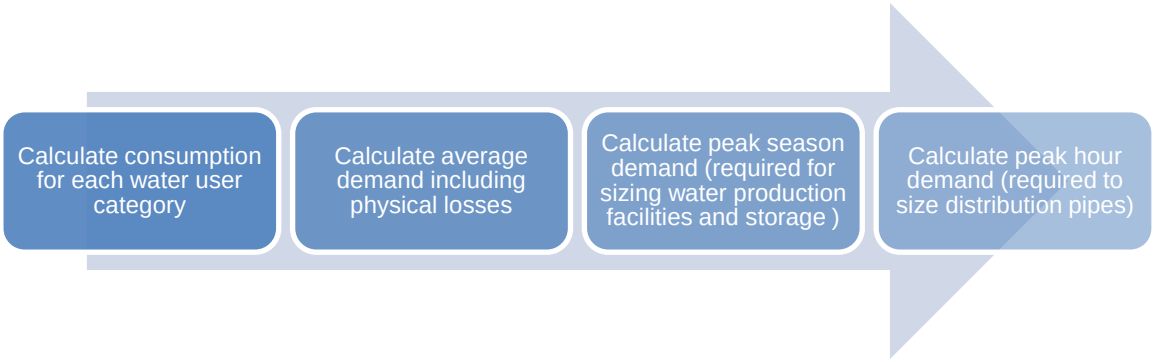
5.3 Water Demand

The level of investment required to provide water supply and sewerage services to a population is driven by the water demand and the resultant wastewater flows. Water demand comprises domestic, institutional, commercial and industrial water use (consumption), and the inevitable water losses resulting from the physical leakages and inefficiencies in the commercial operations of the service provider (NRW). The water

consumption varies over time, so the water supply and sanitation infrastructure is sized and designed with capacity to provide services during the highest possible demand (peak period).

5.3.1 Calculation Methodology

The current and projected water demand is calculated using the process illustrated in the figure below and the formulae stated hereunder.



$$Domestic\ Consuption\ (DOMc) = Population\ \times per\ capital\ consumption$$

$$Institional\ Consumption\ (INSTc) = Domestic\ Consuption\ \times 15\%$$

$$Industrial\ (INDc)\ or\ Commercial\ consumption(COMc) = Unit\ area\ consumtion\ \times Area$$

$$Total\ Consumption\ (TC) = DOMc + INSTc + INDc + COMc$$

$$Average\ Demand\ (DEMave.) = TC/(1 - Physical\ Loss\ Rate)$$

$$Peak\ Season\ Demand\ (DEMps) = DEMave.x\ Peak\ Season\ Factor\ (Fps)$$

5.3.2 Greater Harare

The water demand summary tables for Greater Harare are presented in the tables below. Table 5-13 shows the demand summary for all the towns put together, while Table 5-14 shows the peak season demand for each town. The total peak season demand for Greater Harare is currently around 712,000 m^3/d. It reduces to 662,000 m^3/d in the medium term and then grows to just over 820,000 m^3/d in the long term. The reduction in the medium term is due to the assumed reduction in the physical losses over the next 7 years and the gradual reduction in per capita water consumption over time. As elaborated in the Inception Report, for these assumptions to take root, there must be significant investment in network rehabilitation, including awareness campaigns aimed at changing water usage habits.

Table 5-13: Water Demand Summary – Greater Harare

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	257,399	294,352	394,687
Institutional Consumption	m^3/d	38,610	44,153	59,203
Commercial Consumption	m^3/d	11,308	13,996	16,837
Industrial Consumption	m^3/d	33,656	44,806	54,815
Total	m^3/d	340,973	397,306	525,543
Water Loss Rate	%	40%	25%	20%
Water Loss	m^3/d	229,238	132,435	131,386
Average demand	m^3/d	570,212	529,742	656,929
Peak Season factor	/	1.25	1.25	1.25
Peak season demand	**m^3/d**	**712,765**	**662,177**	**821,161**

Table 5-14: Water Demand in Each Town

City/Town	Average Demand (m^3/day)			Peak Season Demand (m^3/day)		
	2013	2020	2030	2013	2020	2030
Harare	465,166	396,681	494,013	581,457	495,852	617,516
Chitungwiza	54,469	54,499	68,471	68,086	68,123	85,589
Epworth	14,371	28,829	30,436	17,963	36,037	38,045
Norton	20,031	22,666	29,008	25,039	28,333	36,260
Ruwa	16,175	27,066	35,000	20,219	33,832	43,750
Greater Harare Total	**570,212**	**529,742**	**656,929**	**712,765**	**662,177**	**821,161**

The Greater Harare area is currently utilizing water from the Upper Manyamen Catchment, except for Ruwa which uses sources in the Mazoe Catchment. The 4% risk yield of the four dams (Seke, Harava, Chivero, Manyame) that provide storage for the water supply in Greater Harare is around 478,000 m^3/d (allowing for upstream commitments only) . clearly, the demand already exceeds the available water at 4% risk. The available water could increase if the risk factor was to be relaxed to 10% as is being advocated in some quarters.

However, the evident climate change effects on the environment, particularly rainfall patterns, may weaken the argument for relaxing the risk factor.

In terms of water production facilities (raw water abstraction and treatment), the installed capacity currently stands at a total of just over 710,000 m3/d, even though the actual production is around 540,000 m^3/d. The plant rehabilitation efforts currently going on under various financing sources are expected to restore the water works to design capacity. Given the demand figures presented in the tables above, it is clear that investment in new production facilities will not be needed in the medium term. Investments must rather be directed towards arresting the physical losses in the distribution network. It will only become necessary to invest in new sources in the long term. Given the low yield and general environmental degradation of the Upper Manyame Catchment, the additional sources and production facilities must be located in other catchments. The Kunzvi dam and water treatment plant in the Mazoe catchment will have to be built within the period 2020 to 2030.

The figure below shows the balance between water production and demand over the planning horizon. In the medium term, the production deficit will be addressed by investments in the distribution network to reduce losses and the rehabilitation of water works to restore production capacity. Kunzvi Dam will only become necessary after 2020.

Given the low yield and general environmental degradation of the Upper Manyame Catchment, additional production facilities located in other catchments are needed soon. The Kunzvi dam and water treatment plant in the Mazoe catchment will have to be built as soon as possible.

We propose that Kunzvi should be constructed first instead of Muda Dam because it can provide all the required capacity at one site. If Muda were to be developed first, Kunzvi would still have to be developed with a short period because Muda Dam WTW (with a capacity of 50,000 m^3/day would not provide enough water to satisfy the projected demand within the planning horizon. However, the Muda Dam and the Shabanove schemes should also be considered in the long term beyond the planning horizon of this study

Kunzvi will be developed in two phases – phase I with a capacity of 100,000 m^3/day should come online by 2022. A second module of capacity 50,000 m^3/day should come start production by 2029. The development of Kunzvi was chosen over Muda Dam

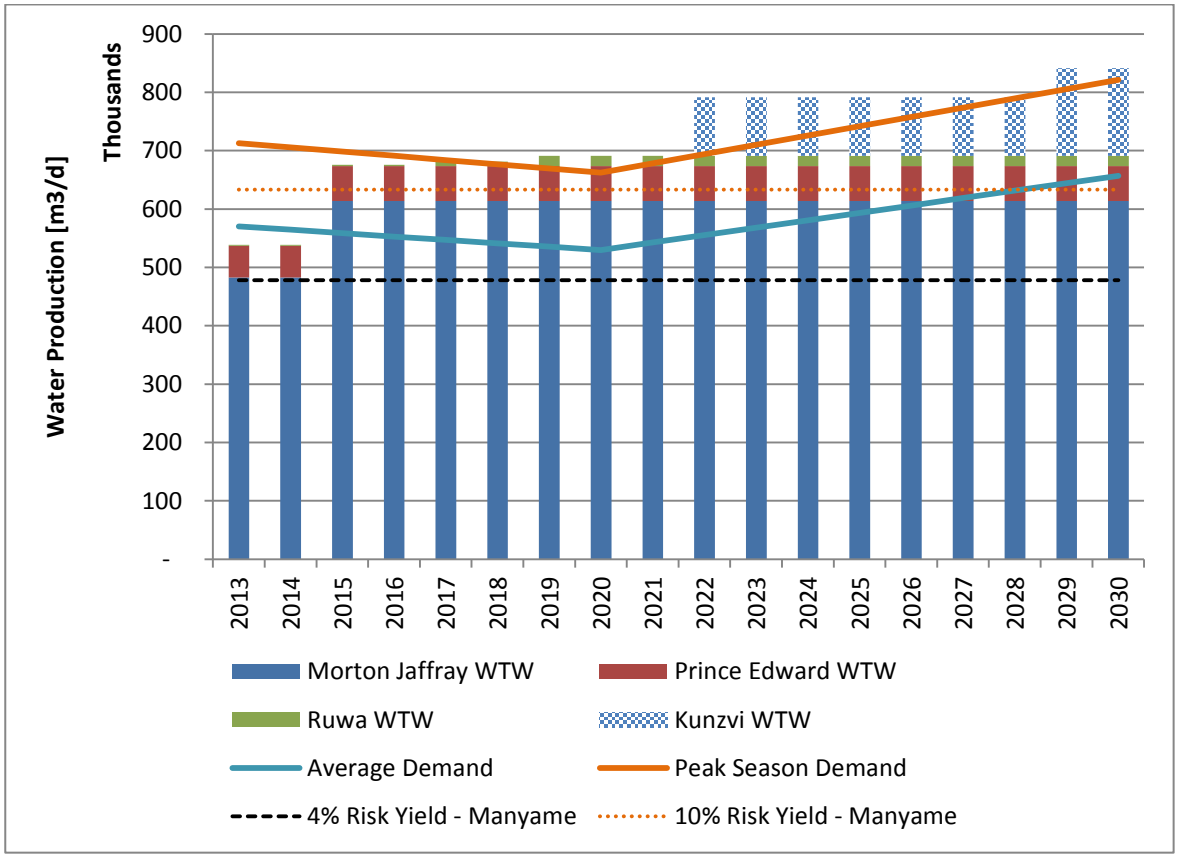


Figure 5-2: Water Production Vs Demand

5.3.3 Harare

The water demand for Harare is summarised in the table below. The important thing to note is that Harare would be able to meet its water requirements even in the long term if the satellite towns had their own sources. However, it is not economically and, in some cases, technically feasible to develop own sources in each the satellite towns. As explained above, the collective water deficit in the long term will have to be addressed collectively as greater Harare in the long term.

Table 5-15: Water Demand Summary – Harare

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	201,930	219,028	296,982
Institutional Consumption	m^3/d	30,290	32,854	44,547
Commercial Consumption	m^3/d	9,130	11,087	13,043
Industrial Consumption	m^3/d	28,446	34,542	40,638
Total	m^3/d	269,796	297,511	395,210
Water Loss Rate	%	42%	25%	20%
Water Loss	m^3/d	195,370	99,170	98,803
Average demand	m^3/d	465,166	396,681	494,013
Peak Season factor	/	1.25	1.25	1.25
Peak season demand	**m^3/d**	**581,457**	**495,852**	**617,516**

In terms of storage requirements in the distribution network, the design criteria are that there should be at least 1 day storage (of the peak season daily demand). The total reservoir storage in Harare is currently around 830,000 m^3. It may appear as if there is enough storage capacity for the long term horizon. But, given the restructuring of the network necessitated by the addition of the Kunzvi scheme, some of the main reservoir sites such as Letombo and Alexandra Park will have redundant capacity that cannot be utilized in the new structure. Hence there will be need to upgrade some of the reservoir sites in order to provide the required 1 day storage for the zones commanded. The table below shows the zones where there is need to upgrade storage capacity. Reservoirs that will supply the new development areas in Harare South and the northern low density outskirts will have to be upgraded. The deficits at Hatcliff and Kambanji reservoirs will be compensated by the huge surpluses at Alexandra Park and Greendale respectively.

Table 5-16: Zone Demands and Reservoir Capacities

Zone	2030 Demand	Available storage	Storage Deficit	Remark
	[m^3/d]	[m^3]	[m^3]	
Hatcliff	26,401	11,400	15,001	Deficit
Kambanji	7,348	5,680	1,668	Deficit
Philadelphia	3,782	7,580	(3,798)	Surplus
Adylinn	21,776	1,140	20,636	Deficit
Highlands	8,372	61,710	(53,338)	Surplus
Arundel	3,460	7,580	(4,120)	Surplus
Epsilon	10,939	4,090	6,849	Deficit
Bluff Hill	16,401	5,680	10,721	Deficit
Emerald Hill	4,098	25,750	(21,652)	Surplus
Greendale	12,257	70,770	(58,513)	Surplus
Donnybrook	43,738	47,460	(3,722)	Surplus
Alexandra Park	23,968	111,950	(87,982)	Surplus
Ridge Road	3,234	3,580	(346)	Surplus
Meyrick Park	4,098	2,280	1,818	Deficit
Dzivaresekwa	37,002	16,480	20,522	Deficit
Letombo	72,620	236,400	(163,780)	Surplus
Kopje	24,982	7,960	17,022	Deficit
Mutiny	4,106	11,400	(7,294)	Surplus
Viking	13,460	27,260	(13,800)	Surplus
Lochinvar	53,573	72,160	(18,587)	Surplus
Ventersburg	50,467	22,800	27,667	Deficit
Hatfield	49,663	13,610	36,053	Deficit
Marimba Park	24,898	34,700	(9,802)	Surplus
Waterfalls	56,128	5,680	50,448	Deficit
Kuwadzana	56,192	11,940	44,252	Deficit
Shamva RD	7,452	-	7,452	Deficit
Mt Pleasant Heights	15,145	??	#VALUE!	#VALUE!

5.3.4 Chitungwiza

The table below shows the water demand summary for Chitungwiza. Chingwiza relies on bulk water from Harare Water. It is estimated that Chitungwiza currently receives around 16,000 m^3/d from Harare Water. This is clearly nowhere near meeting the current water requirements for Chitungwiza, let alone long term water requirements. The JICA study

concluded that there is no ground water potential in the area around Chitungwiza and that developing Muda Dam as an own source for Chitungwiza is more expensive than buying bulk water from Harare water. The deficit therefore will have to be addressed by rehabilitating the bulk transmission pipeline from Harare and strengthening the water purchase agreement with Harare Water or indeed merging with Harare into one water utility company – an economic and political decision that will have to be taken by the government. Our recommendation, however, is that it would be in the best interest of Chitungwiza to be part of single Greater Harare utility.

Table 5-17: Water Demand Summary – Chitungwiza

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	29,645	31,538	42,095
Institutional Consumption	m^3/d	4,447	4,731	6,314
Commercial Consumption	m^3/d	1,681	2,018	2,581
Industrial Consumption	m^3/d	1,811	2,587	3,787
Total	m^3/d	37,583	40,874	54,777
Water Loss Rate	%	31%	25%	20%
Water Loss	m^3/d	16,885	13,625	13,694
Average day demand	m^3/d	54,469	54,499	68,471
Peak Season factor	/	1.25	1.25	1.25
Peak season day demand	**m^3/d**	**68,086**	**68,123**	**85,589**

The Chitungwiza water scheme currently has one reservoir site in the Seke area with a total storage volume of 46,000 m^3. This represents less than one day storage volume, which is below the stipulated criteria. Additional reservoirs are recommended, both at the location of the existing reservoirs and in the Nyatsime area where most of the new housing developments are planned.

5.3.5 Epworth

The water demand summary for Epworth is shown in the table below. Epworth relies on bulk water from Harare even though supply is dismal. It is technically and economically not feasible to construct an own water source for Epworth. The yield for ground water sources is very poor and there is no surface water source within the vicinity of Epworth. Hence it should continue relying on supply from Harare.

Table 5-18: Water Demand Summary – Epworth

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	8,706	18,690	21,052
Institutional Consumption	m^3/d	1,306	2,804	3,158
Commercial Consumption	m^3/d	47	128	139
Industrial Consumption	m^3/d	-	-	-
Total	m^3/d	10,059	21,622	24,349
Water Loss Rate	%	35%	25%	20%
Water Loss	m^3/d	5,417	7,207	6,087
Average day demand	m^3/d	15,476	28,829	30,436

Peak Season factor	/	1.25	1.25	1.25
Peak season day demand	**m^3/d**	**19,345**	**36,037**	**38,045**

There is currently no storage reservoir in Epworth and this has emerged as one of the major issues around demand management raised by the local board. Given that there is no high ground within Epworth where a storage reservoir can command the with reasonable pressure, Epworth will continue using Ventersburg Resrvoirs and measures have been proposed to improve supply from the reservoirs to Epworth.

5.3.6 Norton

The water demand summary for Norton is shown in the table below. Norton relies on bulk water from Harare Water. It currently estimated that Norton receives around 5,000 m^3/d from Harare Water. This is clearly not enough to meet the town's current water service requirements. There is a general suspicion that the main bottleneck that limits the amount of water to Norton is the hydraulic capacity of the ND 300 transmission main. Given the proximity of the Norton to Morton Jaffray (MJ) WTW, it is more economical for the town to continue getting bulk water than building an own source. The hydraulic capacity of the transmission main from MJ WTW will be increased in phases to meet the water requirements for the town.

Table 5-19: Water Demand Summary – Norton

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	9,209	11,402	15,955
Institutional Consumption	m^3/d	1,381	1,710	2,393
Commercial Consumption	m^3/d	110	175	219
Industrial Consumption	m^3/d	2,320	3,712	4,640
Total	m^3/d	13,020	17,000	23,207
Water Loss Rate	%	35%	25%	20%
Water Loss	m^3/d	7,011	5,667	5,802
Average day demand	m^3/d	20,031	22,666	29,008
Peak Season factor	/	1.25	1.25	1.25
Peak season day demand	**m^3/d**	**25,039**	**28,333**	**36,260**

In terms of storage, Norton relies on 2 x 5,000 m3 capacity reservoirs situated on the south-eastern outskirts of the town. The available storage volume is way below the one day storage requirement. Hence additional storage is required. The additional storage will be strategically located within the service area.

5.3.7 Ruwa

The water demand summary for Ruwa is presented in the table below. Ruwa is the only satellite town with its own source, in addition to bulk water from Harare Water (though unreliable according to the council). There is a water treatment plan in the Tara township area with a nominal capacity of 7,500 m^3/day abstracting water from the Green Sykes Dam. The plant is currently not operating at full capacity because there is not enough raw water in the Green Sykes Dam.

A new raw water pipeline from Nora Dam to Green Sykes Dam has just been commissioned. This will increase available raw water to Ruwa. With this pipeline fully operational the water treatment plant should be able to operate at full capacity throughout the year. Even at full capacity, the amount of water produced will not be enough to satisfy current and future demand. Since the new raw water pipeline has a hydraulic capacity of 21,000 m^3/d, there is room to expand the treatment facilities. The council has proposed to increase the capacity of the existing plant by 10,000 m^3/d to bring the total nominal capacity to 17,500 m^3/d. This proposal has been adopted in this investment plan. Even with this increase in water production capacity, it will still be short of the estimated medium and long term water demand. Hence Ruwa will still continue relying on Harare Water to close the deficit. The construction of the Kunzvi water supply scheme will make more water available for bulk supply to Ruwa

Table 5-20: Water Demand Summary – Ruwa

Parameter	Unit	Present	2020	2030
Domestic Consumption	m^3/d	7,909	13,693	18,603
Institutional Consumption	m^3/d	1,186	2,054	2,790
Commercial Consumption	m^3/d	340	587	856
Industrial Consumption	m^3/d	1,079	3,965	5,751
Total	m^3/d	10,514	20,299	28,000
Water Loss Rate	%	35%	25%	20%
Water Loss	m^3/d	5,661	6,766	7,000
Average day demand	m^3/d	16,175	27,066	35,000
Peak Season factor	/	1.25	1.25	1.25
Peak season day demand	**m^3/d**	**20,219**	**33,832**	**43,750**

In terms of reservoirs, the total existing reservoir volume is 3,700 m3 – way short of the 1 day storage requirement. There is need to construct more reservoirs in the network over the planning horizon until the total volume is around 44,000 m^3.

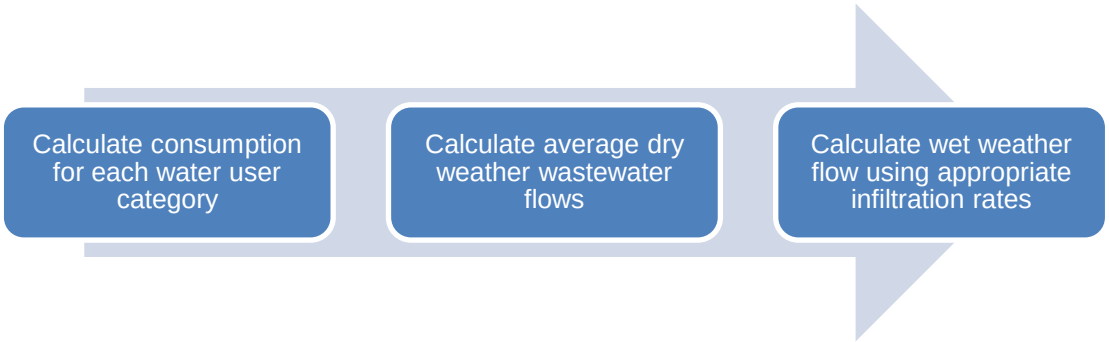
5.4 Wastewater flow Estimations

Wastewater flow is closely correlated with water use. The water supplied to a property is used for consumption, watering the garden and cleaning. The water used for cleaning and other hygienic uses ends up as wastewater. Zimbabwe's low density properties are generally huge with lush gardens that require a lot of water to maintain. Studies in Zimbabwe have shown that 50-85 % of the water supplied ends up as wastewater depending on the housing category.[3]

The wastewater calculation procedure and the results are elaborated in the following sub-sections.

5.4.1 Calculation Methodology

The current and projected wastewater flow is calculated using the process illustrated in the figure below and the formulae stated hereunder.



$$Average\ Dry\ Weather\ Flow\ (DWF) = water\ consumption\ for\ each\ category\ \times appropriate\ return\ rate\ for\ each\ categor$$

[3] Ministry of Local Government and Housing- Design Approach to Water and Sewerage Problems Relative to Urban (Predominantly High Density) and Rural Communities in Zimbabwe

$$Wet\ Weather\ Flow\ (WWF) = Total\ Average\ Dry\ Weather\ Flow\ \times Infiltration\ rate$$

5.4.2 Greater Harare

A summary of the wastewater flow estimated for Greater Harare is presented in the table below.

Table 5-21: Summary of Wastewater Flow Estimates

City/Town	Wastewater flow (Dry Weather) [m3/d]		
	Present	2020	2030
*Harare	182,354	191,270	242,468
Chitungwiza	37,872	40,985	55,328
Epworth	-	7,299	7,934
Norton	3,805	8,743	13,266
Ruwa	9,221	18,416	25,801
Total	**233,251**	**266,712**	**344,798**

The present wet weather wastewater flow for Harare is estimated to be around 182,000 m^3/d, increasing to 191,000 m^3/d in 2020 and 243,000 m^3/d in 2030. The nominal hydraulic capacity of the treatment facilities in Harare is 219,000 m^3/d. However, the treatment facilities are in a dilapidated state. Harare Water estimates the current treatment capacity to be a paltry 26,000 m^3/d. The Zim-fund Project and the loan from Exim Bank of China are expected to extensively rehabilitate the wastewater treatment facilities and restore the nominal treatment capacities in the short and medium term. In the long term, there will be a capacity deficit. Most of the additional sewage is expected in the Harare South development area.

Wastewater flow in Chitungwiza is estimated to be round 38,000 m^3/d, increasing to 55,000 m^3/d in the long term. Chitungwiza has a 20,000 m^3/d BNR plant which has not been operational since 2005 and a 35,000 m^3/d modified conventional plan which is partially operational. Hence, most of the wastewater from Chitungwiza is discharged to the water courses untreated. Rehabilitation works under the Zim-Fund project are expected to restore the modified conventional treatment plant to nominal capacity. The BNR plant is not being rehabilitated under the Zim-fund project, but has been included in this investment plan. Hence, the existing plants would suffice for the long term when rehabilitated. However, the need to avoid pumping and the topographical configuration of the new development areas means that the sewage from St Mary's and the Nyatsime area will be transmitted to the new Harare South wastewater treatment facility.

Wastewater from Ruwa is not being treated at present because the pond system the town was using has been abandoned due to land wrangles with Epworth Local Board. The Epworth Local Board has taken back the land on which the ponds are located because it falls within their boundaries. Hence there is urgent need to find a solution for treating the estimated wastewater out of Ruwa.

Epworth has a sewer reticulation network, which was never commissioned because the treatment plant to which it was designed to discharge was never built[4]. Hence, residents

[4] The Safege sewerage master plan of 2003 had proposed a wastewater treatment plant just south of Epworth that would cater for the Donny Brook area and Epworth. This facility was never built due to lack of finances

are currently using pit latrines and septic tanks. The sewer network can still be utilised once there is a treatment plant that can receive the sewage from Epworth.

A combined solution for the treatment sewage from Ruwa, Donny Brook, Epworth, Harare South and parts of Chitungwiza has been proposed. The sewage treatment facility will be strategically located at the lowest point so that the sewage from all these areas will be collected and conveyed by gravity. The treatment facility will have enough capacity to handle the estimated sewage flows for the target areas. A detailed description of this proposal is presented in the Appendix.

The wastewater flow for Norton is expected to increase from the current 3,800 m^3/d to 13,200 m^3/d in the long term horizon. Norton currently operates one old wastewater treatment plant a nominal capacity of 3,200 m^3/d. There is a new plant under construction, which, when complete, will be able to treat 4,400 m^3/d, bringing the total treatment capacity to 8,200 m^3/d. This will barely meet the requirement for the medium term. Additional treatment facilities will be required in the long-term, especially in the new development west of Knowe.

CHAPTER 06: STRATEGIC PLANNING PRINCIPLES FOR WATER AND SANITATION

6 STRATEGIC PLANNING PRINCIPLES FOR WATER AND SANITATION

6.1 Introduction

The objective of the medium- and long term investment plan for Greater Harare is to provide cost estimates, along with implementation schedules for specific water supply and sewerage infrastructure components. Such investments must be tailored towards agreed national water sector objectives and policy directions. Such are enshrined in the National Water Policy published by the Ministry of Water Resources Development and Management in March 2013. The policy defines the vision for urban water supply and sanitation services as follows:

'All urban water users should enjoy adequate, continuous, readily accessible, safe, hygienic, sustainable and affordable domestic water and sanitation services provided by accountable, efficient, coordinated, funded and capacitated institutions'

The policy document is clear in its strategic objectives. The key urban water and sanitation policy guidelines are summarised as follows. These guidelines provide the foundation for the planning strategies applied in this investment master plan.

Table 6-1: Key policy principles of the National Water Policy

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
6.2.2.	Integrated water resources management (IWRM)	IWRM is intended to bring about improved equity of access to water, greater efficiency of water use, environmental protection and greater sustainability for the benefit of current and future generations.	Consideration of **IWRM principles** in the planning of investment measures.
6.2.6	Water for primary needs	Water for primary needs is a RIGHT for all Zimbabweans. Access to WSS services in sufficient quantity and adequate quality to sustain life is a human right which is accompanied with the responsibility of all to meet their obligations to other users and water service providers.	Objective to provide **sufficient quantity and adequate quality** to all Zimbabweans.
		In urban settings, because water treatment, transmission, storage and distribution networks is expensive, primary water needs are based on lifeline tariffs and only in cases where people cannot afford to pay, can free life saving water per household of 10m3 per month be supplied.	Principle application of lifeline tariffs. Exceptions are people who cannot **afford to pay**.
		Water for primary needs, termed 'Primary Water' includes water for direct personal consumption, personal household hygiene, and food preparation and for household productive purposes such as gardening and household stock watering, not for commercial purposes.	Public water supply is for direct **personal consumption**.
6.2.8	Water demand management	Water is a finite, limited and scarce resource that must be conserved and used efficiently. Various mechanisms are needed to manage demand	Water must be used **conservatively and efficiently.** Water demand management methods and

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
		including water pricing mechanisms, volumetric abstraction monitoring, volumetric allocation and licensing, and through regulation to require service providers to monitor and reduce unaccounted for water	principles are required and **NRW** shall be reduced.
6.2.10	Water institutions and decentralisation	The private sector and civil society have an important role to play in the water sector. Government ministries or departments or local authorities should restrict themselves to and focus on policy making, establishing regulatory regimes that provide incentives for achieving goals and sanction for serious failures and that they leave operations to parastatals and private sector based on sufficient autonomy to control outcomes	**Private sector** can play a role in service provision. Operations can be undertaken by **parastatals and private sector**.
6.2.11	Water in growth and development	Planning will take into account the long-term needs of the economy, national strategic interests, regional integration and social/environmental impacts. Economic feasibility is vital: This means that the level of development of the infrastructure must be defined by what the country as a whole can afford to operate and maintain. It is important however to concentrate on a recovery programme in order to restore services to acceptable levels	Investment plans must consider **economic feasibility** and infrastructure services must be **affordable.**
6.2.12	Water investments	Investments in primary water for basic needs of urban areas may be subsidized but recurrent costs will be borne by the users to ensure sustainability. Given the principle that users bear the costs of operation and maintenance, service levels will be tailored to be flexible, affordable and technically appropriate, allowing for upgrading once user affordability increases	**Recurrent costs are to be financed by the users**. Service levels are to be tailored to be **flexible, affordable and technical appropriate**.
6.2.13	Water pricing	To achieve efficiency, water prices will be based on the user pays and polluter pays principles and be socially acceptable to different interest groups in the water sector. Subsidies will be targeted to users who are not in a position to pay the full cost of the service provider or where national interests would be compromised. Water pricing will reflect the full costs of provision of water for all uses (capital and recurrent costs), except for primary water where the price will at	User pays and polluter pays principle. **Subsidies are the exception** only for users not able to pay for services.

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
		least reflect the operation and maintenance costs. The price will take into account user viability. Water pricing will be used as a demand management instrument to encourage efficient use of scarce water resources. Water pricing should be based on the quantity of water used by volume to manage demand Water billing will revert back to being clear, transparent and based on actual volumetric readings and income derived will be applied to the costs of providing water, otherwise the 'user pays' principle collapses together with the services The payment of water service bills by public consumers including government institutions is vital for viability of water service providers. Regulations will be drawn up to permit recovery of unpaid bills directly from PSIP allocations of the institutions involved	Water pricing is used as a **demand management** instrument. Billing shall be done on **volumetric readings.** Payment of water services from public consumers including government institutions is vital.
6.3.4	Capacity building	All government institutions and parastatals that deal directly with water services need to be strengthened and in many instances rebuilt with respect to human resources, equipment, information and technology. Government will provide financial resources to enhance capacity of the key institutions in the water sector in a way which will be sustainable.	**Capacity building** is key to sustainable operations. Investments in equipment, information and technology for **operation and maintenanc**e are important.
6.5.2	Service authorities and service providers	Urban local authorities are responsible for ensuring the welfare of urban residents through the provision of efficient and affordable water supply and sanitation services. However, a distinction is made between the responsibility of urban authorities to ensure that services are provided and the actual operation of services which may be more efficiently undertaken by a dedicated service provider as a function delegated by the local authority	Local authorities are responsible for efficient and affordable water supply services and are free to delegate services to a dedicated **service provider**.
6.5.3	Targets, technical norms and standards of Urban WSS	In order to ensure universal access to water supply and sanitation services for all urban residents the previous high service standards will be temporarily reduced during the recovery period. This will be followed by a full resumption of high standards once the situation is normalised. The policy is therefore to temporarily lower	**Past high service standards can be temporarily reduced**. The policy suggests to return to the high standards once situation is normal.

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
		the technical standards during the recovery phase and upgrade them to the current standards during the normal development phase.	
6.5.5	Financing	Revenue derived from water sales will be applied to the costs of providing water services in order to maintain consumer confidence and not compromise cost recovery and the 'user pays principle'. Local Authorities should undertake cost accounting and ring-fence revenue from water sales. Tariffs should be set to achieve full cost recovery. Government will provide interim subsidies to Urban Authorities through PSIP and donor financing that will be coordinated within a Water Sector Investment Framework to finance rehabilitation and expansion of infrastructure during the recovery period. Long-term financing during the normalized growth phase will be the responsibility of ULAs	Local authorities shall apply **ring fencing** to revenue collected from water and sanitation services and ensure that such revenue is used for service provision. **Tariffs should be set to achieve full cost recovery**.

The National Water Policy provides the principle development objective and necessary foundation to develop planning strategies for this investment master plan. The policy document demands for adequate and affordable services to all residents and underlines the importance of efficient and conservative management principles when producing and supplying drinking water.

Recurrent cost recovery is a key feature of the policy, which also underlines the importance of private and public users, to pay for services. Metering of water production and consumption is an important instrument for effective operation and demand management, which is also promoted by the policy document. Also, the reduction of Non-Revenue Water (NRW), is promoted by the policy document and considered to be an important aspect of demand management.

The policy also acknowledges the fact that operations can be provided by private service providers and that capacity building and investments in operation and maintenance equipment are necessary for sustainable service provision.

The policy document considers the past service standards as being high, and suggests that such high standards could be reduced until Zimbabwe has reached again a normalised situation. It is believed that this aspect of the policy may be reconsidered. Promotion of conservative standards for water production, storage, use and treatment, which consider recent environmental sound technologies and sustainable approaches can be suggested, which do not contradict high service level and improved living standards.

6.2 Planning strategies of the investment master plan

In the following sections, we summarise the principle strategies applied under this investment master plan, split into specific subjects, such as:

a) water demand management,

b) water supply service improvement,

c) extension of water supply services,

d) sanitation service improvements,

e) extension of sanitation services,

f) Accompanying measures.

6.2.1 Water demand management

Investment measures considered under water demand management are designed to promote the effective and efficient operation of the water supply infrastructure.

These project components will entail the procurement and installation of new water meters for all consumer connections (100% metering), procurement and installation of pre-paid water meters for large bulk water consumers, consumers database review and identification of illegal and unregistered connections, network re-structuring to allow for bulk metering and water balancing, rehabilitation/ replacement of existing water distribution network, rehabilitation and installation of section valves to facilitate zoning of the network into metering districts, installation of bulk meters/ data loggers and pressure reducing valves, the implementation of leakage control, monitoring and repair programme and set-up of permanent computerised monitoring programmes and a replacement programme of leaking house connections.

Table 6-2: Water demand management and its benefits

Component	Benefits
Procurement and installation of water meters at all existing consumers (public, commercial and larger private consumer may be connected to pre-paid meters)	Reduce wastage at existing consumer level, presently charged on flat rate. Increase revenues from water users with high water consumption.
Re-investment in the replacement of water meters after 5 years of operation	Reduce wastage at existing consumer level, presently charged on flat rate. Increase revenues for water users with high water consumption
Registration of all consumers (consumer database update) to identify illegal and unregistered connections	Reduce “administrative loss” component and increase in revenue.
Detailed technical assessment, mapping of infrastructure, hydraulic modelling/ calibration of primary and secondary distribution system	Improve management of distribution network (e.g. pressure zoning). Effective management of the system through better understanding of layout and structure.
Rehabilitation/ replacement of existing water distribution network	Reduce “physical loss component” of UFW. Promote the identification of illegal/ unregistered connections.
Rehabilitation and installation of section valves to facilitate zoning of the network into metering districts and installation of bulk meters/ data loggers	Monitoring and control of supply, as well as improved supply services through service management. Facilitate identification and reduction of “physical loss component” of UFW.
Installation of new pressure reducing valves	Reduction of downstream pressure will reduce excessive pressure and promote loss reduction through pressure management
Implementation of leakage control, monitoring and repair programme and set-up of permanent computerised monitoring programme	Reduction of “physical loss component” of UFW through improved principles of operation.

Promotion program to repair leaking in-house installations	Reduction of wastage inside consumer premises. Water conservation and promotion of efficient water use.

6.2.2 Water supply service improvement

The investment measures covered under the water supply service improvement component will lead to adequate services in terms of quantity and quality. We have developed specific criteria to define the water production requirements for various planning horizons and determined the adequacy of present service levels and defined progressive service level improvements for the planning horizon (see Section 6.3 for more details).

The investment measures in this component cover the rehabilitation and extension of water production facilities, reservoirs, pumping stations, the installation of telemetry system for monitoring of reservoir levels and provision of water quality monitoring equipment.

Table 6-3: Water supply service improvements and its benefits

Component	Benefits
Rehabilitation and expansion of water production facilities	Reliability of supply and service level improvements. Optimisation of operation and maintenance costs.
Rehabilitation and expansion of reservoirs	Reliability of supply through additional storage capacity and expansion of services in upcoming development areas. Optimisation of operation and maintenance costs
Rehabilitation and extension of pumping stations	Reliability of supply and optimisation of operation and maintenance costs
Rehabilitation and installation of transmission and primary mains	Reliability of supply and service level improvements though additional pipelines where necessary
Installation of telemetry system for monitoring of reservoir levels	Improved management and control of operations Optimisation of operation of pumping station pumping into storage tanks. Reduction in energy cost and reduction in maintenance costs
Provision of water quality monitoring equipment	Improved control of quality and level of services

6.2.3 Extension of water supply services

Extension of water supply services are required in areas presently not serviced and in future development areas. The investment measures under this component cover the installation of new service connections and water meters in existing areas presently not served and costs for the installation new distribution networks and service connections (with water meters) in newly developed or future developing areas. The investments will lead to improved service coverage, larger consumer base and enhanced revenue generation.

Table 6-4: Extension of water supply services and its benefits

Component	Benefits
Installation of new service connections in existing areas presently not serviced	Improved service coverage and increase in customer base (revenue enhancement)
Installation of new distribution network and service connection in newly developed urban areas	Expansion of service area in un-serviced areas leading to higher service coverage and increased customer base
Installation of water kiosks and flow limiters in informal settlements	Provision of water equitably at low cost to poor sections of society

6.2.4 Sanitation service improvements

The sanitation service improvements are required to rehabilitate or expand existing wastewater treatment facilities, sewer networks and pumping stations. The detailed scope will be defined as per present situation analysis and effluent flow projections. The investments into these sanitation improvements will lead to improved collection and treatment of sewage and promote public health and the environment. Sanitation service improvements will have an important environmental benefit in that reduction in pollution of the main water sources will result in reduction of risks to health and reduction in water treatment costs.

Table 6-5: Extension of sewage services and its benefits

Component	Benefits
Rehabilitation and expansion of sewage treatment plants	Improvement of sewerage service and improvement of effluent quality/ environmental improvements
Rehabilitation of sewage network	Improvement of sewerage service and reduction of environmental impacts of leaking sewage into the groundwater/ environment
Replacement of missing man-hole covers	Reduction of sediments in pipe network during rainy season. Reduction of blockages in network and sewage treatment plants
Rehabilitation and expansion of sewage pumping station	Improvement of sewerage service and improvement of operation and maintenance costs

6.2.5 Extension of sanitation services

Extension of sanitation services are required in areas presently not serviced and in future development areas. The investment measures under this component cover the installation of new sewer networks and service connections presently not served and costs for the installation new networks and house connections in future developing areas. The investments will lead to improved service coverage, larger consumer base and enhanced revenue generation. In areas where reticulated sewerage is not possible or practical, safe on-site sanitation infrastructure such as septic tanks and VIP latrines will be provided.

Table 6-6: Extension of water supply services and its benefits

Component	Benefits
New sewerage networks in newly developed areas, close to existing network systems	Improved service coverage and increase in customer base (revenue enhancement) Environmental benefits due to off-site sewage collection and centralised treatment
New sewerage networks in newly developed areas, close to existing network systems	Expansion of service area in un-serviced areas leading to higher service coverage and increased customer base

6.2.6 Accompanying Measures

The accompanying measures include investment measures aimed at improving capacity to carry out technical and commercial operations such as, revenue improvement program, technical and commercial operations management, management and technical information systems and professional services.

Revenue improvement program

The revenue improvement program covers the scope of a complete customer survey and data base clean-up of the existing billing database. The component also considers the upgrading or procurement of a modern computerised billing system, which allows for consumer meter management, NRW applications, asset management and other utility related operational activities. The benefits of a modern and improved billing and infrastructure management systems are significant and lead to reduced revenue loss and enhanced asset management.

Table 6-7: Revenue improvement program and its benefits

Component	Benefits
Customer survey and data base clean-up of existing customer base	Reduce “administrative loss” component of UFW
Procurement and installation of billing and asset management information system	Effective and efficient management of customers, operations and assets Strategic asset use Promotion of informed decision making

Operations management

The procurement of tools and equipment for the water and sanitation service teams are necessary to allow for active operation control and maintenance. This will reduce down-times and promote infrastructure lifespan. The required tools and equipment are aligned with the existing and proposed infrastructure development. Workshops for general and specific maintenance are equally required, as well as suitable transport for technical supervision and maintenance teams. A large proportion of low density housing areas are operated with individual septic tank systems, which require emptying. Provisions for the purchase of vacuum tankers, including tools for the operations, may be necessary.

Table 6-8: Operations management investments and their benefits

Component	Benefits
Procurement of tools and equipment for water and sewer operations and maintenance	Improve operations and maintenance procedures Reduction in overflow sewers and elimination of pollution of surface
Establishment of meter control, testing and repair workshop Provision of portable meter control instrumentation	Repair of defective and faulty water meters Improve life span of water meters Improve customer satisfaction by testing water meters
Provision of vehicles for operation and maintenance teams	Improve operations and maintenance procedures
Provision of vacuum tanker for septic tank emptying	Improve operations and maintenance procedures

Management and technical information systems

Management and technical information systems are important tools for utility management, especially for larger urban service providers. We consider under this investment component the procurement of a modern accounting and payroll system, the procurement and installation of network information/asset management system, based on GIS technology, and other types of information systems or modules (e.g. asset management, demand management and customer support service in combination with the billing system). Especially the asset management system will provide a number of advantages as far as monitoring, operations and maintenance of the network infrastructure is concerned.

Table 6-9: Management and technical information systems and their benefits

Component	Benefits
Procurement and installation of accounting and payroll system	Improved quality and timeliness of financial information
Procurement and installation of Network Information System, based on GIS technology	Improved control and management of technical system components
Procurement and installation of various other types of information systems (e.g. asset management, demand management and customer support service) – in combination of billing system (see section above)	Improved quality of data for decision making on management level

IT Infrastructure and Professional Services

These investment measures are intended to support and facilitate the implementation and operation of technical infrastructure. These measures include provision of IT hard- and software, tools, materials and consulting services. These investments will provide the necessary tools to undertake effective and efficient operating and maintenance procedures, promote capacity and skill enhancement and lead to sustainable operations. Consulting services for study, design, supervision and capacity building are covered under this investment component, which are necessary to implement the proposed works and training programs.

Table 6-10: Additional measures and their benefits

Component	Benefits
Procurement and installation of other office equipment (e.g.IT hard- and software, furniture, equipment, etc.)	Improved technical and administrative planning and day-to-day services Improved and modern IT systems lead to efficient operation of infrastructure
Training and capacity building	Improved skills and performance of staff. Continuous training and planned education of staff allows for replacement and rotation staff at outside training institutes or schools
Public awareness and sensitisation campaigns	Improved customer satisfaction and awareness Reduction of vandalism and theft Improved willingness to pay for water bills
Consulting services required to study, design and implement works	Detailed investigations and design of proposed infrastructure investments Construction supervision service to control and monitor contractors Assistance during defects liability period
Consulting services to provide specific services (land use master plans, capacity building and training, etc.)	Capacity building services to enhance billing, accounting, operation and maintenance skills Capacity building to promote coordinated planning and implementation of future infrastructure needs Capacity building to promote improved infrastructure mapping and network modelling

6.3 Service levels and performance indicators

6.3.1 Introduction

Services must be provided according to a defined level to the consumers. This guarantee of service is necessary to provide value for money to customers and is an instrument for regulating the consumer's and service provider's interests.

In an environment of limited market competition, the water and sanitation services should be regulated and be organised in accordance with specific guidelines to ensure that consumers are provided with adequate and reliable services. It is also in the interest of a service provider to offer and provide such agreed services in order to promote and increase customer satisfaction and willingness to pay for services.

Service levels are considered a minimum standard the service provider should aim at exceeding such levels. Considering the present dilapidated state of infrastructure in Harare and the satellite towns, the following proposed service levels can only be achieved after the implementation of the medium term investment program.

6.3.2 Proposed Investment Performance indicators

Considering the service level guidelines in the National Water Policy and the current situation in Greater Harare, the investment plan intends to achieve the performance targets indicated in the table below.

Table 6-11: Proposed service levels

Service Levels	Unit	Present	Mid-term	Long-term
		2013	**2013-2020**	**2020-2030**
Hours of water supply	hours/day	Range from 0 to 12	18 hours a day	24 hours a day
Water Quality	/	WHO	WHO guidelines	WHO guidelines
Water supply service area coverage[1]	%	70	80%	90%
Metered connections	%	90%	100%	100%
Working meters	%	10%	100%	100%
Pressure in the network	m	Too low and too high in places	min 7m / max 50m	min 7m / max 50m
Technical water losses	%	40	25%	20%
Commercial water losses	%	20	10%	5%
NRW	%	60	35%	25%
Effluent discharge	/		Zimbabwe Effluent Discharge Standards (Statutory Instrument 274 of 2000)	Zimbabwe Effluent Discharge Standards (Statutory Instrument 274 of 2000)
Sanitation service cover for people outside the sewer boundary (to be provided with septic tanks & VIP latrines	%	?	100%	100%
Collection ratio	%	60%	80%	95%
Debt collection from government institutions	months	NIL	3 month	1 month

The performance indicators in are defined as follows.

a) Hours of water supply: average daily water supply at individual connections;

b) Water Quality: as per Zimbabwean or WHO drinking water guidelines;

c) Water supply service area coverage: percentage of population served with drinking water from the public water distribution network;

d) Metered connections: percentage of consumers being provided with a metered house or yard connection;

e) Working meters: percentage of operational consumer meters in the system;

f) Pressure in the network: measure minimum and maximum pressure during specific times and at defined locations in the network;

g) Technical water losses: physical water losses in the infrastructure;

h) Commercial water losses: revenue losses due to wrong or incorrect billing;

i) NRW: combination of technical and commercial losses;

j) Effluent discharge: as per Zimbabwean or WHO water guidelines;

[1] Service in informal settlement will be provided by way of water kiosk and yard taps with flow limiters in the medium term

k) Collection ratio: percentage of revenue collected from issued bills;

l) Debt collection from government institutions: actions to promote reduction of water wastage at public institutions and collection of outstanding debts.

CHAPTER 07: DESCRIPTION OF PROPOSED WATER AND SANITATION INVESTMENT MEASSURES

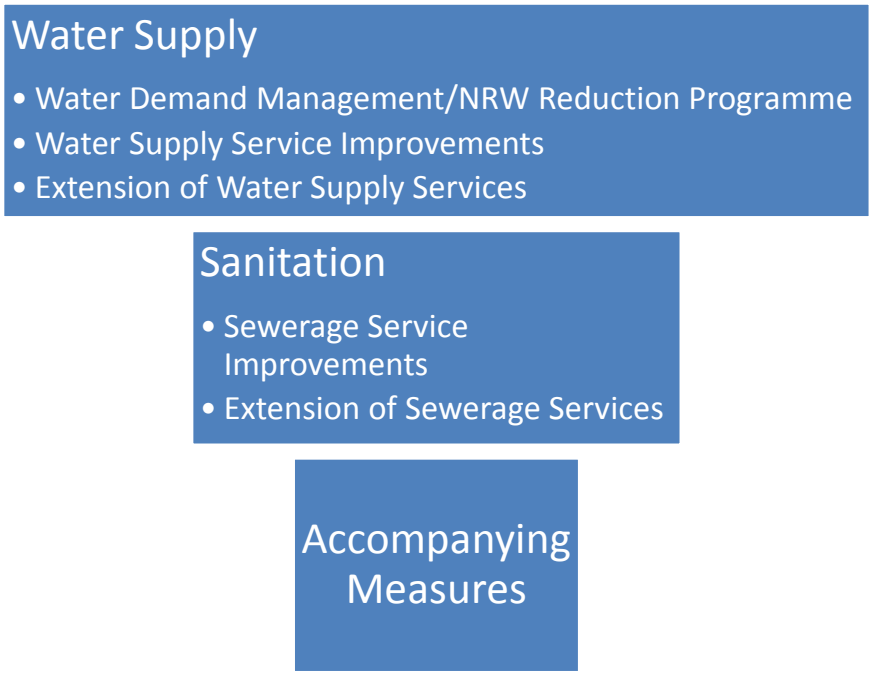
7 DESCRIPTION OF PROPOSED WATER AND SANITATION INVESTMENT MEASURES

The assessment of the existing water supply and sewerage systems described in chapter 4 has concluded that there is need for major rehabilitation investment to bring the facilities back to good working order. Further analysis of the water and sewerage service requirements detailed in Chapter 5 indicates that the water and sewerage reticulation networks will need to be extended in the medium and long term horizons.

The water demand production capacity in the medium term will be addressed by the rehabilitation of the existing water treatment facilities and implementation of a structured NRW reduction strategy. Additional water production capacity will only be added in the long term, with the construction of the Kunzvi scheme. Priority will also be given to the rehabilitation of the existing sewerage reticulation network and wastewater treatment facilities in order to improve the quality of raw water in the Manyame catchment.

This chapter summarises the identified investment measures. The conceptual design of the technical investment measures is presented in the Appendix 4. The proposed investment measures have been designed to meet the service requirements for the medium term year of 2020 and long term year of 2030.

The proposed investment measures are grouped in the broad categories illustrated in the figure below.



The following sections briefly describe the proposed investment measures included in the investment plan for each town.

7.1 Harare

Investment measures in Harare are summarized in the figure below. The maps in Figure 7-2and Figure 7-3 show the spatial location of the proposed water supply investment measures and sewerage investment measures, respectively.

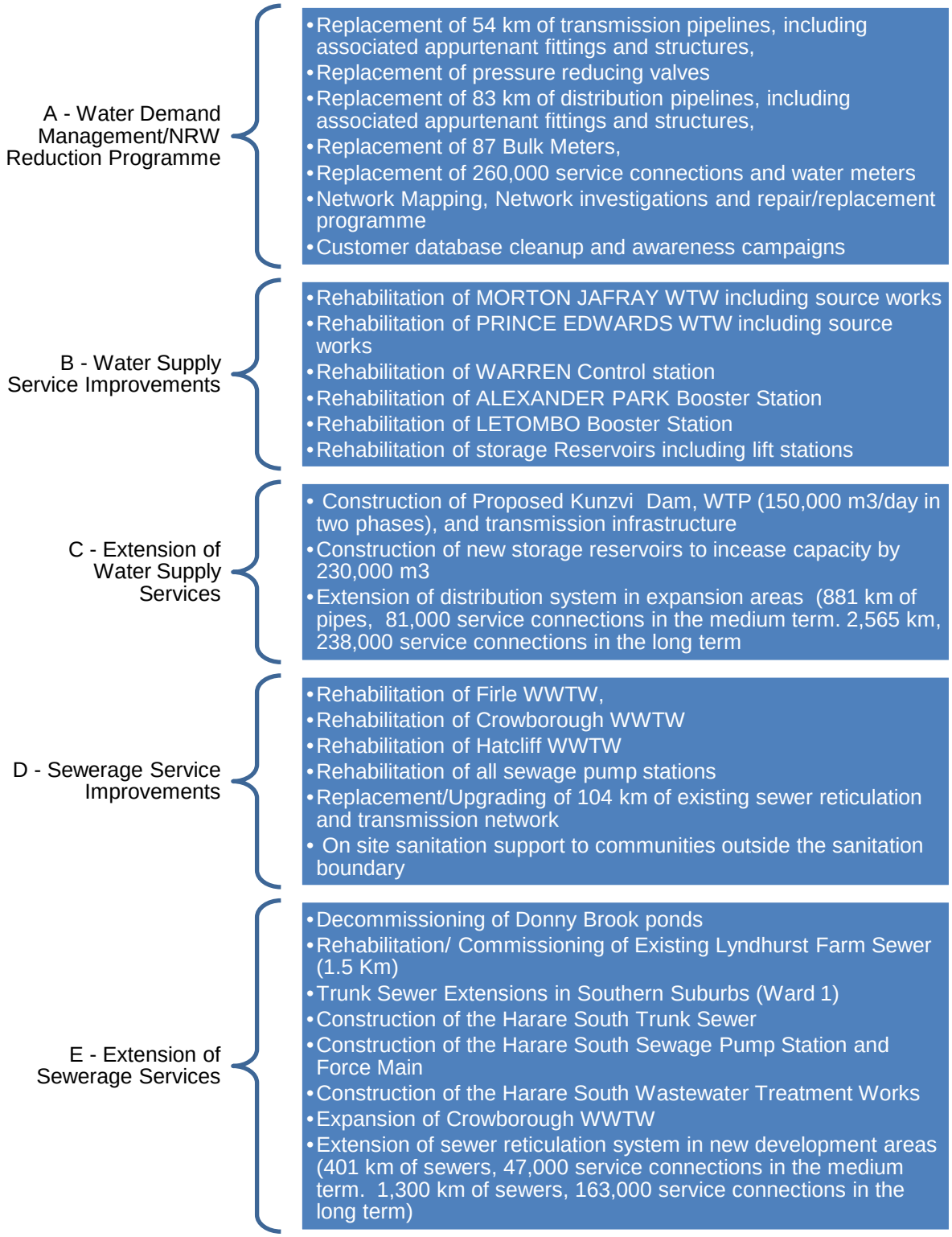
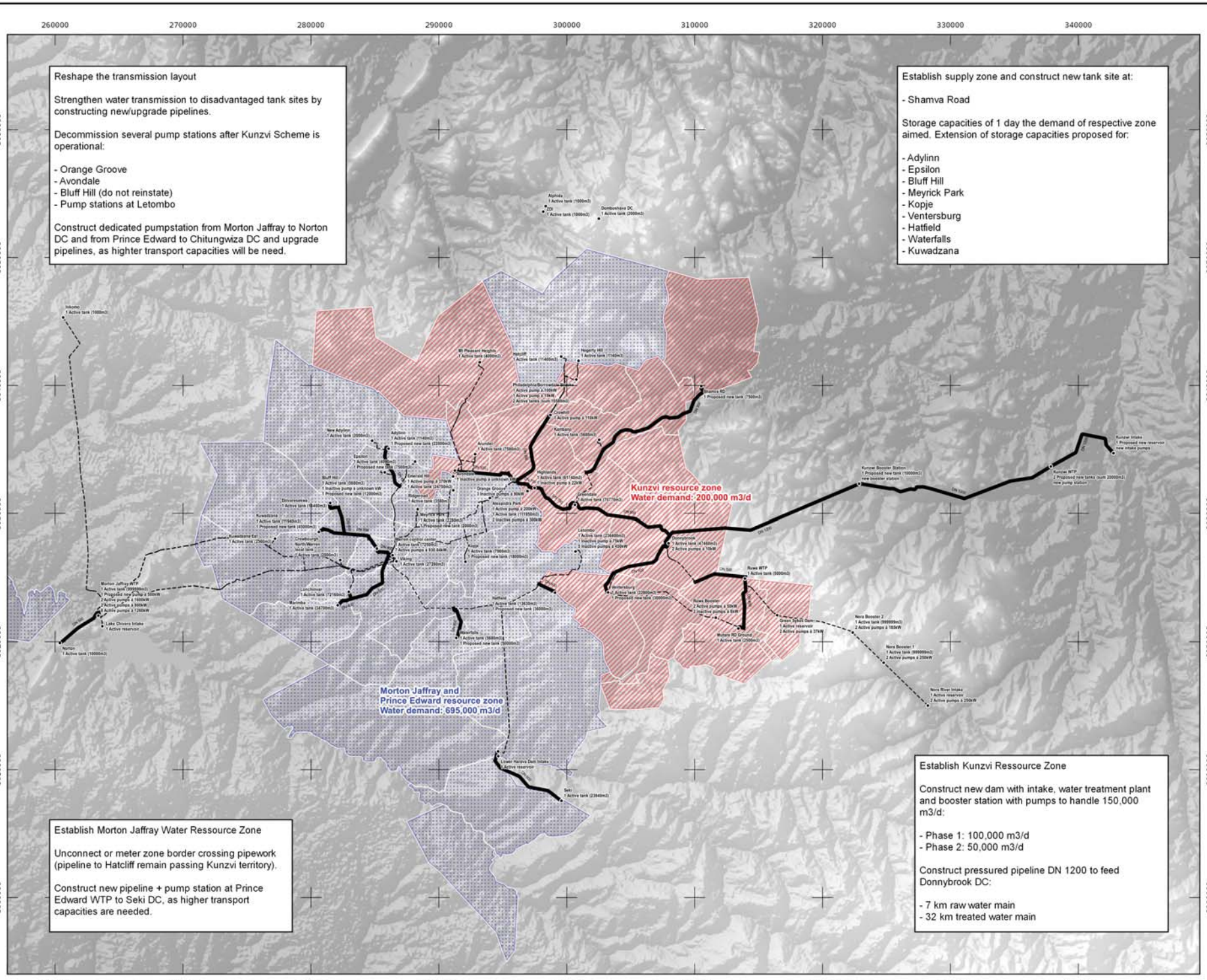


Figure 7-1: Summary of Investment Measures in Harare



LAYOUT OF PROPOSED INVESTMENT MEASURES

1:275,000

Datum: WGS84 Z36S

HARARE

Legend

Transmission system

- Proposed new pipe
- Existing pipe

Water ressource zone

- Kunzvi
- Prince Edward, Morton Jaffray

Urgent Water Supply and Sanitation Rehabilitation Project (USSRP)

JBG Gauff Ingenieure

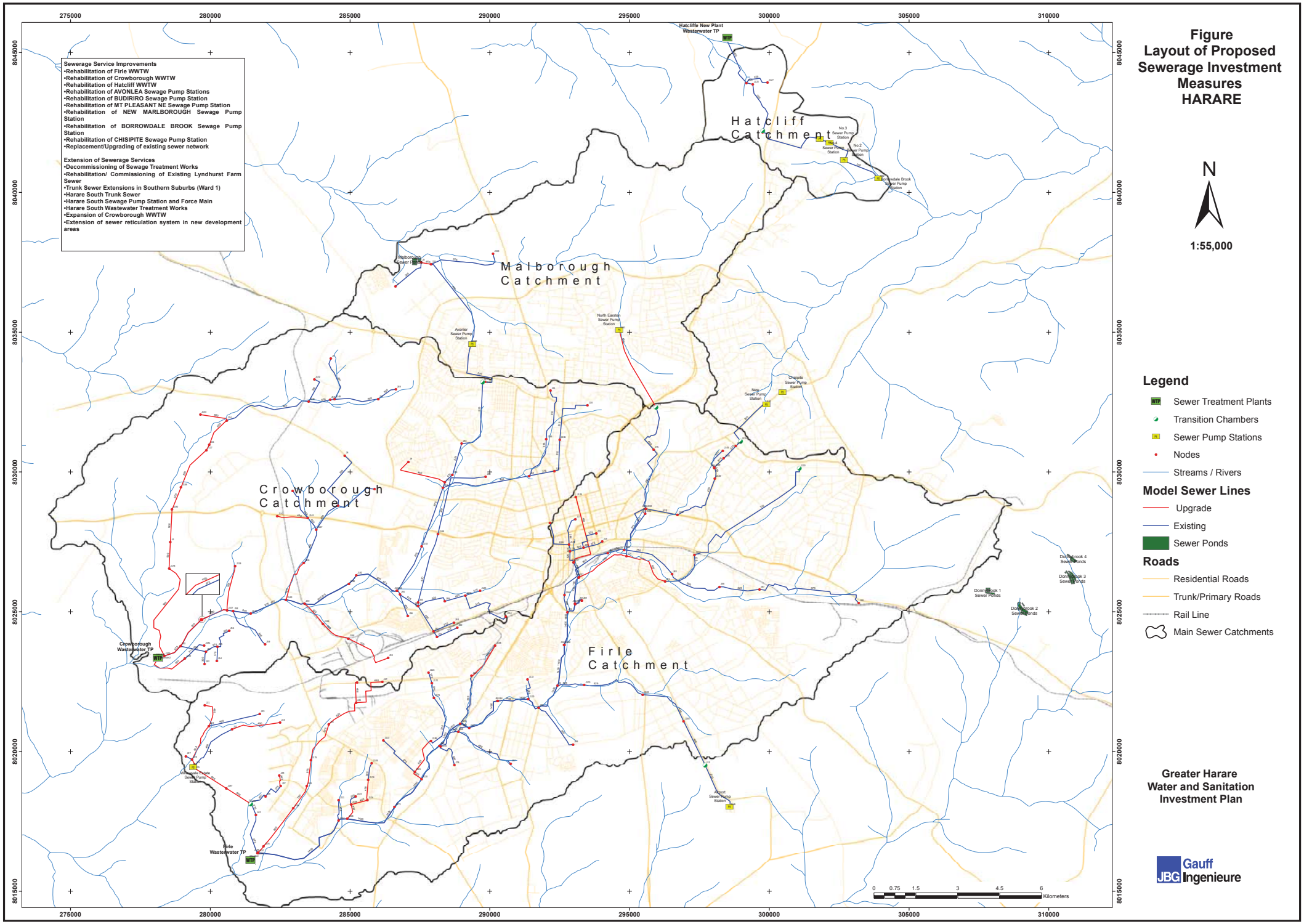


Figure
Layout of Proposed Sewerage Investment Measures
HARARE

N

1:55,000

Legend

- Sewer Treatment Plants
- Transition Chambers
- Sewer Pump Stations
- Nodes
- Streams / Rivers

Model Sewer Lines

- Upgrade
- Existing
- Sewer Ponds

Roads

- Residential Roads
- Trunk/Primary Roads
- Rail Line
- Main Sewer Catchments

Greater Harare Water and Sanitation Investment Plan

JBG Gauff Ingenieure

7.1.1 A – Water Demand Management/NRW Reduction Measures

Any efforts aimed at reducing NRW water including network rehabilitation should be preceded by a comprehensive NRW assessment and other preliminary activities such as network mapping. The NRW assessment will shade more light on the components of NRW and the results of this exercise will inform a comprehensive NRW reduction action plan. The following activities will have to be undertaken

- Assessment of commercial losses: This activity will include review of billing and revenue collection processes that impact commercial losses. This activity will first quantify and categorise commercial losses as guided IWA's "best practice" water balance. It will also identify commercial processes that contribute to commercial losses. Then a comprehensive strategy to reduce commercial losses will be developed. The strategy may involve policy and major work processes changes.
- Assessment of physical losses in some pilot District Metering Areas (DMAs): The aim of this activity is to determine the quantity of physical losses in typical areas and also determine the amount of resources needed reduce the physical losses. The results obtained from the pilot areas will then be used to estimate the physical losses in the entire network and the level of effort required to reduce the losses within economic reason. The outcome of this activity will be a network rehabilitation investment programme and a sustainable strategy to reduce physical losses over a reasonable period of time.
- Development and calibration of a hydraulic model for the water supply system: The objective of this activity is to have a model for predicting the behaviour of the water supply system under certain operating conditions. The model will be used to optimise the distribution network for better management of physical losses.
- Pressure measurements: Among the many factors that affect water network leakage is pressure. Pressure affects leakage in a number of ways, including: the rate of leakage, frequency of bursts, location of leaks, pressure surges and pressure cycling. The objective of the pressure measurements is to establish the diurnal pressure profiles in the different parts of the distribution network. The pressure measuring exercise will yield the requisite information for the development of the performance indicators and the planning of the NRW management strategy.
- Review of network operating procedures: this activity is necessary to ensure a sustainable leakage control programme. It is important to understand why the water is being lost in the first place. This activity will involve carrying out a thorough review of the physical characteristics of the network and the current operational practices. The outcome will be a catalogue of problems caused by poor infrastructure and poor network management practices. This information will form the basis for structural reforms in the management of the water supply system.
- Establishment of a Computerised Network Information System: record keeping is an integral part of a good water network management system. A GIS database management system is preferred because of the location dimension of the network elements. The City of Harare has no functional GIS-based network information system at the moment. Network data is still on hard copy maps that are hardly updated. So there is an urgent need for a comprehensive network mapping exercise. This should actually precede all the other leakage related network investigations.

These activities should be sequenced (and grouped) as shown in the figure below

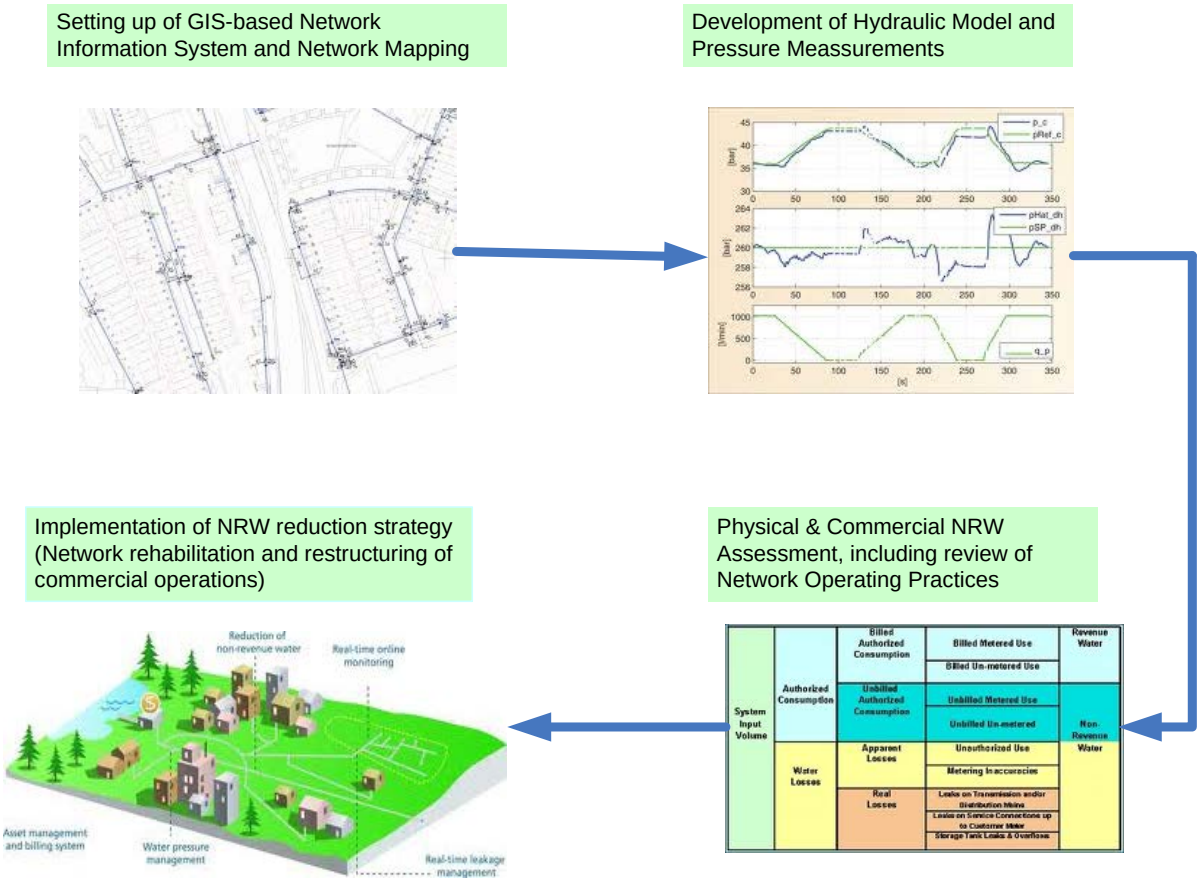


Figure 7-4: NRW Reduction Strategy Sequence of Activities

In order to bring the physical water losses down to around 20% by 2030, the network will be systematically rehabilitated (replacing pipes and valves in bad condition). The ToR stipulates that the network rehabilitation measures for the entire network shall be determined using statistical methods. Pipe and valve condition assessments were conducted in a pilot area that could be deemed as representative of the entire network. The details of the pilot area investigations have been presented in Chapter 4. The findings of the investigation are summarised below:

- The AC distribution pipes are reported to be in good condition despite their age;
- All of the gate valves are in poor condition. Network leakages occur at these fittings;
- The majority of service connections are corroded and incrusted. This is where most of the network leakages occur;
- Areas of the city with GI Pipe networks are badly corroded. Some replacement has been carried out in the CBD but significant work remains to replace all GI pipes.
- The majority of water meters are non-functional and few functional ones are not measuring water usage accurately;
- Significant amount of water is wasted after the meter resulting in unnecessary water use/ wastage.

In light of the above findings, the following measures are recommended:

- Since the AC pipes are still in good condition, they should be left in service except for the broken pipes identified by council;
- Network replacement programmes shall target areas where the ditribution network is in poor condition, especialy areas with GI pipes.
- All pressure reducing valves shall be replaced
- All network appurtenant structures such as valves and fire hydrants should be replaced;
- All service connections and water meters should be replaced;
- All bulk water meters should be replaced;
- A database cleanup programme shall be carried out which shall include measures to locate unmetered connections and illegal connections.
- Under normal circumstances, line after the service meter and the plumbing system in a property is the responsibility of the property owner or water user. But, if the property is not metered, there is no incentive for the water user to keep their plumbing system in good condition and reduce water wastage. In a water supply scheme where most water users are not metered (or meters are not working) as is the case in Harare, there are huge water losses at the properties and this is usually part of the NRW since the customers are billed on normal usage estimates. Hence, we recommend that council should, firstly, meter all customers and then implement a water conservation programme that has elements of rehabilitating household plumbing installations and household education and awareness programmes. The finances for such a programme are part of the investment plan.

Given the recommendations outlined above, the investment measures needed to rehabilitate the network and reduce physical losses are presented in the table below. The network rehabilitation measures proposed will be implemented under the medium term project.

Table 7-1: TransmissionNetwork Rehabilitation Measures - Harare

Investment Measures	Unit	Qty
Rehabilitation/replacement of treated water transmission network		
Replacement of pipes		
ND 150 (OD 160) PVC	m	13,000
ND 200 (OD 225) PVC	m	2,700
ND 225 (OD 280) PVC	m	4,300
ND 250 (OD 280) PVC	m	740
ND 300 (OD 315) PVC	m	13,320
ND 375 (ND 400) PVC	m	1,590
ND 400 DI	m	530
ND 450 DI	m	7,160
ND 525 (ND 500) DI	m	2,210
ND 600 DI	m	2,000
ND 750 DI	m	6,000
Replacement of gate/butterfly valves		
ND 400	nos	3
ND 450	nos	10
ND 500	nos	2
ND 600	nos	2
ND 750	nos	4
ND 800	nos	1
ND 1000	nos	5
Replacement of bulk water meters:		
ND 375	nos	10
ND 400	nos	2
ND 450	nos	9
ND 525 (ND 500)	nos	5
ND 600	nos	7
ND 700	nos	1
ND 750	nos	3
ND 800	nos	1
ND 975	nos	2
ND 1000	nos	
ND 1300	nos	2
ND 1500	nos	1
Replacement of air valves	nos	45
Reconstruction of broken chambers and covers	nos	80

Table 7-2: Distribution Network Rehabilitation Measures - Harare

Investment Measures	Unit	Qty
Rehabilitation/replacement of water distribution network		
Replacement of pipes		
ND 75 (OD 80) PVC	m	8,250
ND 100 (OD 110) PVC	m	28,380
ND 150 (OD 160) PVC	m	26,620
ND 200 (OD 225) PVC	m	1,000
ND 225 (OD 280) PVC	m	1,100
ND 300 (OD 280) PVC	m	15,070
ND 400 DI	m	3,000
Replacement of air valves	nos	76
Replacement of fire hydrants	nos	152
Replacement of gate/butterfly valves		
ND 80	nos	10
ND 100	nos	45
ND 150	nos	30
ND 200	nos	10
ND 250	nos	5
ND 300	nos	12
ND 350	nos	5
ND 375 (ND 400)	nos	5
Replacement of pressure reducing valves:		
ND 50	nos	20
ND 80	nos	20
ND 100	nos	15
ND 150	nos	25
ND 200	nos	15
ND 250	nos	5
ND 300	nos	8
Replacement of bulk water meters:		
ND 50	nos	1
ND 75	nos	3
ND 100	nos	18
ND 150	nos	38
ND 200	nos	16
ND 225 (ND 250)	nos	2
ND 300	nos	8
ND 325 (ND 300)	nos	1
Replacement of non-return valves	nos	100
Clean and service sluice valves	Sum	1
Reconstruction of broken chambers and covers	Sum	1
Replacement of service connections		
Domestic (ND 15) (OD 20)	nos.	209,600

Investment Measures	Unit	Qty
Non-Domestic (ND 25)	nos.	52,400
Replacement of service water meters		
Domestic (ND 15)	nos.	209,600
Non-Domestic (ND 25)	nos.	52,400
Provisional sum for network mapping, network investigations and repair/replacement programme		
Provisional sum for customer database clean-up and awareness campaigns		

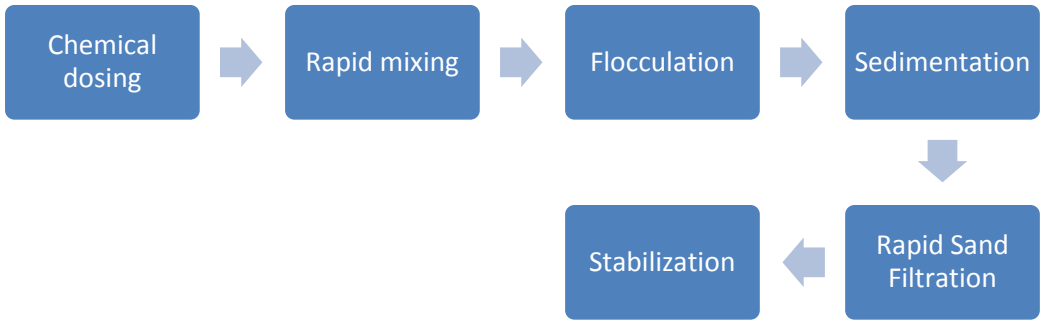
7.1.2 B – Water Supply Service Improvements

7.1.2.1 Rehabilitation of Morton Jaffray WTW including Source Works

Raw water for Morton Jaffray WTW is abstracted from three intake works namely;

- The old intake tower (intake No. 1) constructed in 1952 and draws water at five water levels; three being the City of Harare intakes and the other two an irrigation intake and the river outlet pipe respectively. The COH intakes are connected to a common 1100 mm diameter water main which transports raw water to the distribution chamber at the head of the water treatment works. This tower was abandoned because of water quality issues and recently has only been used as an irrigation abstraction point by local farmers.
- The new intake tower constructed in 1976 in order to resolve the issue of abstraction levels in the old intake tower and to move the intake to an area that was not affected by windblown weed. This discharges raw water into a mixing chamber via a 3 m x 3 m tunnel before it is fed into the treatment works.
- The Lake Manyame 3m x 3m rectangular 15.4 km long tunnel. The tunnel is approximately 45m into the ground at the works and raw water is pumped from a riser shaft.

Morton Jaffray Water Treatment Works was constructed in three stages. All three units are conventional surface water treatment plants consisting of the process units illustrated in the schematic below:



The first module was constructed in a number of phases starting in 1953, with an initial rated capacity of 162,000 m^3/d, followed by the second module in 1976 with a rated capacity of 227,000 m^3/d. The third module was constructed in 1994 with a rated capacity of 227,000 m^3 /d. Therefore, the total capacity of the Treatment Works is thus 616,000 m^3/d. However, due to operational challenges, it has been reported that, the present combined output under the current mode of operation is limited to only 429,408 m^3/day.

All the intakes and the components of the treatment units were subjected to comprehensive condition and capacity assessment. The details of the assessments are presented in Chapter 4 and Appendix 4.1. The general finding is that facilities are in urgent need of rehabilitation so that they are restored to the nominal design capacity. The identified rehabilitation measures are summarised in the table below.

Table 7-3: Rehabilitation Measures at Morton Jaffray WTW

Component	Description	Remarks
Rehabilitation of Lake Chivero Intake	Rehabilitation/Replacement of 4 no. Periscope Lifting Mechanisms, 2 no. Penstock Gates 3mx3m, and Intake Building	some of the parts (not cited here) will be replaced under the China EXIM Bank loan
Rehabilitation of Lake Manyame Intake	Rehabilitation/Replacement of Periscope Lifting Mechanism, butterfly valves and actuators , desludging pump, Forebay Pumps, Penstock Gates, screens and lifting mechanism, transformer, LV Switchboard,small Power and Lighting, building and security Fence, desludging pumps and hoist, DN 150 in Shaft 5	
Raw water transmission and pumping	Replacement/Rehabilitation of Raw Water Pumps (Q = 5,400, H = 60 m) and Controls, Raw Water Pump Suction Gate Valves with Actuators (DN 700), Raw Water Pump Delivery Gate Valves with Actuators (DN 700), Non-Return Valves (DN 700), Pressure Gauges, Air Valves, Raw Water Pump 3.3 kV Starter Switchboard, Raw Water Pump 3.3 kV Starter Consoles, Raw Water Pump 3.3 kV Remote Starter Panels, Raw Water Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pumps and Ventilation Fan	
Chemical Preparation and Dosing Unit 1, 2 and Unit 3*		Rehabilitation of all units is covered under the China EXIM Bank loan
Rehabilitation of Unit 1 Clarifiers	Rehabilitation/modification/replacement of Vertical Flow Patterson Candy Clarifiers (nr 04, nr 05 & nr 06), Degremont Pulsator Type Clarifier (nr 07), Small Power and Lighting	
Rehabilitation and Modification of Unit 2 and 3 Clarifiers	Rehabilitation/Modification/Replacement of Unit 2 Degremont Type of Clarifiers (nr 09 & nr 10), Unit 3 Degremont Type of Clarifiers (nr 11, nr 12 & nr 13), Small Power and Lighting	

Component	Description	Remarks
Rehabilitation of Unit 1 Filters	Replacement of Pressure Gauges, Air Valves, Overhead Electric Wire Rope Hoist, 5t, Air Scour Blowers, Delivery Gate Valves (DN 150), Safety Valves, Pressure Gauges, Small Power and Lighting, Backwash Switchboard	Some of the rehabilitation works are covered under the China EXIM Bank loan
Rehabilitation of Unit 2 and Unit 3 Filters	Rehabilitation of Degremont Filters, Overhead Electric Wire Rope Hoist,	Most of the rehabilitation works are covered under the China EXIM Bank loan
Rehabilitation/Replacement and Maintenance of HL Pumps: Unit 1 (Pump Nrs 1 - 3)	Replacement of Small Power and Lighting, overhead Wire Rope Hoist, Dewatering Pumps, and Ventilation Fans	Most of the rehabilitation works are covered under the China EXIM Bank loan (CMEC) and the Zim-Fund Phase I project
Rehabilitation/Replacement and Maintenance of HL Pumps: Unit 2 (Pump Nrs 4 - 6)	Replacement of Small Power and Lighting, overhead Wire Rope Hoist, Dewatering Pumps, and Ventilation Fans	Most of the rehabilitation works are covered under the China EXIM Bank loan and the Zim-Fund Phase I project
Rehabilitation/Replacement and Maintenance of HL Pumps: Unit 3 (Pump Nrs 7 - 10: 2 Stage)	Replacement of Small Power and Lighting, overhead Wire Rope Hoist, Dewatering Pumps, and Ventilation Fans	Most of the rehabilitation works are covered under the China EXIM Bank loan
Rehabilitation/Replacement of High Lift (HL) Pumps: Unit 4 (Pump Nrs 11 - 14: 2 Stage)	Replacement of Small Power and Lighting, overhead Wire Rope Hoist, Dewatering Pumps, and Ventilation Fans	Most of the rehabilitation works are covered under the China EXIM Bank loan
Clear water valves, flowmeters and level gauges		All rehabilitation works are covered under the China EXIM Bank loan
Rehabilitation of the Washwater Recovery Plant	Rehabilitation/Replacement of Secondary Clarifier, Turbine Pumps (Q = 1,800 m3/h, H = 18 m), Raw Water Pump Delivery Gate Valves (DN 500), Non-Return Valves (DN 500), Pressure Gauges, Raw Water Pump 380 V LV	

Component	Description	Remarks
	Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, Dewatering Pumps, Alum Dosing System, Farm Irrigation System	
Replacement/Rehabilitation of Transformers	Rehabilitation of Transformer for HL Pump Station 01: 1 MVA, 33/3.3 kV, Transformer for the HL Pump Station 01: 100 kVA, 3.3/.40 kV, Transformer for the HL Pump Station 01: 200 kVA, 3.3/.40 kV, Transformer for the HL Pump Stations 02 & 03: 6.3 MVA, 33/3.3 kV, Transformer for the HL Pump Station 02: 1600 kVA, 3.3/.40 kV, Transformer for the Waste Water Stations: 2 MVA, 33/3.3 kV	
Miscellaneous	Security lights and fence, Standby generators, Rehabilitation of buildings and roads, Replacement of boats, Replacement of vehicles, tractors and plant,Laboratory equipment, SCADA and Radio communication systems	

7.1.2.2 Rehabilitation of Prince Edwards WTW

Prince Edward Water Treatment Works was constructedin 1972.The design capacity of PE WTP is 90,000 m^3/d. The amount of water currently being treated at PE-WTW is 55,000 m^3/d during the wet season and 40,000 m^3/d in the dry season respectively. The raw water intake amounts during the above periods are around 60,000 m^3/d and 45,000 m^3/d respectively.

The plant was subjected to comprehensive condition and capacity assessment. The details of the assessments are presented in Chapter 4 and Appendix 4.1. The general finding is that facilities are in urgent need of rehabilitation so that they are restored to the nominal design capacity. The identified rehabilitation measures are summarised in the table below.

Table 7-4: Rehabilitation Measures at Prince Edward WTW

Component	Description	Remarks
Rehabilitation of Dam Intake	Replacement/Rehabilitation of Intake Gate Valves (DN 1000), Butterfly Valves and Actuators (DN 1200), Desludging Pumps, DN 50 with lifting mechanism,Screens and liftin mechanism, 75 mm mesh, 1200 mm dia, Transformer, 100 kVA, LV Switchboard, Small Power and Lighting	
Raw Water Pumps, Fittings and MV Switchboards and MCCs	Replacement/Rehabilitation of RW Water Pump Controls, Replacement of Non-Return Valves, DN 500, Pressure Gauges, Air Valves, Raw Water Pump 3.3 kV Starter Feeder Switchboard, Raw Water Pump 3.3 kV Starter Consoles, Raw Water Pump 3.3 kV Remote Starter Panels, Raw Water Pump 380 V LV Switchboard, Small Power and	

Component	Description	Remarks
	Lighting, overhead Wire Rope Hoist, 7.5t Dewatering Pumps, Ventilation Fan	
Chemical preparation and dosing plant	Replacement of Alum Mixers, Replacement of Alum Dosing Pumps, 0 - 45 l/min, Air Agitation System for Alum, Lime Mixers, 0 - 45 l/min, Lime Dosing Pumps, PAC Plant, Silica Mixers, Silica Dosing Pumps, Chlorinator Unit (Post-chlorination), 20 kg/h, Chlorination Unit (Pre-Chlorination), Small Power and Lighting, Chemical LV Switchboards and MCC	
Vertical flow clarifiers (LxWxD: 18m x 9m x 9m)	Replacement/Rehabilitation of BW Water Pump Controls, Pressure Gauges, Air Valves, Overhead Electric Wire Rope Hoist, 3 t, Air Scour Blowers and fittings, Q = 3,179 m3/h; Diff Press = 1.0 bar, Delivery Gate Valves, DN 200, Safety Valves, Small Power and Lighting, BW Switchboard	Some works (blowers) covered under Phase 1 Zim-Fund project
High Lift Pumps (Pump Nrs 1 - 3)*	Installation/Rehabilitation of HL Water Pump Controls, Pressure Gauges, Air Valves, Replacement/Maintenance/Replacement of Small Power and Lighting, overhead Wire Rope Hoist, 10 t, Dewatering Pumps, Ventilation Fans	Some works covered under Phase 1 Zim-Fund project
Clear water valves, flowmeters and level gauges	Replacement/Rehabilitation of Valves, Flowmeters and Level Gauges	
Sludge pump house	Replacement/Rehabilitation of Sludge Pumps (Q = 350 m3/h, H = 40 m), Sludge Pump Suction Gate Valves, DN 300, Sludge Water Pump Delivery Gate Valves, DN 250, Non-Return Valves, DN 250, Pressure Gauges, Sludge Pump 380 V Incomer Switchboard, Sludge Pump 380 V LV Switchboard and MCC, Small Power and Lighting, overhead Wire Rope Hoist, 3 t, Dewatering Pumps, Screen, DN 400, the Main Valve , DN 250	
Miscellaneous	Rehabilitation/Replacement of transformers, security lights and fence, Existing Generator, 87 kVA, Office and Workshop Buildings Incl. Electrical and Mechanical Works, Compound Roads, Supply and Delivery/Replacement of Boat, operational Vehicles, Tractors and Plant, Laboratory Equipment, SCADA and Radio Communication Systems	

7.1.2.3 Rehabilitation of Warren Control Station and Other Booster stations,

Warren control station is the main distribution centre for all the water that comes from Morton Jaffray WTW. It costs of a number of pumps pumping water to the various reservoir sites dotted around the city. Given that this is a key installation, it was given special

attention during the condition assessment. Other booster stations such as Alexandra Park and Letombo were also assessed.

The identified rehabilitation measures are summarised in the table below.

Table 7-5: Rehabilitation Measures at Booster Stations

Component	Description	Remarks
WARREN CONTROL STATION		
Chemical preparation and dosing plant	Rehabilitation/Replacement of Chlorination Unit , 20 kg/h, Ammonia Unit , 5 kg/h, Small Power and Lighting, Lifting Hoist and Adapters, 3t, Chemical LV Switchboards and MCC, Chlorination Chamber	
Replacement/Rehabilitation of High Lift Booster Pumps (Pump Nrs 1 - 14)		All Rehabilitation works covered under the Chinese loan
Clear water valves, flowmeters and level gauges	Replacement of Flowmeters, DN1500, Flowmeters, DN1400, Flowmeters, DN800 (to Emerald Hill), Flowmeters, DN 975 (to Alexandra Park), Flowmeters, DN 750 (to Alexandra Park), Level Gauges on Clear Water Reservoir, Mechanical Level Gauge on Clear Water Reservoir	Some Rehabilitation works covered under the China EXIM Bank loan
Miscellaneous	Replacement/Rehabilitation of Power Transformers, Security lights and fence, Standby generators, Buildings, Vehicles, plant and equipment, SCADA and radio communication systems	
ALEXANDER PARK BOOSTER STATION		
Replacement/Rehabilitation/ Replacement of Booster Pumps (Pump House No. 01)	Rehabilitation/Replacement of Booster Pumps, Q = 1250, H = 55 m, of Booster Pumps, Q = 1250, H = 55 m, Booster Pump Controls, Booster Pump Suction Gate Valves, DN 400, Booster Pump Delivery Gate Valves, DN 400, Booster Water Pump NRVs, DN 400, Pressure Gauges, Air Valves, DN 100, Feeder Switchboard, Booster Pump Starter Console, 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 5t, Dewatering Pumps, Ventilation Fans	

Component	Description	Remarks
Rehabilitation/Replacement of Booster Pumps (Pump House No. 02)	Rehabilitation/Replacement of Booster Pumps, Q = 1035, H = 95 m, Booster Pump Controls, Booster Pump Suction Butterfly Valves, DN 400, Booster Pump Delivery Gate Valves, DN 400, Booster Water Pump NRVs, DN 400, Pressure Gauges, Air Valves, DN 100, 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Gravity Drainage System, Ventilation Fan	
Rehabilitation/Replacement of Valves	Rehabilitation/Replacement of Butterfly Valve, DN 525 (outflow from Pump House 01), NRV, DN 525 (outflow from Pump House 01), Gate Valve, DN 525 (main inflow), Level Gauges on Clear Water Reservoir	
Installation/Replacement of Flowmeters	Installation /Replacement of Inflow Flowmeter, DN 600 (from Warren), Inflow Flowmeter, DN 750 (from Warren), Outflow Flowmeters, DN 450 (to Hatcliff), Outflow Flowmeters, DN 525 (to Crow Hill)	
Miscellaneous	Rehabilitation/Replacement of Transformer : 500 kVA, 11/0.40 kV (Pump House 02), Transformers : 750 kVA, 11/0.40 kV (Pump House 01), security fence and lights, Generator, 60 kVA (for dewatering pumps and security lights), Office and Workshop Buildings Incl. Electrical and Mechanical Works, SCADA and Radio Communication Systems	

All the other smaller booster stations also need rehabilitation. Generally all electro-mechanical installations will have to be replaced.

7.1.2.4 Rehabilitation of storage Reservoirs

The water supply system of the City of Harare (COH) has 27 treated water reservoir sites. The reservoirs are dotted all around the city between 1,460 m and 1,600 m amsl. The main reservoirs in terms of capacity are Letombo, Alexandra Park, Lochinvar, Greendale and Highlands which together have a storage capacity of approximately 553,740 m^3. This is about 70% of the total storage capacity of the water supply system.

All the reservoirs were assessed. The table below shows the rehabilitation measures at each reservoir site.

Table 7-6: Rehabilitation Measures at Reservoir Sites

Reservoir Site	Assessment Notes	Rehabilitation measures
Emerald Hill	Security Fence needs to be redone, all air vents are corroded, level gauge is damaged, internal access ladders heavily corroded	Install security fence, replace air valves, install level gauge, replace access ladder
Arundel	Security Fence needs to be redone, all air vents are corroded, internal access ladders heavily corroded, external access ladder vandalized	Install security fence, replace air vents, replace access ladder,
Episilon	Float valve removed, 300mm inlet heavily corroded, 375mm outlet pipes heavily corroded, access ladder and handrails are heavily corroded, security fence needs to be redone, gate valves are damaged, work platform is corroded inside the tank	Replace valve float, replace inlet,replace outlet pipes, replace ladder and handrails, Install security fence, replace valves
Adylinn	Security fence needs to be redone, internal access ladders heavily corroded, reservoir not in use, 225mm inlet heavily corroded, 375mm outlet pipes heavily corroded	Replace security fence, replace access ladder, replace inlet, replace outlet pipes
Bluff Hill	Tank missing security fence,air vents vandalized, internal access ladders heavily corroded, access covers vandalized	Replace security fence, replace access ladder, replace access covers
Meyrick Park	Wire fence heavily vandalized,inlet pipes are corroded and leaking,access covers are vandalized,internal access ladders heavily vandalized,external access ladders heavily vandalized, 300mm Float Valve is damaged, level gauge is damaged	Replace fence , replace covers covers, replace access ladder, replace access ladder, replace Float Valve, replace gauge
Dzivaresekwa Low	No internal access ladder, no external access ladder,valve chamber covers stolen,no security fence installed,all air vents are corroded,float valve is damaged, work platform inside tank is corroded	Install access ladder, install access ladder, replace valve chamber, install security fence, replace air vents, replace Float Valve
Dzivaresekwa High	No external access ladder, no security fence installed	Install external access ladder, install security fence
Kuwadzana	No security fence installed,reservoir not in use,outlet pipes are vandalized, internal access ladders are vandalized,external access ladders vandalized, reservoir	Install security fence, replace all outlet pipes, replace all internal access, replace all external access, replace all reservoir

Reservoir Site	Assessment Notes	Rehabilitation measures
	access covers have been stolen,air vents are corroded	access, replace all air vents
Kuwadzana Ext.	No security fence installed, internal access ladders are vandalized, external access ladders vandalized, reservoir access covers are stolen, air vents are corroded, float valve is damaged	Install security fence, replace all internal access, replace all external access, replace all reservoir access, replace all air vents, replace all float valve
Hogerty Hill	No security fence	Install security fence
Mutiny	No security fence,internal access ladders are corroded, external access ladders corroded, inlet pipes are heavily corroded, outlet pipes are heavily corroded, air vents are heavily corroded, reservoir access covers are vandalized	Install security fence, replace all internal access ladders, replace all external access, replace all inlet pipes, replace all outlet pipes, replace all air vents, replace all reservoir access
Viking	Wire fence heavily vandalized, inlet pipes are corroded and leaking, access covers are vandalized, internal access ladders heavily vandalized, external access ladders heavily vandalized, no float valves installed, level gauge is damaged	replace security wire fence, replace all inlet pipes, replace all access covers, replace all internal access ladders, replace all external access ladders, replace Float Valve, replace level guage
Marimba Park	No security fence installed, access covers are vandalized, internal access ladders heavily vandalized, external access ladders heavily vandalized, float valves are damaged, no level gauges installed	Install security fence, replace access covers, replace internal access ladders, replace external access ladders, replace Float Valve, install level gauge
Marimba High (Braithwaite)	Tank leaking heavily, float gauge is damaged, access ladder from platform to tank inlet is damaged, tank internal bracings are corroded	Replace Braithwaite tank complete with all accessories, refurbish tank stand
Kopje	Float valves are damaged, inlet pipes are corroded and leaking, all air vents are heavily corroded, security fence needs rehabilitation	Replace Float Valves, replace Inlet Pipes Are Corroded, replace all Air Vents, replace security access fence
Alexandria Park	No security fence installed	Install security fence
Highlands	Security fence heavily vandalized,internal access ladders heavily corroded, reservoir access cover vandalized, all air vents are corroded, no float gauge installed	Replace security fence, internal access ladders, access covers, air vents and install float gauge
Hatfield	No security fence installed,internal ladders heavily corroded, one tank leaking on joints, float valves are damaged,	Install security fence, replace internal access ladders, repair all leaking points, replace float

Reservoir Site	Assessment Notes	Rehabilitation measures
	external ladder missing, access covers vandalized, air vents are corroded, float gauges are damaged	valves, replace external access ladder, replace access covers, replace air vents, replace float gauges
Letombo	Wire fence heavily vandalized, access covers vandalized, no level gauge installed	Replace Security Fence, replace access covers, replace level guages
Greendale	Security fence vandalized, float valves are damaged, external ladder missing, access covers vandalized/corroded, air vents are corroded, float gauges are damaged/missing	Replace Security Fence, replace float valves, replace external access ladder, replace access covers, replace air vents, replace float gauges
Kambanji	Internal access ladder is corroded, security wire fence is partly vandalized, float valveis damaged, access covers are vandalized	Replace access ladder, replace Security Wire Fence, replace float valves, replace access covers
Philadelphia	Fence is heavily vandalized, float gauge is damaged, outlet valves are damaged, access cover vandalized, air vents are corroded	Replace fence, float gauge, outlet valves, access covers, and air vents
Donny Brook	Wire fence heavily vandalized, internal access ladders are corroded, access covers are vandalized, no level gauge installed	Replace Security Fence, replace internal access ladders, replace access covers, install level gauges
Ventersburg	No security fence, valve chamber covers heavily vandalized, flow meter chamber heavily vandalized, flow meter housing is heavily vandalized	Install security fence, replace chamber covers, reconstruct meter chamber
Waterfalls	Fence is heavily vandalized, float valves are damaged, no level gauge installed	Reconstruct security fence, replace covers, install level gauge
Hatcliff	Fairly new reservoir, no security fence installed, no float valves installed, no level gauge installed	construct security fence, install float valves, install level gauge

7.1.3 C – Extension of Water Supply Services

7.1.3.1 Kunzvi Water Supply Scheme

The Kunzvi water production facilities will be needed to augment current production in the medium and long term. The facilities have been sized to produce and deliver 150,000 m^3/d of water during the peak month. Hence the average production will be 120,000 m^3/d and total production per year will be 43,800 Ml p.a. according to ZINWA, the 4% risk yield after deducting upstream commitments is 43,200 Ml p.a – which is the same order of magnitude as the planned capacity of the plant. It should also be noted that the plant will be designed

to take into account the need to accommodate the raw water from the proposed Musami scheme on the Shavanoe River.

Kunvi will be built in two phases. Phase I with a capacity of 100,000 m^3/d will be built over a period of three years starting in 2019. Phase II with a capacity of 50,000 m^3/d will be added in 2029.

The scheme was extensively studied in 1999 by GKW Consult and BCHOD. Under this study, we have endeavoured to update the parameters used and revisited the sizing of the different components. A new hydraulic model has been built to resize the facilities. The scheme will comprise a dam, an intake tower, raw water transmission mains, a water treatment plant (150,000 m^3/day), two treated water pump stations, and a transmission main to deliver treated water to Donny Brook Reservoirs. There will also be need to restructure the water distribution system so that the water from Kunzvi is only restricted to the eastern parts of the city, while the water from Morton Jaffray WTW is restricted to the western and north-western parts. Hence, high level primary transmission and secondary distribution mains needed to effect the resource zoning, have been identified and sized. The full discussion on the hydraulic analysis is presented in Appendix 4.1. The proposed investment measures for the Kunzvi Scheme, including the primary transmission mains is shown in the table below.

Table 7-7: Kunzvi Scheme Investment Measures

Investment Measure	Unit	Qty
Construction of Dam	sum	1
Water Production, Treatment and Transmission Facilities		
Raw water intake and pump station	Sum	1
Raw water transmission main (ND 1200)	m	8,050
Water Treatment Plant (150,000 m3/day)	ML/day	150
First treated water pump station	Sum	1
Treated water transmission main (ND 1200)	m	39,432
Second treated water pump station	Sum	1
Miscellaneous (access roads, surge relief structures, special pipe surports, power supply etc)	Sum	1
Transmission Pipelines downstream of Donny Brook Reservoirs		
ND 900 from Donny Brook to Greendale pipeline	m	9,413
ND 350 from Greendale to Highlands and Crowhill	m	6,303
ND 350 from Greendale to Shamva Rd	m	12,750
ND 600 from Donnybrook to Vernterberg	m	7,100
Warren to Munity and Kuwadzana and Dzivaresekwa		
ND 300	m	3,116
ND 600	m	4,927
ND 700	m	1,553
Warren to Lonchinvar and Marimba Park		
DN 350	m	576
DN 400	m	1,176
DN 500	m	5,311
to Adylinn (See map)		

Investment Measure	Unit	Qty
DN 300	m	454
DN 450	m	2,148
DN 650	m	1,049
ND 600 Off Warren-Letombo line to Waterfalls (off-take)	m	2,715
ND 600 Off Warren-Letombo line to Hatfield (off-take)	m	1,481

7.1.3.2 Construction of new storage reservoirs

In terms of storage requirements in the distribution network, the design criterion is that there should be at least 1 day storage (of the peak season daily demand). The total reservoir storage in Harare is currently around 820,000 m^3. There is enough storage even for the long term horizon. However, there will be need for localised reservoirs for the new development areas such as the northern low density extension areas around Sally Mugabe. We have proposed a new 8,000 m^3 reservoir along Shamva Road.

7.1.3.3 Extension of Distribution Network to new areas

The water reticulation network will be extended to cover the new development areas. As outlined in Chapter 3, most of the additional population in the medium and long term will settle in Harare South, Whitecliff, Rainham, Mount Hampden, Mount Pleasant Heights, Sally Mugabe and Caledonia.There will also be some infill growth in a few wards that are not saturated yet. The water network requirements in the new development areas have been calculated on the basis of population and the per capita infrastructure requirements. The per capita infrastructure requirements were calculated using the existing network quantities and the population from the 2012 census. The parameters below were used to calculate the infrastructure requirements in extension areas

- House hold size (assuming one connection per household): 6 people
- Tertiary pipe network lengths per capita – ND 75: 1.2 m/ca.
- Tertiary pipe network lengths per capita – ND 100: 0.8 m/ca.

The table below shows the investment measures needed to extend the water network to the new development areas.

In addition to the above measures which will cover the areas formally supplied with water there will remain in the short term some areas where no formal water supply exists. These areas will need to be provided with kiosks with water supply from the nearest point of supply in the city or by borehole.

Table 7-8: Investments for New Development Areas - Harare

Investment Measures	Unit	2020	2030
Pipes			
ND 75 PVC	m	408,312	1,187,929
ND 110 PVC	m	326,649	950,343
ND 160 PVC	m	146,992	427,654
Section valves			
ND 75 Gate	nos.	4,083	11,879
ND 100 Gate	nos.	3,266	9,503
ND 150 Gate	nos.	1,470	4,277

Investment Measures	Unit	2020	2030
Fire hydrants			
ND 80	nos.	947	2,756
Service connections and water meters			
ND 15	nos.	68,052	197,988
ND 25	nos.	13,610	39,598
Water Kiosk supplies to peri urban areas			
Boreholes to supply peri urban areas	nos.	40	
Water Kiosks	nos	20	

7.1.4 D – Sewerage Service Improvements

The sewerage improvement measures will focus on rehabilitating existing sewage collection transmission, treatment and disposal facilities. An extensive condition assessment was carried out on all the major facilities such as Firle WWTW, Crowborow WTW, Hatcliff WTW, and a number of sewage pump stations. Capacity assessments of the sewerage network were also carried out. The proposed investment measures aimed at improving sewerage services and protecting the Manyame catchment are briefly described below.

7.1.4.1 Rehabilitation of Firle WWTW

Firle sewage treatment works comprises a total of 5 individual wastewater treatment streams with a nominal overall design treatment capacity of 144,000m^3/d. Units 1 and 2 were commissioned around 1970, and have a nominal design treatment capacity of 18,000 m^3/d each. Unit 3 is a modified activated sludge process biological reactor commonly known as a BNR with a 5 stage configuration for biological nutrient removal of nitrogen and phosphorous, and was commissioned in 1982 and has a nominal design treatment capacity of 18,000 m^3/d.Unit 4 is also a modified activated sludge process biological reactor with a 3-stage configuration for the biological nutrient removal of nitrogen and phosphorous, instead of the 5-stage concept as unit 3. Unit 5 is a modified activated sludge process biological reactor commissioned in 1996 and has a nominal design treatment capacity of 72,000 m^3/d.

Firle WWTW in addition to the above units has 3 No. ponds in series serving all units for additional effluent treatment in order to meet the corresponding standards for land and/or crop irrigation. However, under normal circumstances treated effluent from units 3, 4 and 5 is directly discharged into Mukuvisi River.

Firle Sewage Treatment Works has two separate effluent pump stations – the existing Effluent Pump Station (EEPS) with a total of six pumps, all of which are not working and the new Effluent Pump Station with a total of four pumps, two of which are operational. Treated effluent from Unit 1 & 2 is discharge on adjacent farms owned by the City of Harare for further purification.

The identified rehabilitation measures at Firle WWTW are summarised in the table below.

Table 7-9: Rehabilitation Measures at Firle WWTW

Component	Description	Remarks
Rehabilitation of Inlet Works	Replacement of LV Switchboard, Small Power and Lighting, installation of mechanical screen, extension of inlet works	
Raw sludge pumps (Units 1 to 4)	Replacement of Raw Sludge Pumps, Q = 95 m3, H = 20 m, RW Water Pump Controls, Non-Return Valves, DN 100, Pressure Gauges, Air Valves, Raw Water Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 5t, Dewatering Pumps, Humas Pumps and Fittings, Q = 1620 m3/h, H = 40 m, Irrigation Pumps and Fittings, Q = 40m^3/h, H = 10 m	
BNR Reactor (Units 3 & 4)	Replacement/Rehabilitation of RAS Pump, kW = 11, RAS Pump Delivery Valves, DN 250, RAS Pump Non-Return Valves, DN 250, Ras Pump Pressure Gauges, RAS Pump Air Valves, WAS Pump, kW = 5.5, WAS Pump Delivery Valves, DN 150, WAS Pump Non-Return Valves, DN 150, WAS Pump Pressure Gauges, WAS Pump Air Valves, RAS & Was Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3.0t	
Clarifiers	Rehabilitation of Clarifiers	
Raw Sludge Pumps (Unit 5)	Replacement/Rehabilitation of Raw Sludge Pumps, Q = 95 m3/h, H = 20 m, Raw Sludge Water Pump Controls, Non-Return Valves, DN 100, Pressure Gauges, Air Valves, Raw Sludge Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 5t, Dewatering Pump	
BNR Reactor (Unit 5)	Replacement/Rehabilitation of RAS Pump, kW = 37, RAS Pump Delivery Valves, DN 400, RAS Pump Non-Return Valves, DN 400, Ras Pump Pressure Gauges, RAS Pump Air Valves, WAS Pump, kW = 13.5, WAS Pump Delivery Valves, DN 150, WAS Pump Non-Return Valves, DN 150, WAS Pump Pressure Gauges, WAS Pump Air Valves, RAS & Was Pump 380 V LV Switchboard, Power and Lighting, overhead Wire Rope Hoist, 3.0 t	
Clarifiers (Unit 5)	Rehabilitation of Clarifiers	
Effluent Pump Station A& B		Covered under

Component	Description	Remarks
		the Zim-Fund Phase 1 project and China EXIM Bank loan
Digesters: Unit 1 to Unit 4 and Unit 5	Rehabilitation/Maintenance/Rehabilitation of Primary Digesters and Secondary Digesters	
Heat Exchanger A& B		Covered under the Zim-Fund Phase 1 project
Power Transformers and Switchgear		Covered under the China EXIM Bank loan
Miscellaneous	Security lights and fence, Standby generators, Buildings and roads, Vehicles, plant and equipment, SCADA and radio communication systems	

7.1.4.2 Rehabilitation of Crowborough WWTW

Crowbrough WWTP comprises of 3 units with a combined treatment capacity of 54,000 m^3/d. The estimated dry weather flow is reported to be between 100,000 to 110,000 m^3/d, being twice the design capacity. Unit 1 was commissioned in 1959 and Unit 2 some years later. These have a nominal design capacity of 18,000 m^3/d each. Unit 3, commissioned in 1984 has Nominal design capacity 18,000 m^3/d. Units 1 and 2 have primary settlement with trickling filters. Unit 3 is BNR. The table below summarise the rehabilitation measures identified.

Table 7-10: Rehabilitation Measures at Crowborough WWTW

Component	Description	Remarks
Inlet Works	Replacement/Rehabilitation of the Main Inlet Coarse Screens, 1.2m x 2.0m (approx), Main Intake Fine Screens, 1.2m x 2.0m (approx), Intake Sluice Gates, 1.2m x 2.0m, Grit Tanks, mechanical screen, Air Lift Pumps, Elevators, Flowmeter, Compressors for Air Pumps, Enlargement of Intake Works to 110 ML/D, LV Switchboard, Small Power and Lighting	
Inlet Works: Mufakose	Replacement of Intake Sluice Gates, 1.2m x 1.5m (approx), Main Inlet Coarse Screens, 1.2m x 2.0m (approx), Main Intlet Fine Screens, 1.2m x 2.0m (approx), Flowmeter, LV Switchboard, Air Lift Pumps, Small Power and Lighting, Enlargement and Improvement of Inlet Works, Replacement of Intake Sluice Gates, 1.2m x 1.5m (approx), Inflow DN 900 Concrete Pipes	

Component	Description	Remarks
PSTs, Trickling Filters and Humas Tanks (Unit 1 & 2)	Rehabilitation of the Primary Sedimentation Tanks, Trickling Filters, Humas Tanks*	
Raw Sludge Submersible Pumps Unit 1	Replacement/Rehabilitation of Raw Sludge Pumps, Q = 95 m3, H = 20 m, RW Sludge Pump Controls, Rehabilitation/Replacement of Raw Sludge Pump Delivery Gate Valves, DN 250, Non-Return Valves, DN 250, Pressure Gauges, Air Valves, Raw Sludge Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3 t	
Effluent Pumps to Crowborough Farm	Installation/Replacement/Rehabilitation of Effluent Pumps Controls, Replacement of Pressure Gauges, Air Valves, Effluent Pumps 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pump	Some of the rehabilitation works are cover under the Chinese loan
Raw Sludge Surface Pumps to Ingwe Farm	Installation/Rehabilitation/Replacement of RW Sludge Pump Controls, Pressure Gauges, Air Valves, 3.3 kV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pump	Some of the rehabilitation works are cover under the Chinese loan
Raw Sludge Surface Pumps Mufakose	Installation/Rehabilitation/ Replacement of RW Sludge Pump Controls, Pressure Gauges, Air Valves, Raw Sludge Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pump	Some of the rehabilitation works are cover under the Chinese loan
Effluent Pump Transmission Pipe and Valves	ReplacementMaintenance/Replacement of Gate Valve, DN 450, NRV, DN 450, Steel Pipe, DN 600	
PSTs and Clarifiers (Unit 3)		Covered under the Zim-Fund Phase 1 project
Raw Sludge Surface Pumps Unit 3	Rehabilitation/Replacement of Raw Sludge Pumps, Q = 150 m3, H = 20 m, RW Sludge Pump Controls, Rehabilitation/Replacement of Pressure Gauges, Air Valves, Raw Sludge Pump 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pump	Some of the rehabilitation works are covered under the Zim-Fund Phase 1 project
BNR Unit 3	Replacement/Rehabilitation of RAS Pump, kW = 11, RAS Pump Delivery Valves, DN 250, RAS Pump Non-Return Valves, DN 250, Ras Pump Pressure Gauges, RAS Pump Air Valves, WAS Pump, kW = 5.5, WAS Pump Delivery Valves, DN 200, WAS Pump Non-Return Valves, DN	

Component	Description	Remarks
	200, WAS Pump Pressure Gauges, WAS Pump Air Valves, RAS & Was Pump 380 V LV Switchboard, BNR LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3.0 t	
Digesters	Rehabilitation of Primary Digesters and Secondary Digesters	
Digester Sludge Control Pumps	Installation/Rehabilitation/Replacement of Mixing Pumps Controls, of Injection Pumps Controls, Injection Pumps Delivery Gate Valves, DN 150, Injection Pumps Non-Return Valves, DN 150, Injection Pumps Pressure Gauges, Injection Pumps Air Valves, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pumps	Some of the rehabilitation works are covered under the Zim-Fund Phase 1 project
Heat Exchanger	Replacement/Rehabilitation of Heat Effluent Pumps, kW = 11, Heat Effluent Pumps Controls, Effluent Pumps Suction Gate Valves, DN 150, Heat Effluent Pumps Delivery Gate Valves, DN 150, Non-Return Valves, DN 150, Heat Effluent Pumps Pressure Gauges, Heat Effluent Pumps Air Valves, Recirculation Pumps, kW = 2.2, Recirculation Pumps Controls, Recirculation Pumps Suction Gate Valves, DN 150, Recirculation Pumps Delivery Gate Valves, DN 150, Recirculation Pumps Non-Return Valves, DN 150, Recirculation Pumps Pressure Gauges, Recirculation Pumps Air Valves, Heat Effluent and Circulation Pumps 380 V LV Switchboard, Small Power and Lighting, overhead Wire Rope Hoist, 3t, Dewatering Pumps	
Gas Holders	Replacement/Rehabilitation of Gas Holders and Burner	
Miscellaneous	Power Transformers and Switchgear, Security lights and fence, Standby Generators, Office and Workshop Buildings Incl. Electrical and Mechanical Works, Roads, Vehicles, Tractors and Plant, Laboratory Equipment, SCADA and Radio Communication Systems	

7.1.4.3 Rehabilitation of Hatcliff WWTW

Rehabilitation measures at Hatcliff WWTW are summarised in the table below

Table 7-11: Rehabilitation Measures at Hatcliff WWTW

Component	Description	Remarks
Inlet Works	Modification and Extension/Rehabilitation of Inlet Civil Works, Replacement/Rehabilitation of the Main Inlet Coarse Screens, Main Inlet Fine Screens, Inlet Sluice Gates, construction/rehabilitation of Grit Tanks, installation/replacement of mechanical screen, Air Lift Pumps, Compressors for Air Pumps, Elevator, Flowmeter, LV Switchboard, Small Power and Lighting,	
BNR Unit	Rehabilitation/Replacement of BNR Unit, RAS Pump, RAS Pump Delivery Valves, DN 200, RAS Pump Non-Return Valves, DN 200, Ras Pump Pressure Gauges, RAS Pump Air Valves, Axial Pumps, Axial Pump Delivery Valves, DN 200, Axial Pump Non-Return Valves, DN 200, Axial Pump Pressure Gauges, Axial Pump Air Valves, RAS & Axial Pump 380 V LV Switchboard, Small Power and Lighting,	
Clarifiers Unit	Rehabilitation of Clarifiers	
Miscellaneous	Transformer, 500 kVA, 11/0.40 kV, Security Lights, Security Fence, Generator, 300 kVA, Office and Workshop Buildings Incl. Electrical and Mechanical Works, Road/Compound, Vehicles, Tractors and Plant, Laboratory Equipment, SCADA and Radio Communication Systems	

7.1.4.4 Rehabilitation of Sewage Pump Stations

A number of sewage pump stations were inspected. The identified rehabilitation measures are presented in the table below

Table 7-12: Rehabilitation Measures at Sewage Pump Stations

Component	Description	Remarks
AVONLEA Sewage Pump Stations	Rehabilitation of Pump Sump, Replacement of Sewage Pump, No. 2, Replacement of Sewage Pump, No. 3 and No 4, Miscellaneous	
BUDIRIRO Sewage Pump Station	Rehabilitation of Inlet Works, Rehabilitation of Pump Sump, Replacement of Sewage Surface Pumps, Miscellaneous	

Component	Description	Remarks
MT PLEASANT NE Sewage Pump Station	Rehabilitation of Pump Sump, Replacement of Sewage Surface Pumps, Miscellaneous	
NEW MARLBOROUGH Sewage Pump Station	Rehabilitation of Pump Sump, Replacement of Sewage Submersible Pumps, Miscellaneous	
BORROWDALE BROOK Sewage Pump Station	Rehabilitation of Pump Sump - Pump Station, No. 01*, Rehabilitation of Pump Sump - Pump Stations Nos. 02 - 04*, Replacement of Sewage Pump Station, No. 01, Replacement of Sewage Pump Station, No. 02 – 04, Miscellaneous	Some of the rehabilitation works are covered under the China EXIM Bank loan
CHISIPITE Sewage Pump Station	Rehabilitation of Pump Sump - Old Pump Station, Rehabilitation of Pump Sump - New Pump Station, Replacement of Old Sewage Pump Station, Replacement of New Sewage Pump Station, Miscellaneous	

7.1.4.5 Replacement/Upgrading of existing sewer network

The sewers are generally in good condition, except for the exposed ferrous sections on stream crossing, which are badly leaking. The pipes in these sections will be replaced. Sewers in older parts of the city such as Mbare, CBD, Kuwadzana, Rugare and Westlea are reported to be in bad condition. These sewers will also be replaced. According to the hydraulic model, some trunk sewers will be upgraded to increase carrying capacity. The details of the modelling are presented in Appendix 4.1. The table below summarises the sewers that will be replaced/upgraded.

Table 7-13: Pipe Replacement Measures in the Sewer Network - Harare

Replacement/Upgrading of existing sewer network		
Sewer reticulation pipes in some areas (Mbare, CBD, Kuwadzana, Rugare, Westlea etc)		
ND 150 PVC	m	35,484
ND 250 PVC	m	3,255
ND 315 PVC	m	3,026
Replacement (complete with pipe bridge) of leaking pipe sections on stream/river crossings		
ND 250 ST	m	75
ND 300 ST	m	670
ND 375 ST	m	75
ND 450 ST	m	300
ND 525 ST	m	200
ND 600 ST	m	880
ND 675 ST	m	250
ND 750 ST	m	270
ND 875 ST	m	150
ND 1400 ST	m	2,390

Replacement/Upgrading of existing sewer network		
Trunk sewer upgrades		
ND 450 PVC	m	18,630
ND 525 RC	m	13,517
ND 600 RC	m	6,359
ND 675 RC	m	2,484
ND 750 RC	m	2,896
ND 825 RC	m	3,688
ND 900 RC	m	6,755
ND 1050 RC	m	2,905
ND 1200 RC	m	197

7.1.5 E – Extension of Sewerage Services

7.1.5.1 Harare South sewerage Investment measures

The Harare South sewerage investment measures relate to the sewage collection and treatment for the eastern, south eastern and southern suburbs of Harare. These areas all fall within the Manyame river catchment.

Currently these areas have varied sewage provision and include large un-sewered areas into which the city is expanding. Collected sewage is, with the exception of Chitungwiza, treated in many, dispersed small stabilization ponds which are generally functioning poorly. The current situation in this catchment is that the majority of sewage is therefore discharged into the Manyame and its tributaries untreated.The prince Edward Water Treatment works extracts water from the centre of this increasingly polluted catchment.

Existing Plan

Current plans date back to the 2003 Harare Sewage Master Plan prepared by Safege. This master plan recognized that the major expansions of Harare would be in the southern suburbs, termed in that report the Southern Industrial Area or SIA. That Master Plan expected population growth within the SIA to increase sewage production from zero in 2003 to 85MLD in 2015. The management of this sewage and sewage from eastern suburbs was proposed as follows:

1. Ventersberg, Tafara, Donny Brook, Ruwa and Epworth would all be drained to a new sewage treatment works at Lyndhurst Farm. The plan called for the construction of collector and trunk sewers leading a Biological Nutrient Removal (BNR) plant on Lyndhurst Farm. Considerable progress was made on the sewer construction but none on the treatment works before the project was suspended due to lack of funds.
2. The Southern Harare Suburbs, collectively termed the SIA were divided into six sub catchments. The 2003 plan calls for part of the effluent from the SIA area to be pumped to Lyndhurst Farm WWTW whilst 3 new BNR works and two additional sewage pumping stations would serve the balance of the SIA.
3. Not included in the 2003 Harare Master Plan is Chitungwiza. Current plans are for the construction of a new Sewage Treatment Plant at the confluence of the Nyatsime and Manyame rivers an the North West corner of Chitungwiza.

Proposed Combined Plan

This project is recommending a proposal to combine all of these areas into a single sewage catchment with all of the effluent to be collected into a major new Harare South Trunk Sewer (HSTS) and treated at a new Harare South Wastewater Treatment Works (HSWWTW). The proposal would include the following sub projects:

1. Completion of the Donny Brook to Lyndhurst Farm trunk sewer and connection of Ventersberg, Donny Brook and Mabvuku /Tafara to this line. This was partly constructed in 2003 but not completed. This sub project is required regardless of whether a combined sewage plan is implemented and will allow for the decommissioning of three sets of waste stabilization ponds in Donny Brook.
2. Connection of the Epworth area to the Donny Brook to Lyndhurst Farm trunk sewer which passes through Epworth. This sub project is required regardless of whether a combined sewage plan is implemented and will allow the Epworth sewer system constructed 20 years ago finally to be commissioned.
3. Construction of two trunk sewers to link the collection system in Ruwa to the Donny Brook to Lyndhurst sewer. This construction will allow the decommissioning of three sewage pumping stations in Ruwu which currently regularly discharge raw sewage into the Ruwa river.This sub project is required regardless of whether a combined sewage plan is implemented.
4. An extension from the end of the existing Donny Brook to Lyndhurst Farm Sewer approximately 28km to a proposed new Sewage Treatment Plant close to the confluence between the Manyame and Mukuvisi Rivers.
5. An extension in the trunk sewer proposed to link Chitungwiza to its new WWTW by approximately 1km such that it ties into the trunk sewer from Lyndhurst Farm to the new WWTW.
6. Construction of a single WWTW at the end of the new Trunk Sewer. The construction of this works would obviate the need for construction of the five new WWTWs currently proposed at Lyndhurst Farm, SIA Zones 2,3 and 4 and Chitungwiza.

Ideally these works would be put in place immediately but the HSTS and its associated treatment works represent a very major capital investment at a time when the city has many competing demands for resources. Therefore it is planned that interim measures will be put in place in the short to medium term to keep the existing system functioning and return it to its designed functionality whilst the HSTS scheme will be implemented as a long term investment measure.

Interim measures proposed are as follows:

1. Short term minor works to rehabilitate the existing Donny Brook 1 to 4 waste stabilisation ponds
2. Construction of temporary pond system in Ruwa to treat Ruwa Wastewater in the Medium Term
3. Delay any measures to provide waterborne sanitation in Epworth until the long term when the HSTS will be in place.
4. Develop a 125Ha irrigation area for the disposal of wastewater from the Donny Brook Ponds

5. Only the lowest portion of the Harare South Trunk Sewer will be developed in the Medium Term, from Chitungwiza to the outfall.
6. Initially the new Single Treatment works will be sized for just flows from Chitungwiza and areas downstream and so wil require a small pump station and DN500 force main to the location of the new ponds and irrigation system.

The detailed investment measures are presented in the table overleaf

Table 7-14: Harare South Sewerage System Investment Measures

Investment Measures	Unit	Medium Term	Long Term
Decommissioning of Sewage Treatment Works			
Donny Brook 1	Sum		1
Donny Brook 2	Sum		1
Donny Brook 3	Sum		1
Donny Brook 4	Sum		1
Rehabilitation/ Commissioning of Existing Lyndhurst Farm Sewer			
New / replacement Pipework			
ND 450 PVC	m		300
ND 600 Concrete	m		210
ND 750 Concrete	m		90
ND 900 Concrete	m		390
ND 1050 Concrete	m		340
ND 1200 Concrete	m		190
Construction of replacement manholes	nos.		15
Rehabilitation of manhole cover and frame	nos.		30
New manhole covers only	nos.		106
Complete Pipelaying over Pipe Bridges			
ND 450 ST	m		200
ND 525 ST	m		200
Trunk Sewer Extensions in Southern Suburbs (Ward 1)			
New / replacement Pipework			
ND 400 PVC	m		2,300
ND 450 PVC	m		2,550
ND 525 Concrete	m		1,000
ND 750 Concrete	m		860
ND 825 Concrete	m		2,450
Construction of New Manhole	nos.		114
Harare South Trunk Sewer			
New / replacement Pipework			
ND 750 Concrete	m	2570	
ND 825 Concrete	m	640	

Investment Measures	Unit	Medium Term	Long Term
ND 900 Concrete	m		19,250
ND 1350 Concrete	m		
ND 1500 Concrete	m		9000
Construction of replacement manholes	nos.	54	471
Harare South Sewage Pump Station and Force Main			
Sewage Pumping Station Construction	kW	250	1500
Sewage Pumping Equipment	kW	250	1500
GRP Force Main DN500	m	7000	
GRP Force Main DN1000	m		7000
Harare South Wastewater Treatment Works			
Wastewater Stabiliation Pond System			
Construction of Wastewater Stabilisation Pond System	MLD	12	83
Wastewater Slow Rate (irrigation) disposal system			
Irrigation Set Up	Ha	140	804
Irrigation Pumps and Equipment	Ha	140	945

7.1.5.2 Extension of sewer reticulation system in new development areas

Waterborne Sanitation

The sewer network will be extended to cover the new development areas. As outlined in Chapter 3, most of the additional population in the medium and long term will settle in Harare South, Whitecliff, Rainham, Mount Hampden, Mount Pleasant Heights, Sally Mugabe and Caledonia. There will also be some infill growth in the existing areas. The sewer network requirements in the new development areas have been calculated on the basis of population and the per capita infrastructure requirements. The per capita infrastructure requirements were calculated using the existing network quantities and the population from the recent census. The parameters below were used to calculate the infrastructure requirements in extension areas

- House hold size (assuming one connection per household): 6 people
- Tertiary sewer collector lengths per capita: 1.2 m/ca.

Table 7-15: Sewerage Investment Measures in New development Areas - Harare

Investment Measures	Unit	2020	2030
pipes			
ND 100 PVC	m	118,063	407,876
ND 160 PVC	m	283,352	978,903
Construction of manholes	nos.	8,028	27,736
Sewer service connections			
ND 100	nos.	47,225	163,150

Unserviced Areas

A significant proportion of the population of Harare will remain outside of the areas provided with formal waterborne sanitation, even in the long term. Sewage system investments will take many years to implement and some area will remain outside of the sanitation boundary for the town even in the long term. In these areas support must be given for the proper use of on-site sewage disposal and treatment systems. Support will include:

- In areas of high water table where pit latrines and pour flush latrines are not practical, communities will need support to deploy and manage urine separation composting toilets. This type of toilet offers a good solution in these areas but as they require a more significant structure than pits or pour flush toilets they are often unaffordable. In addition users must be trained in their proper use and communities must find a source of ash which has to be added to the composting solids and is not readily available in Harare where people do not cook on wood stoves.
- In other areas pour flush toilets are clearly the preference of the householders and are seen to be installed where ever sufficient water is available. These offer a cheap alternative to a full waterborne solution with significant benefits over pit latrines. Pour flush systems should only be encouraged in areas where water supply is piped in. Support to communities wishing to use this type of toilet may include:
    - Improvements to water supply such that the householders have sufficient water to operate pour flush systems
    - Training of builders in good practices for construction of pour flush toilets and soakaways.
    - Provision of subsidised components such as cover slabs and squat pans to improve the affordability of pour flush systems
- Only where water supplies are very scarce will pit latrines be favoured by house holders. In future, reliance on pit latrines should therefore be limited to areas where no formal water supply system is in place. Support to communities on pit latrines may include:
    - Training of builders in good practices for construction of pit latrines.
    - Provision of subsidised components such as cover slabs, squat pans and ventilation pipes to improve the affordability of quality pit latrine systems
    - Training of householders in methods of maintaining the toilets and preventing the breeding of insects in the toilets.

7.2 Chitungwiza

Investment measures in Chitungwiza are summarized in the figure below. The maps in Figure 7-6 and Figure 7-7 show the spatial location of the proposed water supply investment measures and sewerage investment measures, respectively.

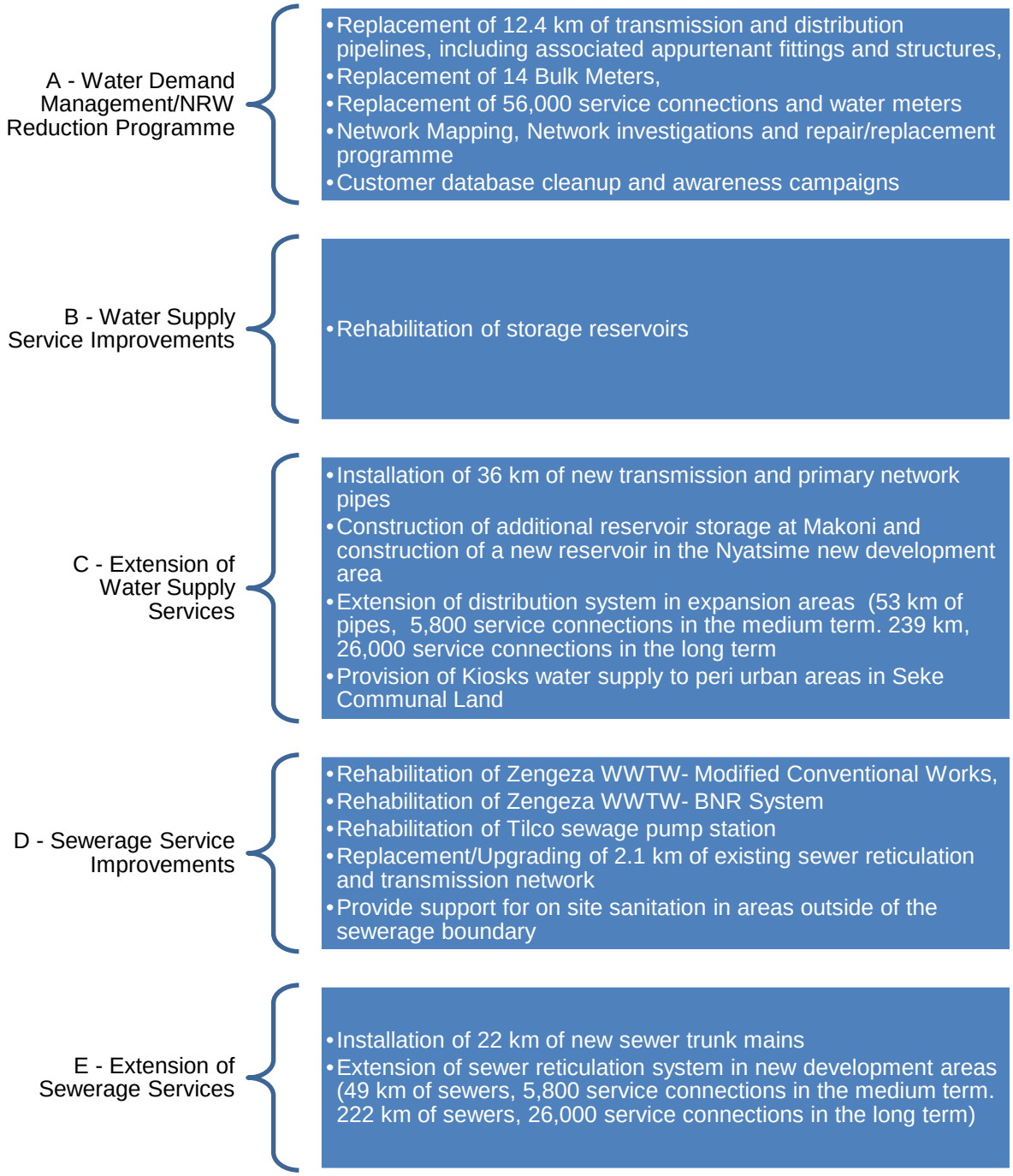


Figure 7-5: Summary of Investment Measures in Harare

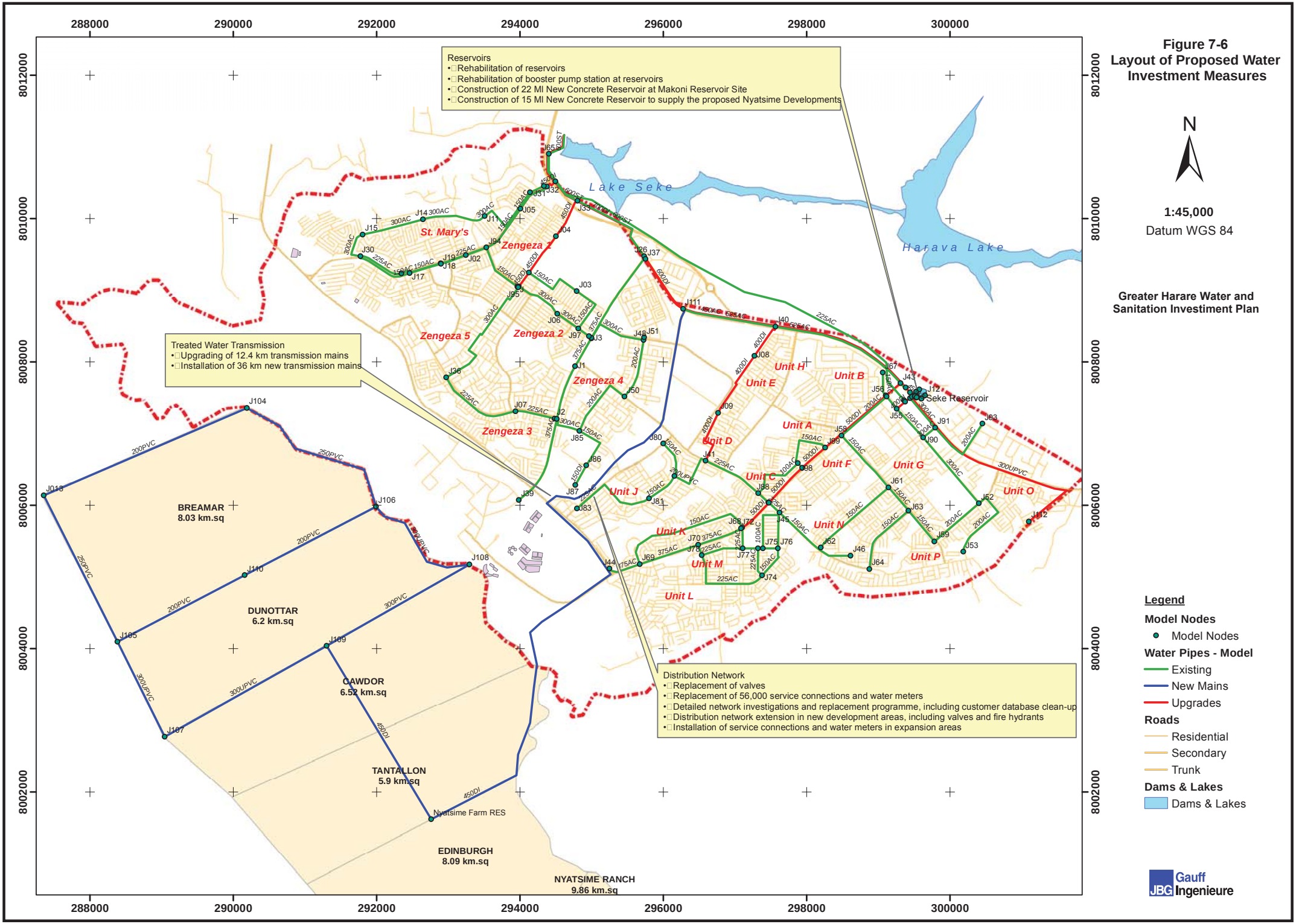


Figure 7-6
Layout of Proposed Water Investment Measures

N

1:45,000
Datum WGS 84

Greater Harare Water and Sanitation Investiment Plan

Legend

Model Nodes
- Model Nodes

Water Pipes - Model
- Existing
- New Mains
- Upgrades

Roads
- Residential
- Secondary
- Trunk

Dams & Lakes
- Dams & Lakes

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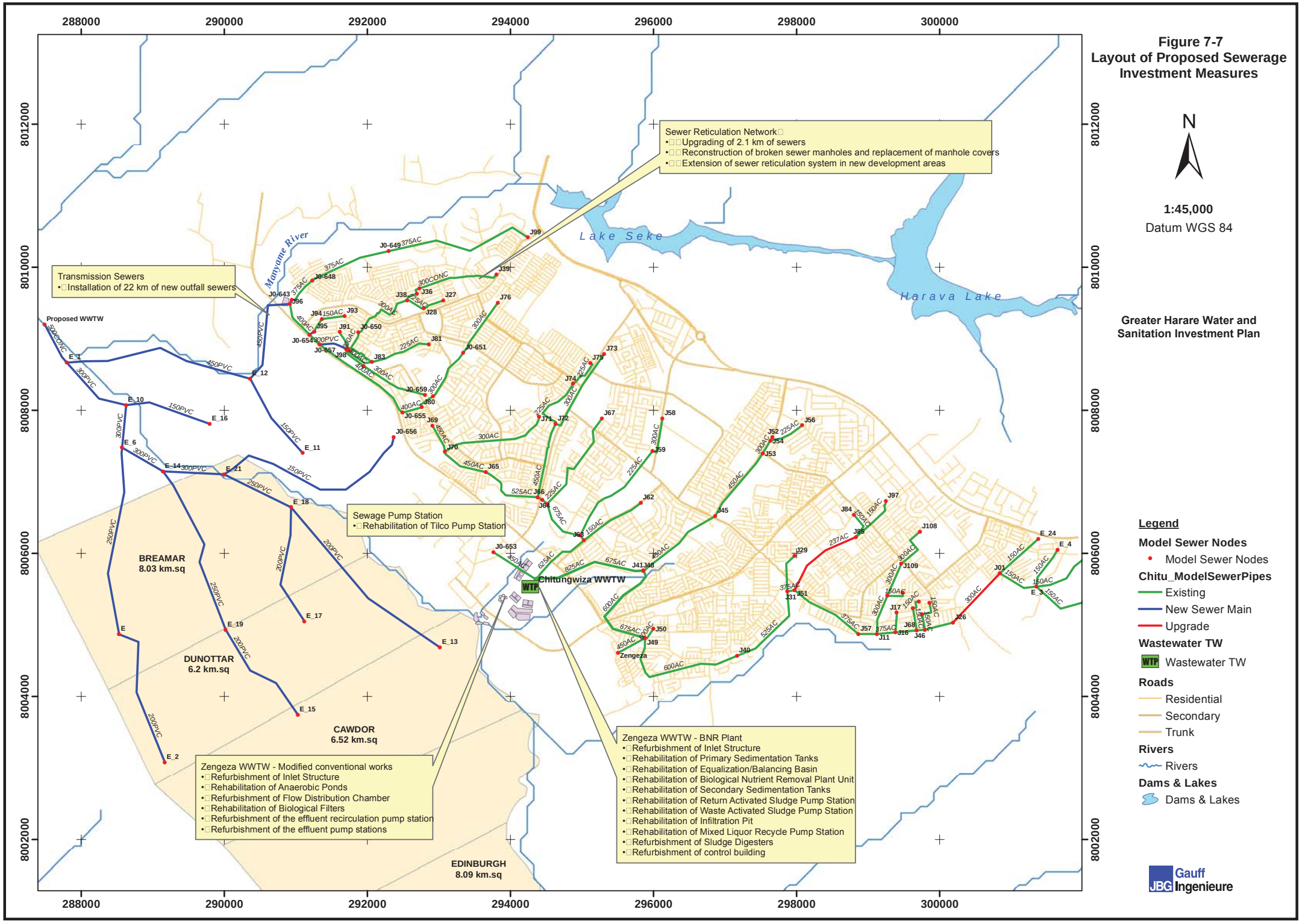
Figure 7-7
Layout of Proposed Sewerage Investment Measures
N
1:45,000
Datum WGS 84
Greater Harare Water and Sanitation Investment Plan
Sewer Reticulation Network
•Upgrading of 2.1 km of sewers
•Reconstruction of broken sewer manholes and replacement of manhole covers
•Extension of sewer reticulation system in new development areas
Transmission Sewers
•Installation of 22 km of new outfall sewers
Sewage Pump Station
•Rehabilitation of Tilco Pump Station
Zengeza WWTW - Modified conventional works
•Refurbishment of Inlet Structure
•Rehabilitation of Anaerobic Ponds
•Refurbishment of Flow Distribution Chamber
•Rehabilitation of Biological Filters
•Refurbishment of the effluent recirculation pump station
•Refurbishment of the effluent pump stations
Zengeza WWTW - BNR Plant
•Refurbishment of Inlet Structure
•Rehabilitation of Primary Sedimentation Tanks
•Rehabilitation of Equalization/Balancing Basin
•Rehabilitation of Biological Nutrient Removal Plant Unit
•Rehabilitation of Secondary Sedimentation Tanks
•Rehabilitation of Return Activated Sludge Pump Station
•Rehabilitation of Waste Activated Sludge Pump Station
•Rehabilitation of Infiltration Pit
•Rehabilitation of Mixed Liquor Recycle Pump Station
•Refurbishment of Sludge Digesters
•Refurbishment of control building
Legend
Model Sewer Nodes
Model Sewer Nodes
Chitu_ModelSewerPipes
Existing
New Sewer Main
Upgrade
Wastewater TW
WTP Wastewater TW
Roads
Residential
Secondary
Trunk
Rivers
Rivers
Dams & Lakes
Dams & Lakes
Lake Seke
Harava Lake
Manyame River
Proposed WWTW
Chitungwiza WWTW
Zengeza
BREAMAR
8.03 km.sq
DUNOTTAR
6.2 km.sq
CAWDOR
6.52 km.sq
EDINBURGH
8.09 km.sq
288000
290000
292000
294000
296000
298000
300000
8012000
8010000
8008000
8006000
8004000
8002000
Gauff Ingenieure

7.2.1 A – Water Demand Management/NRW Reduction Measures

Pilot area investigations yielded the following findings:

- The AC distribution pipes are reported to be in good condition despite their age;
- All of the gate valves are in poor condition. Network leakages occur at these fittings;
- The majority of service connections are corroded and incrusted. This is where most of the network leakages occur;
- The majority of water meters are non-functional and few functional ones are not measuring water usage accurately;
- Significant amount of water is wasted after the meter resulting in unnecessary water use/ wastage.
- The billing database is poorly maintained and revenue collection efforts are hampered by this.

In light of the above findings, the following measures are recommended:

- Since the AC pipes are still in good condition, they should be left in service except for the broken pipes identified by council;
- All network appurtenant structures such as valves and fire hydrants should be replaced;
- All service connections and water meters should be replaced;
- All bulk water meters should be replaced;
- Under normal circumstances, line after the service meter and the plumbing system in a property is the responsibility of the property owner or water user. But, if the property is not metered, there is no incentive for the water user to keep their plumbing system in good condition and reduce water wastage. In a water supply scheme where most water users are not metered (or meters are not working) as is the case in Chitungwiza, there are huge water losses at the properties and this is usually part of the NRW since the customers are billed on normal usage estimates. Hence, we recommend that council should, firstly, meter all customers and then implement a water conservation programme that has elements of rehabilitating household plumbing installations and household education and awareness programmes. The finances for such a programme are part of the investment plan.
- Support will be required to clean up the billing database and to ensure that all mains water connections are properly recorded.

Given the recommendations outlined above, the investment measures needed to rehabilitate the network and reduce physical losses are presented in the table below. The network rehabilitation measures proposed will be implemented under the medium term project.

Table 7-16: Network Rehabilitation Measures - Chitungwiza

Investment Measures	Unit	Qty
Rehabilitation/replacement of water distribution network		
ND 75 PVC	m	
ND 110 PVC	m	
ND 160 PVC	m	315
Replacement/Installation of section valves		
ND 50 Gate	nos.	409
ND 75 Gate	nos.	1,190
ND 100 Gate	nos.	544
ND 150 Gate	nos.	88
ND 200 Gate	nos.	4
ND 250 Gate	nos.	2
ND 300 Butterfly	nos.	1
ND 400 Butterfly	nos.	1
ND 500 Butterfly	nos.	1
Installation of bulk meters		
ND 150 Woltman type	nos.	4
ND 200 Woltman type	nos.	3
ND 250 Woltman type	nos.	2
ND 300 Woltman type	nos.	3
ND 400 Electromagnetic	nos.	1
ND 500 Electromagnetic	nos.	1
Replacement of service connections and water meters		
Domestic (ND 15) (OD 20)	nos.	44,800
Non-Domestic (ND 25)	nos.	11,200
Provisional sum for network mapping, network investigations and repair/replacement programme	Sum	1
Provisional sum for customer database clean-up and awareness campaigns	Sum	1

7.2.2 B – Water Supply Service Improvements

Chitungwiza relies on water supply from the City of Harare. Hence there are not water production facilities to be considered. Investment measures in Chitungwiza under this category are restricted to the rehabilitation of the Makoni reservoirs and replacement/upgrading transmission and primary distribution pipes as shown in the table below

Table 7-17: Transmission Pipe replacements - Chitungwiza

Pipe Diameter	Unit	Qty
ND 315 PVC	m	1,236
ND 400 DI	m	2,978
ND 450 DI	m	1,695
ND 500 DI	m	2,995
ND 600 DI	m	925
ND 700 DI	m	2,553

7.2.3 C – Extension of Water Supply Services

7.2.3.1 Installation of new transmission and primary mains

The new transmission and primary distribution mains are needed mainly to transfer water to the new Nyatsime development areas. The detailed discussion on the capacity analysis and sizing (hydraulic modelling) in presented in Annex 4.2. The table below shows the new transmission and primary mains.

In addition to the above measures which will cover the areas formally supplied with water there will remain in the short term some areas such as the Seke Communal Area where no formal water supply exists. These areas will need to be provided with kiosks with water supply from the nearest point of supply in the city or by borehole.

Table 7-18: Transmission and Primary Mains - Chitungwiza

Investment Measures	Unit	2020
Pipes		
ND 200 PVC (OD 225)	m	7,157
ND 250 PVC (OD 280)	m	4,742
ND 315 PVC	m	11,380
ND 450 DI	m	12,633
Section Valves		
ND 200 Gate	nos.	72
ND 250 Gate	nos.	47
ND 300 Butterfly	nos.	113
ND 400 Butterfly	nos.	126
Water Kiosk supplies to peri urban areas		
Boreholes to supply peri urban areas	nos.	20
Water Kiosks	nos	10

7.2.3.2 Construction of new storage reservoirs

The reservoirs for Chitungwiza are located on the north eastern outskirts of the town north of Makoni Shopping Centre at the end of the network. The reservoir site has four ground reservoirs of equal capacity and an elevated tank. They have a total storage capacity of approximately 46, 000 m^3. A small booster pump station houses the pump sets used to transfer water to the elevated tank.

Considering the long term demand of around 85,000m^3, it is clear that the existing storage capacity will not be sufficient. Hence we recommend the following investment measures:

- Construction of a new 22,000m^3/d concrete reservoir at Makoni Reservoir Site;
- Construction of a new 15,000 m^3/d concrete reservoir at highest point on Nyatsime Farm Development.

7.2.3.3 Extension of distribution system in expansion areas

The water reticulation network will be extended to cover the new development areas. As outlined in Chapter 3, most of the additional population in the medium and long term will

settle on Nyatsime Farms. There will also be some infill growth in the following areas; Seke CL. The water network requirements in the new development areas have been calculated on the basis of population and the per capita infrastructure requirements. The per capita infrastructure requirements were calculated using the existing network quantities and the population from the 2012 census. The parameters below were used to calculate the infrastructure requirements in extension areas

- House hold size (assuming one connection per household): 6 people;
- Tertiary pipe network lengths per capita – ND 75: 1.2 m/ca;
- Tertiary pipe network lengths per capita – ND 100: 0.8 m/ca.

The table below shows the investment measures needed to extend the water network to the new development areas.

Table 7-19: Investment Measures in Expansion Areas

Investment Measures	Unit	2020	2030
Pipes			
ND 75 PVC	m	29,359	132,575
ND 110 PVC	m	23,487	106,060
Section valves			
ND 75 Gate	nos.	294	1,326
ND 100 Gate	nos.	235	1,061
ND 150 Gate	nos.	-	-
Installation of fire hydrants in expansion areas			
ND 80	nos.	47	212
Installation of service connections and water meters in expansion areas			
ND 15	nos.	4,893	22,096
ND 25	nos.	979	4,419

7.2.4 D – Sewerage Service Improvements

Sewerage improvement measures in Chitungwiza consist of rehabilitation of Zengeza WWTW, rehabilitation of Tilco Sewage Pump Station and replacement/upgrading of sewers.

7.2.4.1 Rehabilitation Zengeza WWTW

Zengeza WWTW consist of two treatment facilities constructed in phases – the Modified Conventional Treatment Works and the Biological Nutrient Removal Works. The modified conventional works consist of inlet works, anaerobic ponds, biological trickling filters and an effluent pumping station. The BNR Plant was constructed with some financial support from Japan in 2000.It has a nominal plant capacity of 20,000 m^3/d. It consists of the following process units;

- New Inlet Works complete with a grit system discharging grit to the existing Old Works grit removal system.
- Primary sedimentation tanks,
- Equalisation basin,
- BNR Tank comprising; an anaerobic basin, anoxic basin, and an aerobic basin,

- Final Sedimentation Tanks,
- Maturation Ponds,
- Sludge Thickeners,
- Sludge Digesters.

The plant was operated from the day of commissioning up to 2004 and it hasn't been operated since because it's in a bad state. The table below summarises the rehabilitation measures for both the modified convectional plant and the BNR.

Table 7-20: Rehabilitation Measures at Zengeza WWTW

Component	Investment measures	Remarks
Modified Conventional Works		
Inlet Structure		Covered under the Zim-Fund Phase 1 project
Anaerobic Ponds		Covered under the Zim-Fund Phase 1 project
Flow Distribution Chamber	Rehabilitation of pitted concrete walls and damaged sections, rehabilitation of distribution weirs	
Biological Filters		Covered under the Zim-Fund Phase 1 project
Effluent recirculation pump station	Replacement of pumps, replacement of control gear, rehabilitation of pitted concrete walls and damaged sections	
Effluent pump stations		Covered under the Zim-Fund Phase 1 project
Biological Nutrient Removal Plant		
Inlet Structure	Replacement of screens, hand penstock gates, intake control valve, flow measurement system, refurbishment of grit removal system, replacement of water tower supply pumps, refurbishment of the above ground shed structure, replace baffles in the grit tanks, weir overflow gates, compressor, air receiver, empty and clean grit chambers	
Primary Sedimentation Tanks	Replacement/Rehabilitation of weirs, sludge collectors, inlet and outlet pipes and fittings, pitted concrete walls and damaged sections, sludge pump	
Equalisation/Balancing	Replace/rehabilitate mixers, and flow meters	

Component	Investment measures	Remarks
Basin		
Biological Nutrient Removal Plant Unit	Replacement of mixers, motors and gear box, aerators, motors and gear box, all hand-railing and related steel work	
Secondary Sedimentation Tanks	Replacement of weirs, steel bridges, inlet and outlet pipes and fittings, rehabilitation of pitted concrete walls and damaged sections, replacement of all hand-railing and related steel work, repair sludge collector bridge drives	
Return Activated Sludge Pump Station	Replacement of pumps and control gear, rehabilitation of pitted concrete walls and damaged sections	
Waste Activated Sludge Pump Station	Replacement of pumps and control gear, rehabilitation of pitted concrete walls and damaged sections	
Infiltration Pit	Replacement of pumps and control gear, rehabilitation of pitted concrete walls and damaged sections	
Mixed Liquor Recycle Pump Station	Replacement of pumps, control gear, compressors, Rehabilitation of pitted concrete walls and damaged sections	
Sludge Digesters	Replacement of choked pipes, thickener drives, thickener pumps, mixing pumps, bilge pumps, withdrawal pumps, sludge storage shed roof, pumps and motors	
Control building	Replacement of electrical switchboard, mimic panel, servicing of the main switchboard	

7.2.4.2 Replacement/upgrading of sewers

Given that Chitungwiza is a relatively recent settlement, the sewer pipes are in generally good condition. However some sewer will require upgrading increase carrying capacity. The table below summarises the estimated investment measures in the sewer reticulation system.

Table 7-21: Sewer Replacements - Chitungwiza

	Investment Measures	Unit	Qty
i	Pipes		
b	ND 250 PVC	m	1,188
c	ND 315 PVC	m	954
ii	Manholes		
a	rehabilitation of manholes	nos.	24
b	replacement of missing manhole covers	nos.	24

7.2.5 E – Extension of Sewerage Services

Formally Sewered Areas

The sewer network will be extended to cover the new development areas. As outlined in Chapter 3, most of the additional population in the medium and long term will settle in Longlands, Braemar A, Dunnotar, Cawdor, Tantallon and Edinburgh which are loosely referred to as Nyatsime Farms. There will also be some infill growth in the existing areas. The sewer network requirements in the new development areas have been calculated on the basis of population and the per capita infrastructure requirements. The per capita infrastructure requirements were calculated using the existing network quantities and the population from the recent census. The parameters below were used to calculate the infrastructure requirements in extension areas

- House hold size (assuming one connection per household): 6 people
- Tertiary sewer collector lengths per capita: 1.2 m/ca.

Table 7-22: Sewerage Investment Measures in New development Areas - Chitungwiza

Investment Measures	Unit	2020	2030
pipes			
ND 100 PVC	m	14,495	65,455
ND 160 PVC	m	34,788	157,092
Construction of manholes	nos.	986	4,451
Installation of sewer service connections			
ND 100	nos.	5,798	26,182

Unserviced Areas

Certain areas of Chitungwiza will remain outside of the areas provided with formal waterborne sanitation, even in the long term. Sewage system investments will take many years to implement and some area will remain outside of the sanitation boundary for the town even in the long term. In these areas support must be given for the proper use of on-site sewage disposal and treatment systems. Support will include:

- In areas of high water table where pit latrines and pour flush latrines are not practical, communities will need support to deploy and manage urine separation composting toilets. This type of toilet offers a good solution in these areas but as they require a more significant structure than pits or pour flush toilets they are often unaffordable. In addition users must be trained in their proper use and communities must find a source of ash which has to be added to the composting solids and is not readily available in Harare where people do not cook on wood stoves.
- In other areas pour flush toilets are clearly the preference of the householders and are seen to be installed where ever sufficient water is available. These offer a cheap alternative to a full waterborne solution with significant benefits over pit latrines. Pour flush systems should only be encouraged in areas where water supply is piped in. Support to communities wishing to use this type of toilet may include:
    - Improvements to water supply such that the householders have sufficient water to operate pour flush systems

  - Training of builders in good practices for construction of pour flush toilets and soakaways.
  - Provision of subsidised components such as cover slabs and squat pans to improve the affordability of pour flush systems

- Only where water supplies are very scarce will pit latrines be favoured by house holders. In future, reliance on pit latrines should therefore be limited to areas where no formal water supply system is in place. Support to communities on pit latrines may include:
  - Training of builders in good practices for construction of pit latrines.
  - Provision of subsidised components such as cover slabs, squat pans and ventilation pipes to improve the affordability of quality pit latrine systems
  - Training of householders in methods of maintaining the toilets and preventing the breeding of insects in the toilets.

7.3 Epworth

Investment measures in Epworth are summarized in the figure below. The maps in Figure 7-9 and Figure 7-10 show the spatial location of the proposed water supply investment measures and sewerage investment measures, respectively.

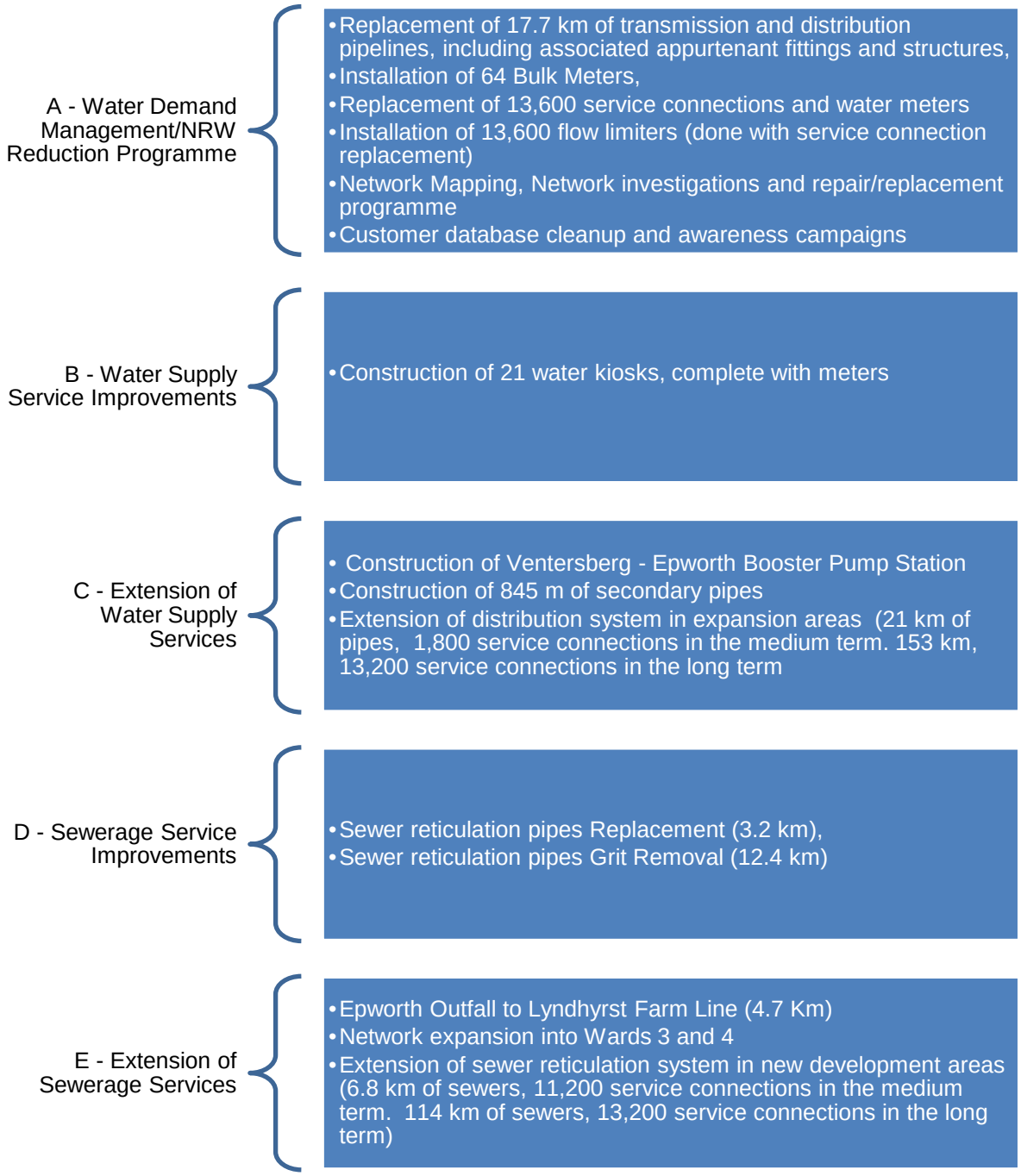

Figure 7-8: Summary of Investment Measures in Epworth

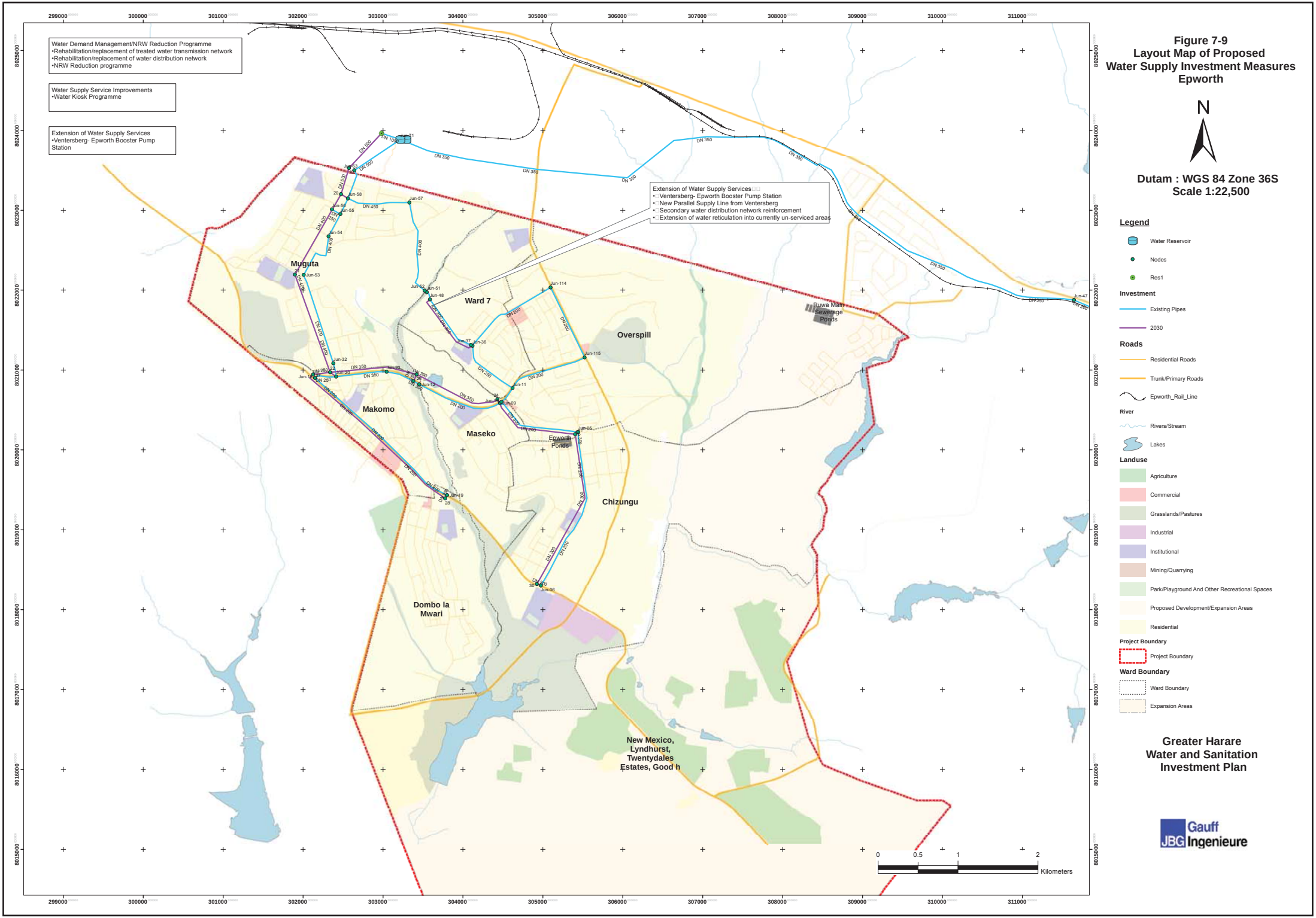

Figure 7-9
Layout Map of Proposed Water Supply Investment Measures Epworth

N

Dutam : WGS 84 Zone 36S
Scale 1:22,500

Legend

- Water Reservoir
- Nodes
- Res1

Investment

- Existing Pipes
- 2030

Roads

- Residential Roads
- Trunk/Primary Roads
- Epworth_Rail_Line

River

- Rivers/Stream
- Lakes

Landuse

- Agriculture
- Commercial
- Grasslands/Pastures
- Industrial
- Institutional
- Mining/Quarrying
- Park/Playground And Other Recreational Spaces
- Proposed Development/Expansion Areas
- Residential

Project Boundary

- Project Boundary

Ward Boundary

- Ward Boundary
- Expansion Areas

Greater Harare
Water and Sanitation
Investment Plan

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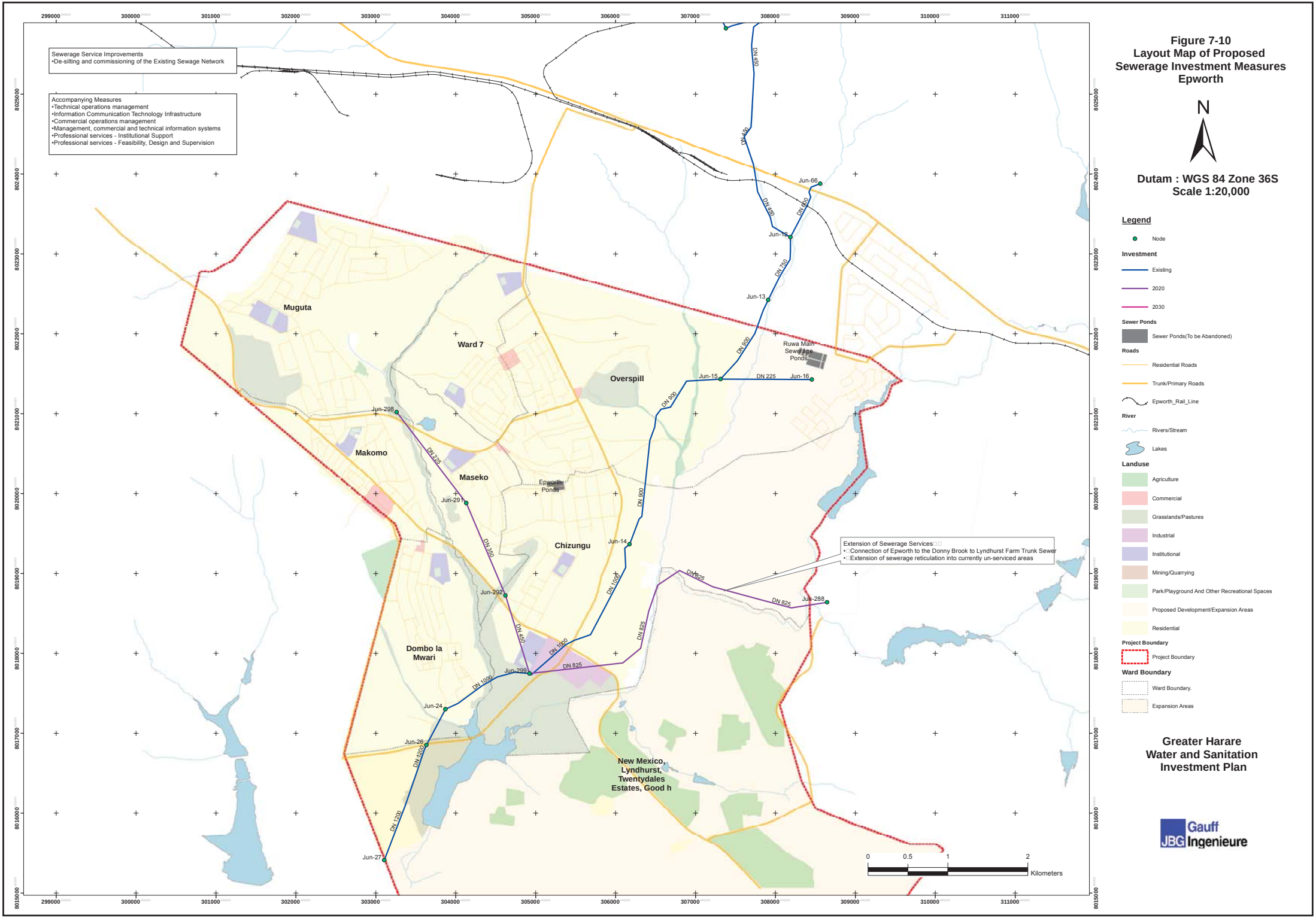


Figure 7-10
Layout Map of Proposed Sewerage Investment Measures Epworth

N

Dutam : WGS 84 Zone 36S
Scale 1:20,000

Legend

- Node

Investment

- Existing
- 2020
- 2030

Sewer Ponds

- Sewer Ponds(To be Abandoned)

Roads

- Residential Roads
- Trunk/Primary Roads
- Epworth_Rail_Line

River

- Rivers/Stream
- Lakes

Landuse

- Agriculture
- Commercial
- Grasslands/Pastures
- Industrial
- Institutional
- Mining/Quarrying
- Park/Playground And Other Recreational Spaces
- Proposed Development/Expansion Areas
- Residential

Project Boundary

- Project Boundary

Ward Boundary

- Ward Boundary.
- Expansion Areas

Greater Harare Water and Sanitation Investment Plan

Gauff JBG Ingenieure

7.3.1 A - Water Demand Management/NRW Reduction Programme

7.3.1.1 Rehabilitation of the Distribution Network

No detailed investigations were done as condition assessments of the water network in Epworth. Rather data gathered for other towns under previous studies was combined with information from local officials to build up a picture of the state of the networks and the cost estimates from replacement of network piping are therefore based on a simple percentage of the total length of the network in place.

Pipes

Whilst the Epworth water network is considerably newer than in many areas of Harare it has had perhaps the worst supply of water. Estimates therefore allow for replacement of up to 10% of the existing network pipes.

Network Valves

Discussions with the operators of the network in Epworth indicate that valves in many areas have not had water and have not been operated for many years. Water supply quantities are too small to allow the operators to practice any form of demand management. Therefore the investment plan allows for full replacement of network valves. The comprehensive valve replacement programme in the short term will not need to be repeated as a long term measure.

Bulk Metering

There are no operational bulk or block meters in Epworth. Therefore estimates for the metering programme are based on the number of meters required to meter all main pipes that feed the demand areas as well as metering both ends of all primary distribution pipes. Experience shows that meter replacement programmes must be regularly repeated as meters have a limited lifespan. Therefore the cost of meter replacements are repeated at the long term also. The cost of metering new and expanded areas is covered in the estimates made for those expansions.

Pressure Reducing Valves

Currently the network into Epworth has no pressure reducing valves. An allowance has been made for one valve which may be required initially of Ventersberg is rehabilitated and it remains necessary to moderate network pressures in Epworth to ensure even distribution of supply to all areas supplied by the tanks.

Replacement of Service Connections

Experience has shown that service connections of galvanised iron as are provided in Epworth are subject to corrosion and heavy loss rates. It is therefore intended to replace all GI connections with HDPE connections prior to or parallel to network rehabilitation.

In Epworth it is not intended to greatly expand the quantity of supply available until the long term investment round. Therefore some form of demand management is required for the interim period. Allowance has therefore been made to fit flow limiting devices to the house connections as they are renewed.

Service connection replacements should have a 60 year life and will not be repeated in the long term investment measures.

Replacement of Service Water Meters

In Epworth, the limited number of metered properties has had almost no water for nearly a decade. Water meters cannot continue to operate reliably under such conditions. Therefore the investment plan includes a short term intervention to replace all service water meters at the same time as the connections are replaced. The fitting of flow limiting devices should allow for network pressures to be maintained even if supply volumes remain low for some time and this will prevent the need to drain and refill the network with the consequent damage to meters caused by venting air.

Commercial Operation Improvement Measures

For each town a package of commercial and operational improvement measures shall be implemented. This shall revolve around giving the network managers the tools they need to effectively identify and manage non-revenue water.

Table 7-23: Network Rehabilitation Measures - Epworth

Item	Unit	2020	2030
Water Pipes			
ND 110 PVC or less	m	11,100	Nil
ND 160 PVC	m	2,800	Nil
ND 200 PVC	m	2,000	Nil
ND 250 PVC	m	300	Nil
ND 315 PVC	m	200	Nil
ND 350 DI	m	200	Nil
ND 400 DI	m	800	Nil
ND 450 DI	m	200	Nil
ND 500 DI	m	100	Nil
Network Valves			
ND 75 Gate	nos.	86	Nil
ND 100 Gate	nos.	36	Nil
ND 150 Gate	nos.	18	Nil
ND 200 Gate	nos.	6	Nil
ND 250 Gate	nos.	3	Nil
ND 300 Gate	nos.	2	Nil
ND 350 Butterfly	nos.	2	Nil
ND 400 Butterfly	nos.	8	Nil
ND 450 Butterfly	nos.	1	Nil
ND 500 Butterfly	nos.	1	Nil
Bulk Meters			
ND 100 Woltman type	nos.	35	35
ND 150 Woltman type	nos.	20	20
ND 200 Woltman type	nos.	4	4
ND 250 Woltman type	nos.	2	2
ND 300 Woltman type	nos.	1	1
ND 400 Electromagnetic	nos.	1	1
ND 500 Electromagnetic	nos.	1	1
Replacement of Service Connections			
Domestic (ND 15) (OD 20)	nos.	11,300	Nil
Non-Domestic (ND 25)	nos.	2,300	Nil
Installation of flow limiter (done with service connection replacement)	nos.	13,000	Nil
Removal of flow Limiters	nos.	Nil	13,000
Replacement of Service Water Meters			
Domestic (ND 15)	nos.	11,300	18,600

Item	Unit	2020	2030
Non-Domestic (ND 25)	nos.	2,300	200
Provisional sum for network mapping, network investigations and repair/replacement programme	Sum	1	
Provisional sum for customer database clean-up and awareness campaigns	Sum	1	

7.3.2 B – Water Supply Service Improvements

In Epworth, to improve the services a water kiosk programme will be rolled out as a short term investment measure. This will ensure that people in all areas of Epworth have access to safe potable water in the short term.

Table 7-24: Kiosk Programme - Epworth

Item	Unit	2020	2030
Construction of Water Kiosks Including Valves etc.	nos.	21	Nil
Pipework Connections to Kiosks			
DN50 HDPE Pipework	m	21,000	Nil
DN160 PVC Mains into Areas to be Kios Supplied	m	9,500	Nil
Metering of Kiosks			
Non-Domestic (ND 25)	nos.	21	Nil

7.3.3 C – Extension of Water Supply Services

7.3.3.1 New Transmission and Storage Facilities

In the short term there will be no investment in expanding the transmission and storage facilities in Epworth. Current supply levels are near zero so the short term will focus on the rehabilitation measures described above.

Long term significant investments will be required in the Epworth water transmission facilities. This will involve construction of a water booster pump station at the Ventersberg Reservoirs, dedicated to the supply of Epworth and the extensions and augmentations to the distribution network as follows:

Characteristic	Unit	Value
Pumps to		Epworth Distribution
Station Maximum Flow	m3/hr	2900
Station Pumping Head	m	70
Motors Make and Model		7.5kW 380V
Coupling		Direct drive
Station Elevation	m	1560
Discharge Elevation	m	1573

Nominal Static Head	m	13m
Rising Main Length	m	20m
Rising Main Nominal Diameter	mm	300
Rising main material		Steel

Table 7-25: Transmission/Primary/Secondary Distribution Investment Measures - Epworth

TRANSMISSION/ PRIMARY/ SECONDARY DISTRIBUTION			
a	Ventersberg to Ward 1 'Overspill' Area	975m of DN500 Ductile Iron parallel to existing DN500	Increased general flow requirements
b	From Ward 1 tee to Ward 7 to tee off to ward 2	2500m of DN400 (// to existing DN400)	Increased general flow requirements
c	Through Ward 2 to Ward 5	2500m of DN200 (// to existing DN400)	Increased general flow requirements
d	Tee at south of ward 1 to tee off to ward 3 and 4	2200m of DN350 (// to existing DN350 and DN200)	Increased general flow requirements
e	Line from ward 6, south into ward 4	4200m of DN300 (// to existing DN200)	Increased general flow requirements
f	Through part of Ward 7	785m of DN300 (// to existing DN300)	Localised bottleneck in supply capacity after end of DN400

A review of the modelling of the Harare water network has shown that increasing the quantity of storage at Epworth would be inefficient with such large available storage volume at nearby Ventersberg. Therefore there are no plans to install any bulk storage within Epworth but rather to rely on a boosted pumped supply from Ventersberg as described above.

7.3.3.2 Extension of Distribution Network to new areas

The predicted population growth in Epworth will require extensions to the distribution system. Some of this work will likely be funded through private developers but in Epworth there are also considerable areas which are already settled and where the council will be responsible for the provision of services.

As it is only intended to significantly increase supply volumes with the installation of new distribution capacity in the long term there will be a period during which demand would greatly outstrip supply and therefore new connections made in this period should be provided with flow limiting devices as recommended for existing connections. The estimated no of new connections and associated water network lengths required are as shown below.

Table 7-26: Investment Requirements in new Development Areas - Epworth

Item	Unit	2020	2030
Extension of Distribution System			
Pipes			
ND 75 PVC	m	9,600	53,000
ND 110 PVC	m	7,680	67,000
ND 160 PVC	m	3,840	33,500
Section valves			
ND 75 Gate	nos.	96	530
ND 100 Gate	nos.	77	670
ND 150 Gate	nos.	38	335
Fire hydrants			
ND 80	nos.	23	201
Service connections and water meters			
ND 15	nos.	1,600	11,047
ND 25	nos.	320	2,209

7.3.3.3 New Bulk Water Management Facilities

With the introduction of the Epworth pump station at Ventersberg there will be need for remote monitoring and control of the reservoirs.

7.3.4 D – Sewerage Service Improvements

7.3.4.1 Rehabilitation of Sewerage Reticulation System

The sewerage system covering most areas that have water supply has never been commissioned. As soon as water supply is restored there are many properties that do have water connections and demand for a sewage system will grow.

Discussions with the local board indicate that sewer pipes are likely to be in good condition whilst manholes will require sand removal and in about 50% of cases, reconstruction of the cover slab.

Short Term Investment Measures

In the short term, the inability to treat any sewage generated in Epworth means that the area must remian on on site sanitation systems.

Long Term Investment Measures

In the long term improvement to the sewer network in Epworth will commence with the activation of the sewer network that was previously installed but never commissioned. This will involve limited replacements, extensive grit removal and refurbishment of nearly all manholes on this system.

Long term expansion of waterborne sanitation in Epworth will depend on the water supply network first being reinforced such that there is sufficient supply for all households with waterborne sanitation. Only once this occurs can the sewer network be expanded.

Table 7-27: Sewerage Reticulation System Investment Measures - Epworth

Item	Unit	2020	2030
Sewer reticulation pipes Replacement			
ND 150 PVC	m		2,720
ND 200 PVC (OD 225)	m		340
ND 250 PVC (OD 280)	m		100
ND 315 PVC	m		100
Construction of manholes	nos.		65
Rehabilitation of Manhole cover and frame	nos.		249
New Manhole Covers only	nos.		-
Sewer reticulation pipes Grit Removal			
ND 150 PVC	m		10,880
ND 200 PVC (OD 225)	m		1,360
ND 250 PVC (OD 280)	m		100
ND 315 PVC	m		100
Clearing of silted Manhole	nos.		249

7.3.5 E – Extension of Sewerage Services

7.3.5.1 Extension of Sewer Reticulation System to new areas

Currently Epworth is not connected to any treatment works. Connection to the Harare South Trunk Sewer will only occur in the long term. Once the HSTS is available the following sewers will be installed to meet the long term requirements for Epworth.

Table 7-28: New Sewer Mains - Epworth

ID	Model Nodes	Investment Required	Reason for Investment
New Mains			
1	J23 to J291	New 1450m of DN250uPVC	Epworth Sewer connection
2	J291 to J292	1260m of DN350 uPVC	Epworth Sewer connection
3	J292 t J299	1020m of DN450 uPVC	Epworth Sewer connection

With the commissioning of the Epworth outfall sewer there will be a considerable increase in the number of properties connected to sewer. As most areas are already developed the responsibility for extending the tertiary sewer network to connect more customers will likely

fall onto the Epworth Local Board. The table below outlines works that will be required to connect customers to the sewer network. All of these works are long trem as they cannot commence until HSTS is in place. Initially this consists mainly of connecting customers to the existing network but eventually a significant length of new network will be required.

Item	Unit	2020	2030
Pipes			
ND 100 PVC	m		85,000
ND 160 PVC	m		35,500
Construction of manholes	nos.		2,400
Sewer service connections			
ND 100	nos.		13,257

7.4 Norton

Investment measures in Norton are summarized in the figure below. The maps in Figure 7-12 and Figure 7-13 show the spatial location of the proposed water supply investment measures and sewerage investment measures, respectively.

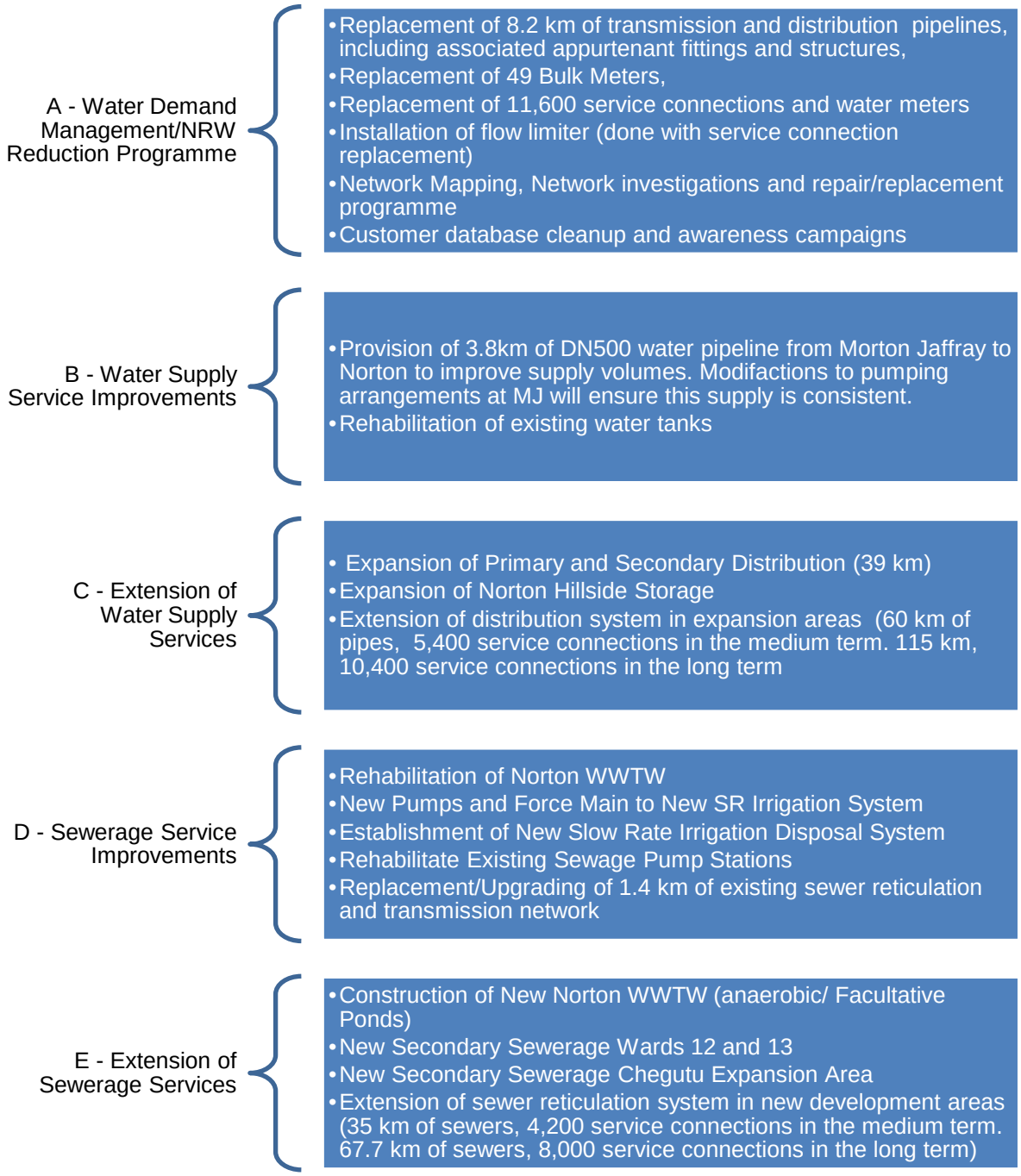


Figure 7-11: Summary of Investment Measures in Norton

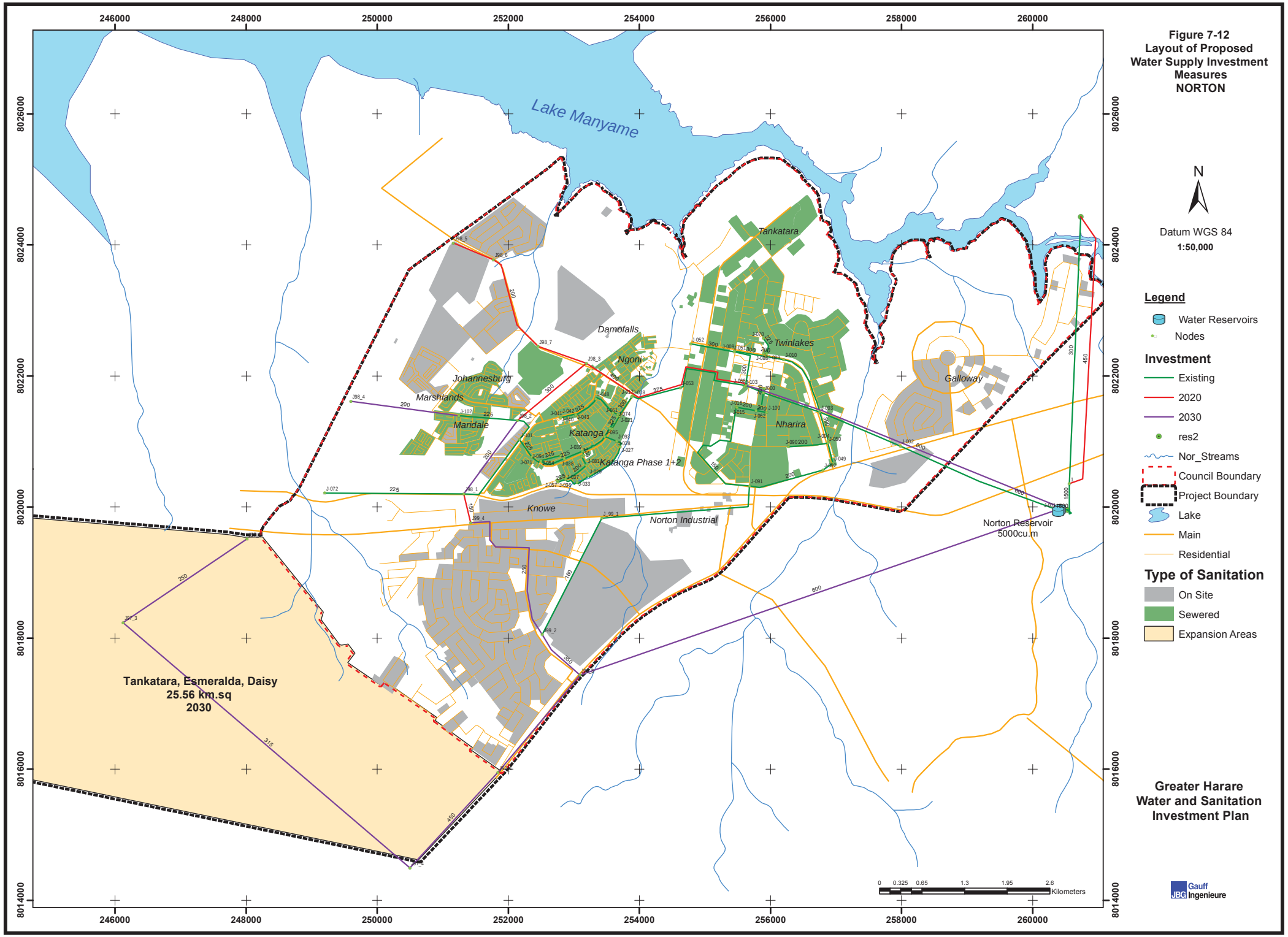
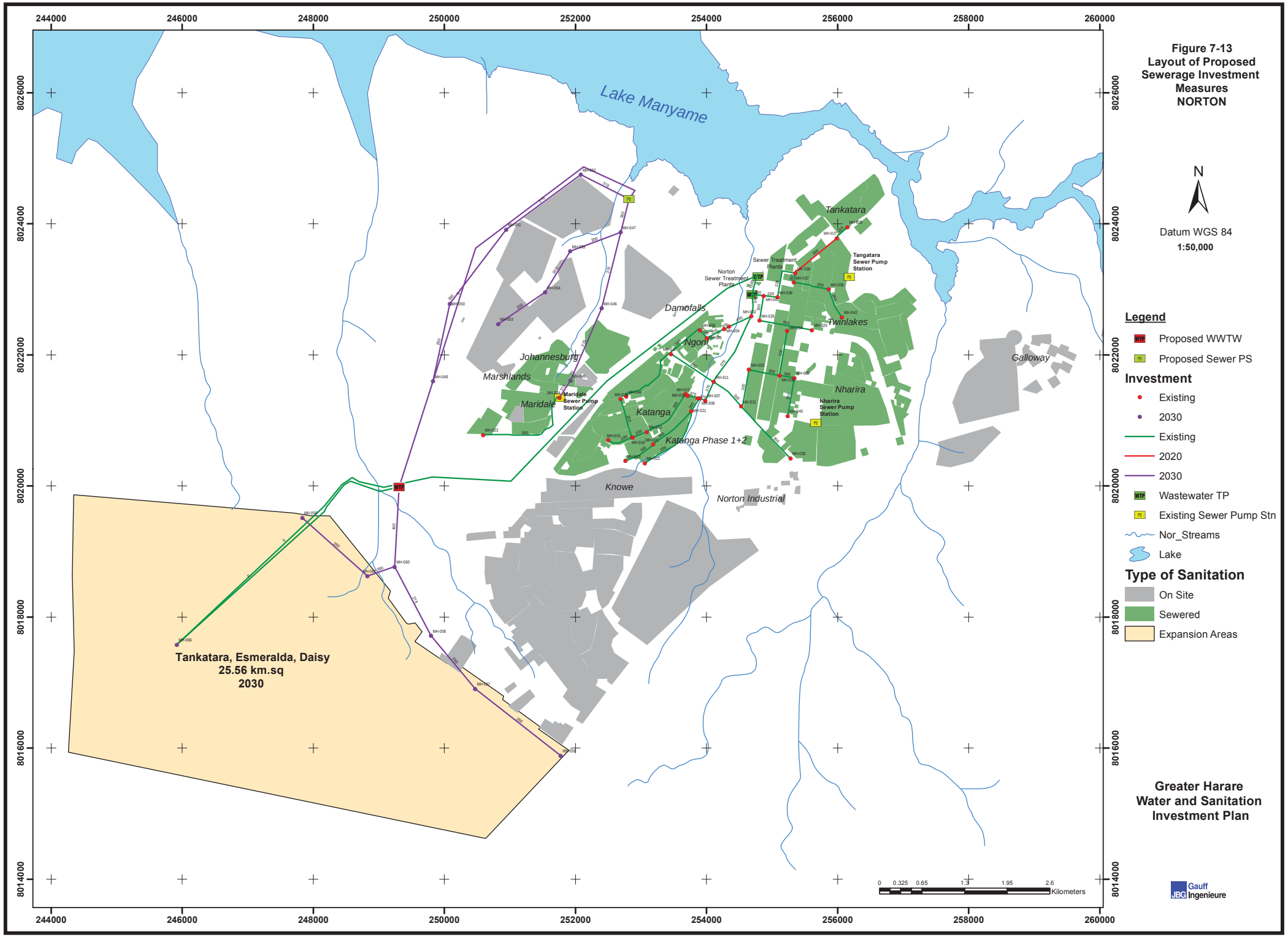


Figure 7-12
Layout of Proposed
Water Supply Investment
Measures
NORTON
Lake Manyame
Tankatara
Damofalls
Twinlakes
Ngoni
Johannesburg
Marshlands
Maridale
Katanga I
Katanga Phase 1+2
Nharira
Galloway
Knowe
Norton Industrial
Norton Reservoir
5000cu.m
Tankatara, Esmeralda, Daisy
25.56 km.sq
2030
N
Datum WGS 84
1:50,000
Legend
Water Reservoirs
Nodes
Investment
Existing
2020
2030
res2
Nor_Streams
Council Boundary
Project Boundary
Lake
Main
Residential
Type of Sanitation
On Site
Sewered
Expansion Areas
Kilometers
Greater Harare
Water and Sanitation
Investment Plan
Gauff
Ingenieure


Lake Manyame
Tankatara
Damofalls
Twinlakes
Ngoni
Johannesburg
Marshlands
Maridale
Katanga
Katanga Phase 1+2
Nharira
Galloway
Knowe
Norton Industrial
Norton Sewer Treatment Plants
Sewer Treatment Plants
Tangatara Sewer Pump Station
Maridale Sewer Pump Station
Nharira Sewer Pump Station
Tankatara, Esmeralda, Daisy
25.56 km.sq
2030
Figure 7-13
Layout of Proposed Sewerage Investment Measures
NORTON
N
Datum WGS 84
1:50,000
Legend
Proposed WWTW
Proposed Sewer PS
Investment
Existing
2030
Existing
2020
2030
Wastewater TP
Existing Sewer Pump Stn
Nor_Streams
Lake
Type of Sanitation
On Site
Sewered
Expansion Areas
0 0.325 0.65 1.3 1.95 2.6 Kilometers
Greater Harare
Water and Sanitation
Investment Plan
Gauff
JBG Ingenieure

7.4.1 A - Water Demand Management/NRW Reduction Programme

7.4.1.1 Rehabilitation of the Distribution Network

No detailed investigations were done as condition assessments of the water network in Norton. Rather data gathered for other towns under previous studies was combined with information from local officials to build up a picture of the state of the networks and the cost estimates from replacement of network piping are therefore based on a simple percentage of the total length of the network in place.

Pipes

Norton's water network is reportedly in generally good condition although specific areas of concern were located with the DN300 AC lines in Ward 1 and Ward 9 and the galvanised iron pipe network in parts of Ward 5 which is known to be severely scaled. Estimates have allowed for the replacement of up to 5% of the existing network pipes.

Network Valves

Discussions with the operators of the network in Norton have indicated that valving in the town should be improved to facilitate proper demand management. A programme of valve replacement is already underway utilising GIZ financing so this investment measure may already be in hand. The comprehensive valve replacement programme in the short term will not need to be repeated as a long term measure.

Bulk Metering

There are no operational bulk or block meters in Norton. Therefore estimates for the metering programme are based on the number of meters required to meter all main pipes that feed the demand areas as well as metering both ends of all primary distribution pipes. Experience shows that meter replacement programmes must be regularly repeated as meters have a limited lifespan. Therefore the cost of meter replacements is repeated at the long term also. A programme of metering is already underway utilising GIZ financing so this investment measure may already be in hand. The cost of metering new and expanded areas is covered in the estimates made for those expansions.

Pressure Reducing Valves

With improvement of network pressures in Norton an allowance has been made in the investment plans for the installation of pressure reducing valves. These will most likely be used, at least initially, in the pressure sustaining role in order to maintain pressures in the mains whilst demands exceed supply in the distribution system.

Replacement of Service Connections

Experience has shown that service connections of galvanised iron as are provided in Ruwa are subject to corrosion and heavy loss rates. It is therefore intended to replace all GI connections with HDPE connections prior to or parallel to network rehabilitation.

Given the age of most of the networks in Norton all historical connections are likely in GI and should be replaced. Visual inspection of newly constructed areas show that in most area the service connections have been vandalised by owners in an attempt to get more flow from the system.

In Norton, despite increases in supply of water to the town, major expansions to the distribution network are not expected until the long term project and therefore flow limiting devices should be fitted to the service connections.

Replacement of Service Water Meters

As a foundation to an effective non-revenue water programme in Ruwa it is intended to replace all service water meters. Those in service now are generally 10 to 20 years old and at least 50% are known to be faulty.

7.4.1.2 Commercial Operation Improvement Measures

For each town a package of commercial and operational improvement measures shall be implemented. This shall revolve around giving the network managers the tools they need to effectively identify and manage non-revenue water.

Table 7-29: Network Rehabilitation Measures - Norton

Item	Unit	2020	2030
Water Pipes			
ND 110 PVC or less	m	5,800	Nil
ND 160 PVC	m	1,100	Nil
ND 200 PVC	m	200	Nil
ND 250 PVC	m	500	Nil
ND 315 PVC	m	200	Nil
ND 400 DI	m	100	Nil
ND 600 DI	m	300	Nil
Network Valves			
ND 75 Gate	nos.	100	Nil
ND 100 Gate	nos.	72	Nil
ND 150 Gate	nos.	23	Nil
ND 200 Gate	nos.	50	Nil
ND 250 Gate	nos.	14	Nil
ND 350 Butterfly	nos.	2	Nil
ND 500 Butterfly	nos.	1	Nil
ND 600 Butterfly	nos.	12	Nil
Bulk Meters			
ND 100 Woltman type	nos.	18	18
ND 150 Woltman type	nos.	15	15
ND 200 Woltman type	nos.	8	8
ND 300 Woltman type	nos.	6	6
ND 600 Electromagnetic	nos.	2	2
Pressure Reducing Valves and Level Control Valves			
ND 300	nos.	5	Nil
Replacement of Service Connections			
Domestic (ND 15) (OD 20)	nos.	11,500	Nil
Non-Domestic (ND 25)	nos.	100	Nil
Installation of flow limiter (done with service connection replacement)	nos.	11,500	Nil

Item	Unit	2020	2030
Removal of flow Limiters	nos.	Nil	11,500
Replacement of Service Water Meters			
Domestic (ND 15)	nos.	11,500	20,547
Non-Domestic (ND 25)	nos.	100	1,909
Provisional sum for network mapping, network investigations and repair/replacement programme	Sum	1	
Provisional sum for customer database clean-up and awareness campaigns	Sum	1	

7.4.2 B – Water Supply Service Improvements

In Norton, work is required to improve the valving at the tanks if additional supplied of water are to be coming from Morton Jaffray. The selected valve replacement will allow the tanks to operate without manual intervention. GIZ have already installed bulk meters on the existing line from Morton Jaffray.

Table 7-30: Rehabilitation Measures at the Tanks - Norton

Item	Unit	2020	2030
Rehabilitation of Existing Water Tanks			
ND 300 Gate	nos.	6	Nil
ND 600 Butterfly	nos.	4	Nil
Level Control Valve 300	nos.	2	NIl

7.4.3 C – Extension of Water Supply Services

7.4.3.1 New Water Production Facilities

Norton will rely on increased production at the Morton Jaffray Water Treatment Plant to meet its short and long term water production requirements.

7.4.3.2 New Transmission and Storage Facilities

Short Term Investment Measures

In the short term the minimal intervention necessary is to supply sufficient water to the town for its population minimal requirements and to reverse the trend of chronic low pressure in the network. The 8MLD that can be supplied by the existing line cannot sustain Norton so this supply must be expanded. At the same time regardless of available supplies pressures will be very low unless certain minimum interventions are carried out. The following short term measures are therefore proposed.

Table 7-31: Transmission Investment Measures - Norton

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
a	Morton Jaffrey to Norton Tanks.	3800m DN500 DI	Increase supply capacity to Norton to meet the town's long term needs
b	Termination of DN600 in Ward 3 to Ward 6	2975m of DN400 DI	Provide sufficient supply to Wards 6, 12 and 13 and improve pressures

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
			throughout.
c	Line J-98_3 to 98_5	2995m of DN200 uPVC	New secondary pipe network for Ward 6 where development has commenced
d	Main connection between ward 6 and ward 13	1365m of DN300 uPVC	Improve supplies to Wards 12 and 13 and allow these to be disconnected from current connection to ward 10. This will improve pressures in all areas.
e	Connect existing DN225 in Ward 12 to Ward 4. Pipeline J98_1 to J99_4	453m of DN150	Improve pressures in ward 4 temporarily. Ward 4 will still require flow limiters until the long term investment measures are in place but will receive improved flow. In the ultimate configuration this line would be valved off.
f	Norton Tanks to Ward 4	8000m of DN600 DI	New line to provide proper rate of supply to ward 4 and to provide the supply to allow for expansion of the network into the Chegutu expansion area.

Water Storage

In the short term the existing 10ML of reservoir capacity will have to suffice as demand management methods are still in place. The storage time will drop well below the recommended 24 hours during this period.

Long Term Investment Measures

The focus of the long term investment measures will be to supply adequate water to meet normal demands at reasonable network pressures in all areas of Norton and to supply the increasing demand of the areas of new development in Wards 2, 4 12, 13 and the Chegutu expansion area (planned expansion of the town into Chegutu District). The following investments will be necessary:

Table 7-32: Primary and Secondary Distribution Investment Measures - Norton

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
PRIMARY DISTRIBUTION			
a	Norton Tanks to Norton Town Center	5150m of DN600 DI	The new line feeds Wards 13 and 6 releasing the old line to its design duty of feeding wards 1, 2, 3, 4, 5, 7,

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
	(Ward 3)		8, 9, 10 and 11. Once this line is in place demand management flow limiters may be removed in all Wards.
SECONDARY DISTRIBUTION			
c	Extension of existing DN200 on boundary of wards 12 and 13	1665m of DN200 uPVC	Allows the completion of the expansion of these wards
d	New Link between J98_2 in ward 13 and J98_1 in Ward 12	1390m of DN200	Allows for higher flow rates and pressures to ward 12 as it expands to full potential size.
e	New supply line into Ward 4 from the new DN600 in (b) above. J99_3 to J99_2	850m of DN350DI	With the installation of the DN600 there will be sufficient supply for ward 4 but the existing pipework in ward 4 is insufficient to distribute it.
f	New line through ward 4 J99_2 to J99_4	2600m of DN250uPVC	All secondary pipework in Ward 4 is currently undersized.
g	New supply line to the Chegutu expansion area from Ward 4. J99_2 to J99_4	3925m of DN450DI	New development area requires main water supply
h	New secondary supply line in Chegutu extension. J97_4 to J97_3	5760m of DN315	Secondary distribution to new expansion area
i	Extension of the above line, J97_3 to J97_2	2285m of DN250	Secondary distribution to new expansion area

7.4.3.3 Water Storage

As a long term measure it will be necessary to build reservoir volume to get back to the required 24hours of storage. This will require the construction of an additional 26ML of storage at the same reservoir site.

7.4.3.4 Extension of Distribution Network to new areas

The predicted population growth in Norton will require extensions to the distribution system. Most of this work will likely be funded through private developers but there are also some

areas which are already settled and where the council will be responsible for the provision of services.

As it is only intended to significantly increase supply volumes in the long term there will be a period during which demand would greatly outstrip supply and therefore new connections made in this period should be provided with flow limiting devices as recommended for existing connections. The estimated no of new connections and associated water network lengths required are as shown below.

Table 7-33: Investment Requirements in New Development Areas

Item	Unit	2020	2030
Extension of Distribution System			
Pipes			
ND 75 PVC	m	27,000	52,000
ND 110 PVC	m	22,000	42,000
ND 160 PVC	m	11,000	21,000
Section valves			
ND 75 Gate	nos.	270	520
ND 100 Gate	nos.	220	420
ND 150 Gate	nos.	110	210
Fire hydrants			
ND 80	nos.	66	126
Service connections			
ND 15	nos.	4,503	8,716
ND 25	nos.	901	1,743
Service water meters			
Domestic (ND 15)	nos.	4,503	8,716
Non-Domestic (ND 25)	nos.	901	1,743

7.4.3.5 New Bulk Water Management Facilities

Improved monitoring and control at the Norton Reservoirs will become essential once supply volumes increase. Control feedback will need to be provided from the reservoirs to Morton Jaffray and at the reservoirs. GIZ have already installed a flow meter with telemetry on the existing DN300 line which whill assist in this exercise.

7.4.4 D – Sewerage Service Improvements

7.4.4.1 Rehabilitation of Sewerage Reticulation System

Norton's sewer system varies in age but is generally considered to be in reasonable condition with no areas reported as causing significant maintenance problems. However general rehabilitation works will be expected on the system including targeted line replacements and manhole rehabilitation and cover programmes.

Table 7-34: Sewerage Reticulation System Investment Measures - Norton

Item	Unit	2020	2030
Sewer reticulation pipes Replacement			
ND 150 PVC	m	400	
ND 200 PVC (OD 225)	m	-	
ND 250 PVC (OD 280)	m	400	
ND 315 PVC	m	500	
ND 450 PVC	m	100	
ND 450 Steel on Existing Pipe Bridge	m		400
Construction of manholes	nos.	-	
Rehabilitation of Manhole cover and frame	nos.	23	
New Manhole Covers only	nos.	200	
Sewer reticulation pipes Grit Removal			
ND 150 PVC	m	10,880	
ND 200 PVC (OD 225)	m	1,360	
ND 250 PVC (OD 280)	m	100	
ND 315 PVC	m	100	
Clearing of silted Manhole	nos.	249	

7.4.4.2 Rehabilitation of Sewage Pump Stations

There are three existing sewage pumping stations in Norton, two of which requiring some degree of rehabilitation. in the long term pumps and generators will need to be replaced at only two of the stations as the third, Maridale is due for decommissioning.

Table 7-35: Rehabilitation of Pump Stations - Norton

Item	Unit	2020	2030
Tangatara SPS			
ND 150 Class 9 HDPE	m	785	
ND 150 Gate	nos.	1	
Sewage Pumps 36$\mathbf{m^3}$/hr @20m Head	nos.	2	2
Standby Generator	No.	1	1
Maridale SPS			
Sewage Pumps 136$\mathbf{m^3}$/hr @11m Head	No.	2	
Standby Generator	No.	1	
Narira SPS			
Standby Generator	No.	1	1

7.4.4.3 Rehabilitation of Wastewater Treatment Plants

The rehabilitation of the Norton SPS will require not only repairs to the existing works but the establishment of a new treated effluent pump station, rising main and a new wastewater disposal system through irrigation onto forest trees. The investments required are as follows:

In the short term it is proposed that the Norton Old and New Sewage Treatment works be fully rehabilitated as these will remain integral to sewage treatment in Norton in the future. The rehabilitation measures shall include:

Old Works

- Intake
    - Replace flow measurement devices
    - Provide grit drying slabs and skip from screenings
- 2 No. Primary sewage clarifiers
    - Mechanical rehabilitation and
    - replacement of corroded steelwork
- 2No. Biological trickling filters
    - Remove, clean and replace media
    - Reconstruct collapsed wall
    - Renew distributor arms
- 2No. Humus tanks
    - Mechanical rehabilitation and
    - replacement of corroded steelwork
- Holding ponds for treated wastewater awaiting pumping to disposal
    - Clear vegetation from embankments
    - Clear vegetation from pond and dredge sediment
    - Fill low areas of embankment where overflow occurs
- Drying beds for clarifier sludge.
    - Clean the drying beds
    - Replace sections of collapsed wall
    - Replace sludge carts

In addition to the above, non-treatment components include:

- Pumps to the filters:
    - Replace 1 duty and 1 standby pump
    - Replace 2No. Sludge Pumps to the drying beds
    - Service all electrical equipment
- New pumps as described below

Norton New Works

The Norton New Works consists of a traditional treatment process with the following components:

- Intake works
    - Replace flow measurement devices
    - Provide grit drying slabs and skip from screenings
- 4 No. Primary sewage clarifiers of the 'Dortmund' upflow type, without scrapers. 2 of the four are generally finished but not yet commissioned
    - Complete commissioning of 2 clarifiers
- 3No. Biological trickling filters. Only one is commissioned and two are partly constructed.
    - No works
- 6No. Humus tanks. Two are commissioned and four are generally finished but not commissioned.
    - No Works
- Sludge drying beds
    - Replace sludge carts
- Digester
    - Construct a sludge digester for the sludge produced by the new and old works
- New treated effluent pump station and force main
    - Install new treated effluent pumps and force main discharging at the proposed new irrigation site with characteristics as follows:

Characteristic	Unit	Value
Pumps to		Irrigation Disposal Site at MH066
No. of Pumps	nos.	3 (2 Duty/ 1 Standby)
Duty Flow (Station)	m^3/hr	325
Station Elevation	m	1352
Discharge Elevation	m	1392
Nominal Static Head	m	40
Rising Main Length	m	11,200
Rising Main Nominal Diameter	mm	315
Rising main material		HDPE PN10

Wastewater Disposal Area

Norton has an existing irrigation scheme on Greenacres farm. This is capable of manging the effluent produced by the two existing works. However the farm is not controlled by the

municipality and the force main, owned by the farm, is in poor condition. The most economical solution would be to rehabilitate this existing system to support the existing WWTWS but because of the lack of control and reliability of this system it is proposed to provide Norton with a new wastewater disposal area. Whilst the investment plan has been prepared on the basis that a new disposal area will be required this decision should be revisited at feasibility study stage. The proposed new disposal area should be outside of the Manyame catchment where there is land available and a promising area has been located at the location of MH 66 on the mapping. This area is within the Chegutu expansion area but outside of the Town's proposed Sewerage Boundary.

At this location it is proposed that Norton shall establish 170Ha of forest plantation onto which its wastewater can be irrigated. The entire 170Ha shall be established as a short term measure as the effluent from the existing WWTW can be disposed of on 170Ha without the need for any storage pond to allow for lower application rates during the rainy season.

In the long term the proposed new pond system in Norton will also discharge to this irrigation area but no additional land will be required as the ponds will provide significant rainy season storage.

The works are summarised as follows. Note that in the long term certain minor rehabilitation measures will also be required to renew mechanical equipment at the works and its associated pump stations.

Table 7-36: Rehabilitation of WWTW - Norton

Item	Unit	2020	2030
Rehabilitation of Norton WWTW			
Rehabilitation of old Works	ML	3.6	
Rehabilitation and Expansion of New Works	ML	4	
			2
New Pumps and Force Main to New SR Irrigation System			1
Sewage Pumps 322m3/hr @80m Head	No.	2	
ND 315 Class 9 HDPE	m	11,200	
ND 300 Gate	nos.	1	
Establishment of New Slow Rate Irrigation Disposal System			
Wastewater Slow Rate (irrigation) disposal system			
Irrigation Set Up	Ha	170	

7.4.5 E – Extension of Sewerage Services

7.4.5.1 Extension of Sewer Reticulation System to new areas

For Norton, it is not planned that any expansion to the existing sewerage reticulation system will be carried out in the short term. Therefore there are no proposed short term measures to expand the main sewage transmission.

Long Term Investment Measures

In the long term Norton's water shortages should be resolved and it is intended to remove flow limiting devices as significantly increased supply volumes become available with the construction of the two new DN600 supply lines into Norton as described above. At this stage it will be necessary to greatly expand the sewerage systems in Wards 6, 12 and in the new Chegutu Expansion area. The following lines are proposed.

Table 7-37: Sewer Mains Investments - Norton

ID	Model Nodes	Investment Required	Reason for Investment
EXISTING MAINS UPGRADES/ AUGMENTATION			
1	MH03 to MH04	390m of DN450 Steel on Existing Pipe Bridge	Original pipe was replaced with new AC. The new line is starting to show signs of similar failure (longitudinal cracking). It will need to be replaced and steel is preferred.
NEW MAINS			
1	MH49-MH50-MH51	1650m of DN230	Western expansion of sewerage boundary in ward 6
2	MH51-MH52-MH48 (new Ward 6 WWTW)	1440m of DN315	Western expansion of sewerage boundary in ward 6
3	MH053-MH54-MH55-MH47	2420m of DN200	Western expansion of sewerage boundary in ward 6
4	MH24-MH45-MH46-MH47	2700m of DN315	Western expansion of sewerage boundary in ward 6
5	MH47-MH48 (new Ward 6 WWTW)	525m of DN350	Western expansion of sewerage boundary in ward 6, 12 and 13
6	MH59-MH61-MH60	1810m of DN200	Chegutu District Expansion Area
7	MH56-MH45-MH57-MH58	2709m of DN200	Chegutu District Expansion Area
8	MH58-MH60	1200 of DN315	Chegutu District Expansion Area
9	MH60-MH62 (new facultative ponds)	1200 of DN315	Chegutu District Expansion Area outfall line to treatment works

Considerable growth is expected in the short and long term in the number of properties connected to the sewer system and in the areas covered by Sewerage. In the short term the expansion of sewerage will be limited to areas where there is already connection to the existing Sewage Treatment Plant. Long term as the new sewage treatment capabilities are added the town will expand its sewerage boundary and numbers of new connections will increase significantly.

Table 7-38: Sewerage Investment requirements in new development Areas - Norton

Item	Unit	2020	2030
Pipes			
ND 100 PVC	m	10,300	19,900
ND 160 PVC	m	24,700	47,800
Construction of manholes	nos.	700	1,354
Sewer service connections			
ND 100	nos.	4,200	8,000

7.4.5.2 New sewage pump stations

No new sewage pump stations are to be added in the sewerage network of Norton. Effluent pumping from the treatment works is covered below.

7.4.5.3 New sewage treatment facilities

Ward 6 WWTW

As a long term measure it is proposed to construct an anaerobic pond at Ward 6 for the purpose of primary treatment of wastewater arising from Wards 12, 13 and 6. Peak and average inflow to this works are predicted at 9.5 and 3.8MLD respectively. The works to be constructed will consist:

- Inlet works with coarse and fine screens and grit screening as well as screening disposal
- Anaerobic pond with 2 streams in parallel of 3 days retention time. Each pond should therefore have volume around 6,000m^3.
- Pump station and force main with characteristics described below:

Characteristic	Unit	Value
Pumps to		Facultative Ponds
No. of Pumps	No.	3 (2 Duty/ 1 Standby)
Duty Flow (Station)	m^3/hr	400
Station Elevation	m	1350
Discharge Elevation	m	1368
Nominal Static Head	m	18
Rising Main Length	m	6600
Rising Main Nominal Diameter	mm	315

Rising main material		HDPE PN10

Facultative Ponds near Chegutu Expansion Area

At the same time as the anaerobic ponds it is proposed to construct a facultative pond system at a location where the Chegutu Expansion area can gravitate to the ponds. This location is between the Chegutu Expansion and Ward 12. The ponds shall provide treatment for wastewater from the Chegutu Expansion area and secondary treatment for the wastewater from the Ward 6 Anaerobic Ponds. The works to be constructed will consist:

- Inlet works with coarse and fine screens and grit screening as well as screening disposal
- Anaerobic pond with 2 streams in parallel of 3 days retention time. Each pond should therefore have volume around 5,000m3 as anaerobic treatment is only required for wastewater from the Chegutu Expansion Area.
- Facultative pond for all wastewater (approximately 9MLD). The pond will require retention time of 20 days and approximate volume 180,000m^3. Typical dimensions would be 600 x 300m which could be subdivided into two parallel streams.
- Pump station and force main with characteristics described below:

Characteristic	Unit	Value
Pumps to		Facultative Ponds
No. of Pumps	No.	3 (2 Duty/ 1 Standby)
Duty Flow (Station)	m^3/hr	435 (designed for average WWF)
Station Elevation	m	1368
Discharge Elevation	m	1392
Nominal Static Head	m	24
Rising Main Length	m	6300
Rising Main Nominal Diameter	mm	315
Rising main material		HDPE PN10

7.5 Ruwa

Investment measures in Ruwa are summarized in the figure below. The maps in Figure 7-15 and Figure 7-16 show the spatial location of the proposed water supply investment measures and sewerage investment measures, respectively.

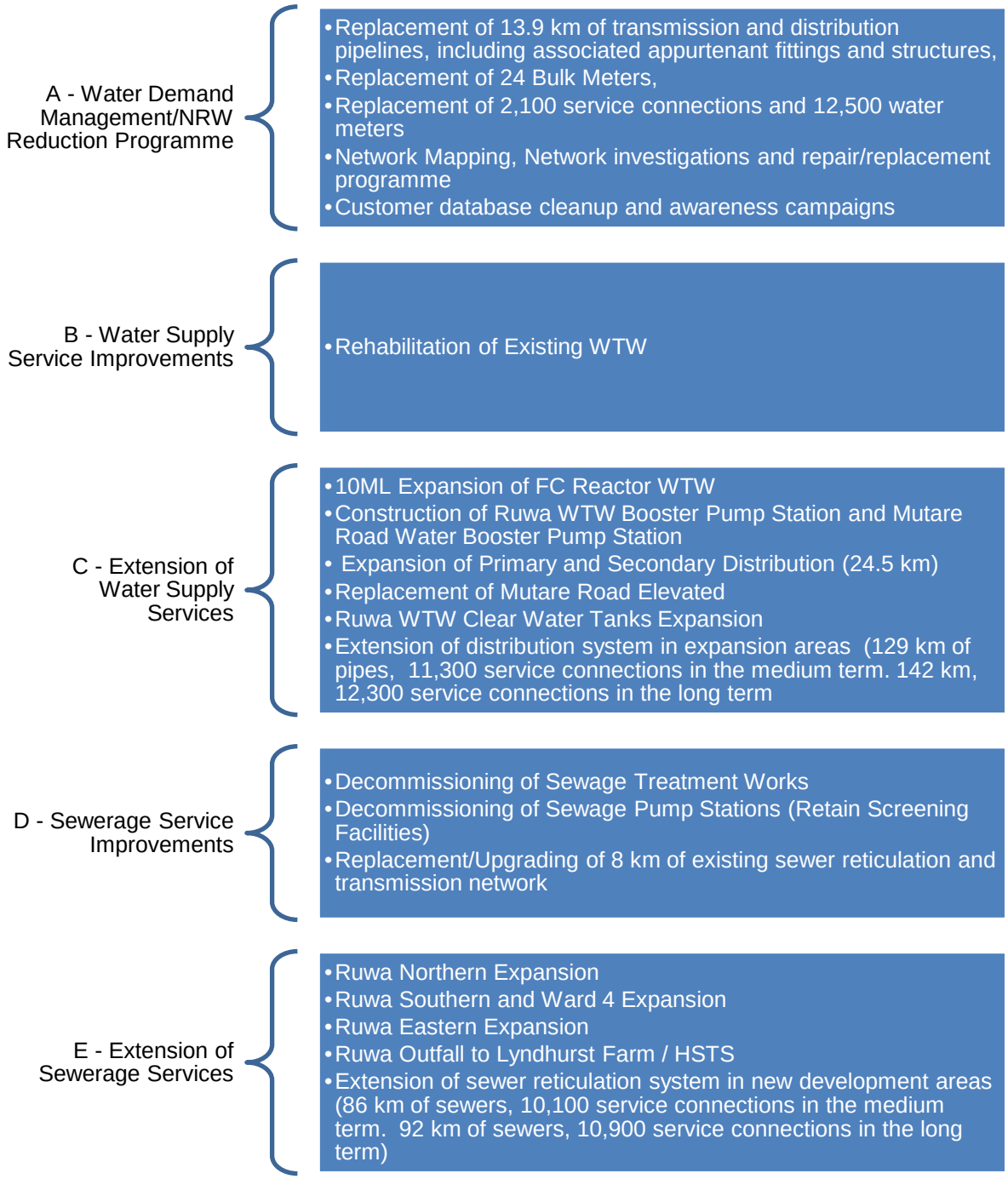


Figure 7-14: Summary of Investment Measures in Ruwa

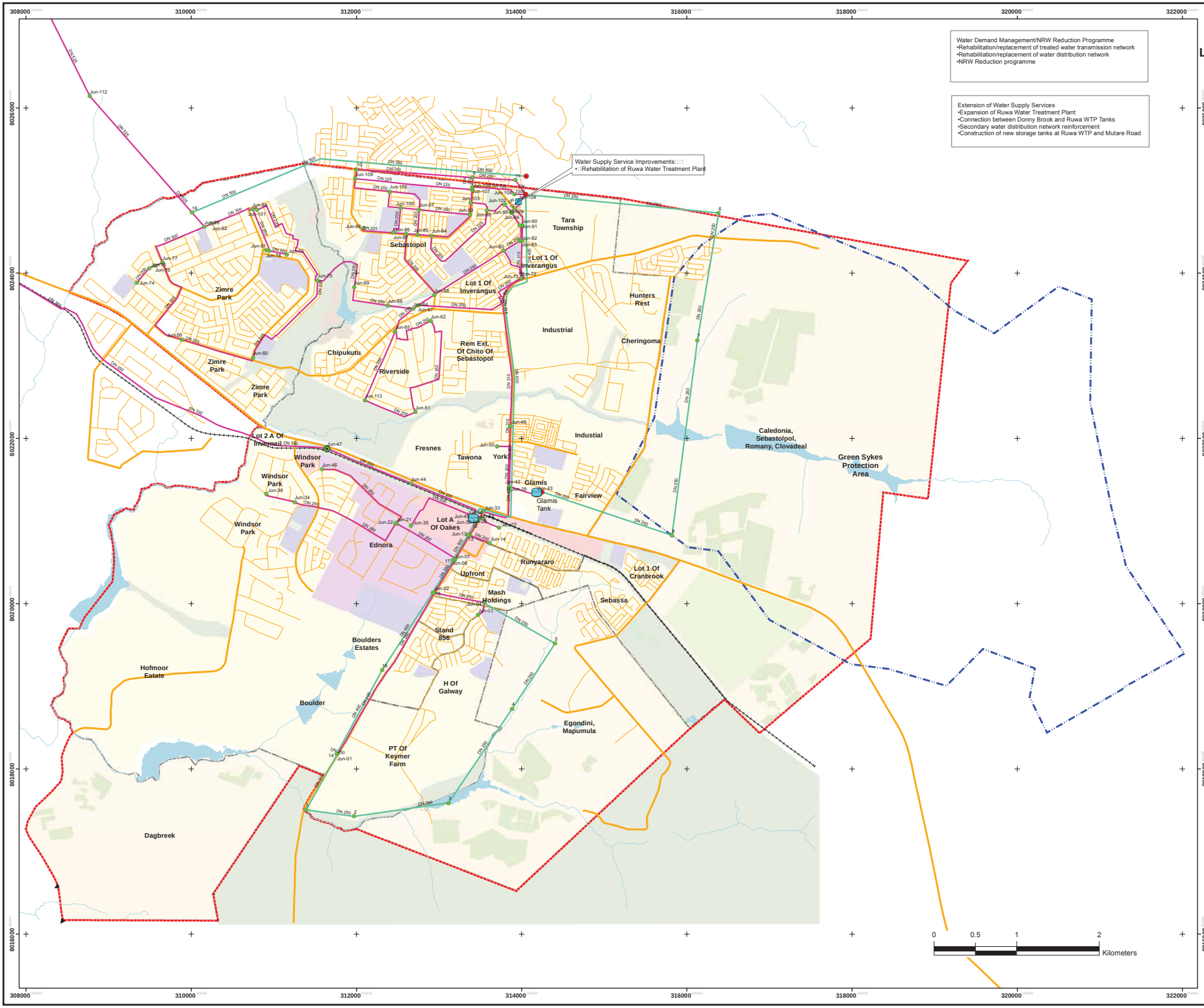


Figure 7-15
Layout Map of Proposed Water Supply Investment Measures
Ruwa

N

Datum : WGS 84 Zone 36S
Scale 1:16,200

Legend

Water Infrastracture
- Reservoir
- Treatment_Plants
- Boster Pump Station
- res1
- Node

Investment
- Existing Pipes
- 2030

Roads
- Trunk/Primary Roads
- Residential

Rail Line
- Rail Line

River/Lake
- River / Stream
- Lakes

Landuse
- Agriculture
- Commercial
- Grasslands/Pastures
- Industrial
- Institutional
- Mining/Quarrying
- Park/Playground And Other Recreational Spaces
- Proposed Development/Expansion Areas
- Residential

Project Boundary
- Project Boundary

Ward Boundary
- Ward Boundary
- Expansion Areas

Catchment
- Green Sykes Dam catchment

Greater Harare
Water and Sanitation
Investment Plan

Gauff JBG Ingenieure

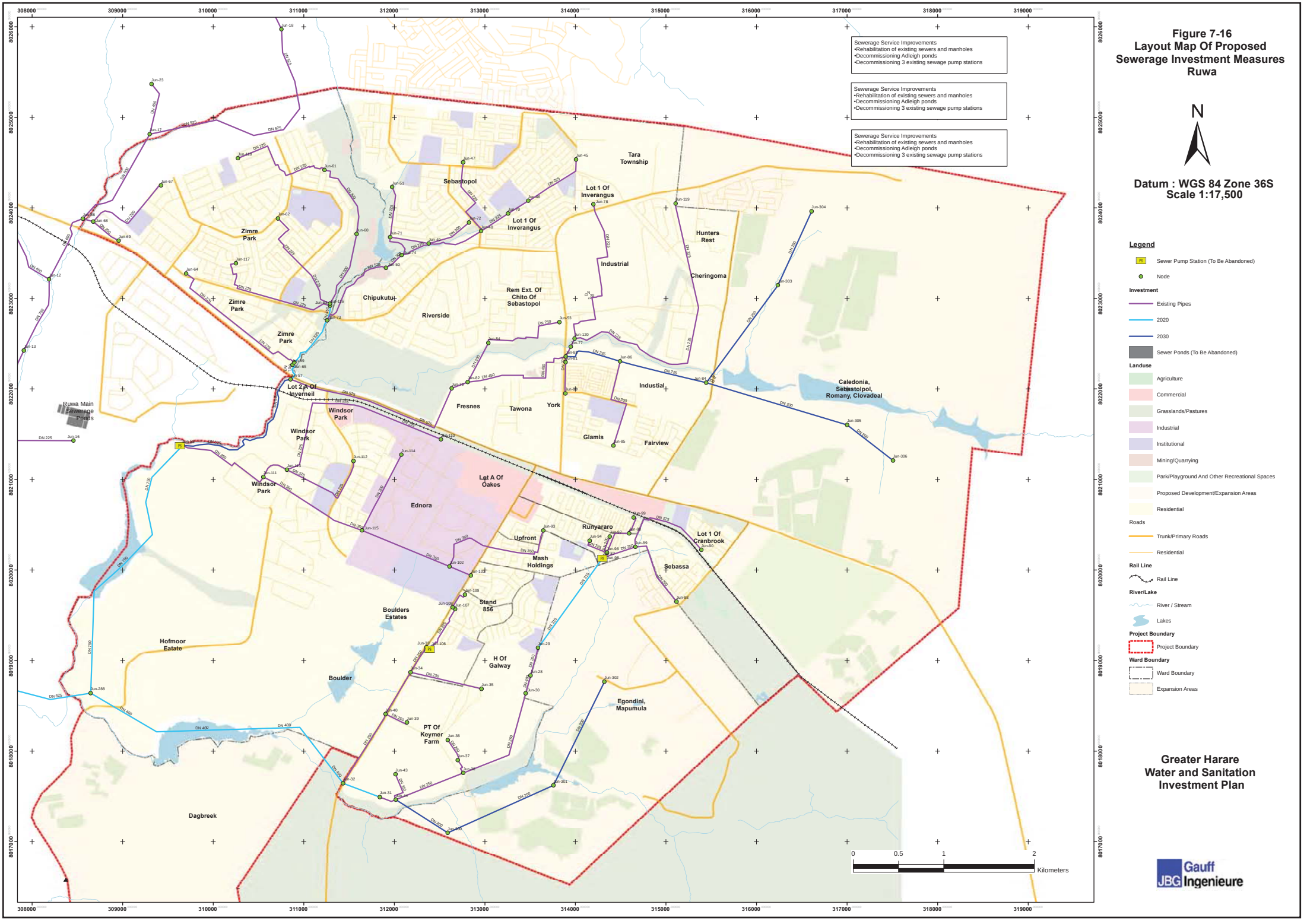


Figure 7-16
Layout Map Of Proposed Sewerage Investment Measures Ruwa

N

Datum : WGS 84 Zone 36S
Scale 1:17,500

Legend

- Sewer Pump Station (To Be Abandoned)
- Node

Investment

- Existing Pipes
- 2020
- 2030
- Sewer Ponds (To Be Abandoned)

Landuse

- Agriculture
- Commercial
- Grasslands/Pastures
- Industrial
- Institutional
- Mining/Quarrying
- Park/Playground And Other Recreational Spaces
- Proposed Development/Expansion Areas
- Residential

Roads

- Trunk/Primary Roads
- Residential

Rail Line

- Rail Line

River/Lake

- River / Stream
- Lakes

Project Boundary

- Project Boundary

Ward Boundary

- Ward Boundary
- Expansion Areas

Greater Harare Water and Sanitation Investment Plan

Gauff JBG Ingenieure

7.5.1 A - Water Demand Management/NRW Reduction Programme

7.5.1.1 Rehabilitation of the Distribution Network

Network Pipes

No detailed investigations were done as condition assessments of the water network in Ruwa. Rather data gathered for other towns under previous studies was combined with information from local officials to build up a picture of the state of the networks and the cost estimates from replacement of network piping are therefore based on a simple percentage of the total length of the network in place.

Ruwa has a relatively new water network, mainly dating from the 1980s and 1990s. Discussions with the network managers indicate that generally the network is not problematic. Pressures have been low for many years and as supply is restored it is likely that rates of pipe failure will increase. Estimates therefore allow for replacement of up to 5% of the existing network pipes.

Network Valves

Discussions with the operators of the network in Ruwa have indicated that valving in the town should be improved to facilitate proper demand management. The comprehensive valve replacement programme in the short term will not need to be repeated as a long term measure.

Bulk Metering

There are no operational bulk or block meters in Ruwa. Therefore estimates for the metering programme are based on the number of meters required to meter all main pipes that feed the demand areas as well as metering both ends of all primary distribution pipes. Experience shows that meter replacement programmes must be regularly repeated as meters have a limited lifespan. Therefore the cost of meter replacements are repeated at the long term also. The cost of metering new and expanded areas is covered in the estimates made for those expansions.

Pressure Reducing Valves

Only one pressure reducing valve is expected to be required in Ruwa in the incoming supply to ZIRE from Donny Brook. In addition there are level control valves required at the two elevated tanks and the ground tanks

Replacement of Service Connections

Experience has shown that service connections of galvanised iron as are provided in Ruwa are subject to corrosion and heavy loss rates. It is therefore intended to replace all GI connections with HDPE connections prior to or parallel to network rehabilitation. These connections are estimated at around 20% of the total falling mainly in the older wards of Ruwa.

In Ruwa there will be an augmentation of supply in the short term from the new Nora Dam water source and so it is not intended to install flow limiting devices on the service connections.

Replacement of Service Water Meters

As a foundation to an effective non-revenue water programme in Ruwa it is intended to replace all service water meters. Those in service now are generally 10 to 20 years old and at least 50% are known to be faulty.

Rationalisation of Zoning

With improved metering and valving there is a need in Ruwa to rationalise the Zoning of the town. In principal the Ruwa WTW will supply the northern areas of Ruwa, Glamis reservoir will serve areas to the between it and Ruwa river and Mutare Road Tanks and Booster Station will supply the southern parts of the town. ZIMRE will continue to be supplied from Harare and valves interconnecting ZIMRE's network with that of the rest of Ruwa should be closed when water supplies normalise.

Modifications to this Zoning may be required as water respources become available from different sources.

7.5.1.2 Commercial Operation Improvement Measures

For each town a package of commercial and operational improvement measures shall be implemented. This shall revolve around giving the network managers the tools they need to effectively identify and manage non-revenue water.

Table 7-39: Network Rehabilitation Measures - Ruwa

Item	Unit	2020	2030
Water Pipes			
ND 110 PVC or less	m	9,000	Nil
ND 160 PVC	m	1,600	Nil
ND 200 PVC	m	600	Nil
ND 250 PVC	m	1,600	Nil
ND 315 PVC	m	300	Nil
ND 350 DI	m	500	Nil
ND 450 DI	m	100	Nil
ND 600 DI	m	200	Nil
Network Valves			
ND 75 Gate	nos.	70	Nil
ND 100 Gate	nos.	20	Nil
ND 150 Gate	nos.	10	Nil
ND 200 Gate	nos.	20	Nil
ND 250 Gate	nos.	5	Nil
ND 300 Gate	nos.	10	Nil
ND 350 Butterfly	nos.	2	Nil
ND 400 Butterfly	nos.	2	Nil
ND 450 Butterfly	nos.	-	Nil
ND 500 Butterfly	nos.	1	Nil
Bulk Meters			
ND 100 Woltman type	nos.	Nil	35
ND 150 Woltman type	nos.	Nil	20
ND 200 Woltman type	nos.	8	4
ND 250 Woltman type	nos.	12	2
ND 300 Woltman type	nos.	2	1
ND 400 Electromagnetic	nos.	Nil	1
ND 500 Electromagnetic	nos.	1	1
Pressure Reducing Valves and Level Control			

Item	Unit	2020	2030
Valves			
ND 50	nos.	Nil	Nil
ND 80	nos.	Nil	Nil
ND 100	nos.	Nil	Nil
ND 150	nos.	Nil	Nil
ND 200	nos.	Nil	Nil
ND 250	nos.	Nil	Nil
ND 300	nos.	5	Nil
Replacement of Service Connections			
Domestic (ND 15) (OD 20)	nos.	2,000	Nil
Non-Domestic (ND 25)	nos.	1,000	Nil
Installation of flow limiter (done with service connection replacement)	nos.	Nil	Nil
Removal of flow Limiters	No.	Nil	Nil
Replacement of Service Water Meters			
Domestic (ND 15)	No.	12,000	28,531
Non-Domestic (ND 25)	No.	500	3,806
Provisional sum for network mapping, network investigations and repair/replacement programme	Sum	1	
Provisional sum for customer database cleanup and awareness campaigns	Sum	1	

7.5.2 B – Water Supply Service Improvements

The Ruwa intakes are new and will not need rehabilitation. Limited rehabilitation works have been identified for the existing water treatment facilities in the short and long term projects as follows:

Short Term Investment Measures

1. Strip down and apply internal and external corrosion protection to the steel 2.5MLD FC reactor unit.
2. General servicing/ rehabilitation of both FC reactor units is required, including:
    a. Attend to seals which are allowing filter media to escape into supply
    b. Install strainers on discharge pipework to catch any filter media that does escape the reactor.
    c. Service all valves
    d. Improve safety and handrailing on walkways and ladders
3. Replace the existing chemical mixing and dosing facilities. As this is the only, very small power requirement of the plant, it is recommended that the current system be replaced with a solar powered dosing system. With a solar power source it will be possible to increase the automation of the chemical dosing system.
4. Complete the 4000m^3 circular clear water reservoir and all connecting pipework. The works currently operate at low flow rate, discharging directly into supply. The 4000m3 clear water reservoir should be constructed to balance outflows and allow the plant to optimize production.

5. Complete the construction of the sludge drying beds. The works are currently operating at low rate but when 17.5MLD of treatment capacity is on site the drying beds will be essential.

Long Term Investment Measures

Short term measures will take the capacity of the Norton WTW to 20MLD, matching the 21MLD supply available through the raw water pipeline. Once the capacity of this supply is exhausted additional flows will come from the Kunzvi scheme. Kunzvi will deliver its treated water to Donny Brook reservoirs which already have a high capacity link to Ruwa. However the works will be maintained at 20MLD capacity even after commissioning of Kunzvi.

Long term investment measures will be limited to repair and rehabilitation of mechanical plant, corrosion protection and servicing of the FC reactor units and the dosing equipment.

Table 7-40: Investment Measures at Ruwa WTW

Item	Unit	2020	2030
Corrosion protection to existing 2.5MLD FC Reactor WT Vessel	m2	412	412
Rehabilitation of FC Reactor Units			
5MLD Unit	MLD	5	5
2.5MLD Unit (Steel)	MLD	3	3
10MLD Unit (2018 Install)	MLD	-	10
Rehabilitation / Extension of Chemical Dosing Facilities			
Provision of 3kW Solar Array with Controller and Batteries for dosing	kW	3	3
Replacement of dosing equipment	nos	1	1
Complete drying beds	m2	400	
Completion of WTW treated water reservoir 4000m3			
Concrete Reservoir 4000m3	m3	4,000	
Supply Pipework DN750	m	110	
Level Control Valve DN750	nos.	1	1

7.5.3 C – Extension of Water Supply Services

7.5.3.1 New Water Production Facilities

Ruwa has recently completed a major Bulk Water Supply project from the Nora Dam. Investigations with ZINWA show that the dam has a high yield potential and should provide a reliable source of water to the town. The town currently only has 7.5MLD in available treatment capacity but the raw water supply is rated at up to 21MLD. To capitalise on the investment made in raw water it is proposed to expand the water treatment capacity by adding a 12.5 ML/d FC reactor to the existing water treatment facilities. The total water production capacity will be 20 ML/d

7.5.3.2 New Transmission Facilities

Short Term Investment Measures

Following from the investment made into supply of water it is necessary to strategically reinforce the distribution facilities in the town. This will include works on booster pump stations and pipework as follows:

The additional water supply availability in Ruwa in the short term will require the construction or reconfiguration of the water booster stations. The purpose of the two proposed booster stations is to maintain reasonable network pressures at high flow rates in high areas which cannot be gravity fed from the tanks. One transfer pumping station is proposed to transfer water from Ruwa WTW to the Mutare Road tanks as a gravity feed of sufficient capacity would require an uneconomically large diameter pipe. Pumping proposed is as follows:

Table 7-41: Pump Stations Reconfiguration - Ruwa

Pump Station Location	Supplies to	Type of Pumping	Capacity
Ruwa WTW	Mutare Road Ground Reservoir	Water Transfer. Constant Speed Pumping	230l/s @25m head
	Wards 9, Damofalls, New Expansions North and East of Ruwa.	Booster pumping. Variable speed pumping preferred	400l/s @25m head
Mutare Road Reservoirs	Wards 1 to 7 and new expansion areas southeast, south and southwest of Ruwa	Booster pumping. Variable speed pumping preferred	455l/s @20m head

The Ruwa Transmission system is to be reinforced in the short term to the extent necessary to properly distribute the water that will become available from the expanded WTW. This requires additional capacity on a north south axis through the town allowing higher feed rate from the Ruwa WTW to Mutare Tanks and from Mutare Tanks to the expansion areas in the south of Ruwa in Wards 5 and 7.

Table 7-42: Transmission/Primary Distribution Short Term Investment Measures - Ruwa

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
a	Ruwa WTW to Mutare Rd Tanks.	4650m DN400 Ductile Iron	Increase supply availability in Southern areas of Ruwa
b	Mutare Road Tanks to Southern Ruwa	3260m DN400 Ductile Iron 775m DN315 uPVC	Augment supply the southern expansion areas of Ruwa currently supplied through the distribution network for existing areas.

Long Term Investment Measures

As Ruwa's water supply situation normalizes it will be necessary to reinforce the primary and secondary distribution system as tabulated below:

Table 7-43: Transmission/Distribution Long Term Investment Measures - Ruwa

Note Refers	Description of Pipeline	Investment Required	Reason for Investment
TRANSMISSION/ PRIMARY DISTRIBUTION			
c	ZIMRE to WTW Tanks	4250m of DN500 Ductile Iron	Allow the existing DN525AC to be used as a main treated water supply line to rather than just as supply to ZIMRE. This will meet Ruwa's expanding treated water requirements in the long term
SECONDARY DISTRIBUTION			
d	New line to supply east of ward 5 and the new expansion area (2030) of Athelney Farm.	3720m of DN200 PVC	Expansion of water supply into new residential areas
e	New line to supply the 2030 expansion area of Mara Farm east of Ruwa WTW and Damofalls.	7900 of DN200 PVC	Expansion of water supply into new residential areas

7.5.3.3 Storage Facilities

In the short term the minimum work will be done on water storage which shall involve the replacement of the elevated tank at Mutare road with a similar sized storage on the same tower. The Council wish to decommission the existing tank because of extensive corrosion.

As Ruwa's water supply situation normalizes the available storage as proportion of daily supply will likely drop significantly below the recommended 24hour minimum. Therefore as a long term measure it will be necessary to augment storage within Ruwa.

The layout of the town is such that the existing WTW is at approximately the highest point but also it is the closest high point in the town which can be easily connected to the Donny Brook Tanks which will supply treated water above and beyond the 17.5MLD that the Ruwa WTW will ultimately be capable of. It is therefore makes sense to construct the town's main storage at this location. This new storage will be sized to provide a total of 24hours of storage in the system. Hence investment in storage will be as follows:

- Replacement of Mutate Road Elevated reservoir in the medium term (200 m^3)
- Ruwa WTW Clear Water Tanks Expansion in the long term (40,000 m^3)

7.5.3.4 Extension of Distribution Network to new areas

The predicted population growth in Ruwa will require extensions to the distribution system. Most of this work will likely be funded through private developers.

Unlike other towns, Ruwa should have sufficient water supplies to expand without having to use flow limiting devices to manage demand.

Table 7-44: Investment Requirements in New Development Areas - Ruwa

Item	Unit	2020	2030
Extension of Distribution System			
Pipes			
ND 75 PVC	m	45,000	49,000
ND 110 PVC	m	56,000	62,000
ND 160 PVC	m	28,000	31,000
Section valves			
ND 75 Gate	nos.	450	490
ND 100 Gate	nos.	560	620
ND 150 Gate	nos.	280	310
Fire hydrants			
ND 80	nos.	168	186
Service connections			
ND 15	nos.	9,392	10,381
ND 25	nos.	1,878	2,076
Service water meters			
Domestic (ND 15)	nos.	9,392	10,381
Non-Domestic (ND 25)	nos.	1,878	2,076

7.5.3.5 New Bulk Water Management Facilities

Ruwa has a complex arrangement of multiple supply sources and multiple reservoirs, some of which boost into supply. To work efficiently this system will require good control and automation of reservoir levels and booster pumping pressures.

Variable speed pumping is recommended on all booster pump stations and should be controlled by network pressures with lower pressures set for off peak hours when system frictional losses are lower.

A system will be required to monitor the status of all reservoirs and to control the feed pumps from the Ruwa WTW to the tanks

7.5.4 D - Sewerage Service Improvements

7.5.4.1 Rehabilitation of Sewerage Reticulation System

Ruwa is a relatively new town and as such there are no significant problems reported with the sewer network. However, in the last decade water supplies have been short and flows therefore low and it is expected that a return to normal supply levels may show up areas

where the existing system has deteriorated. The sewer network rehabilitation measures are designed to be split into two parts to be carried out in the long and short term.

Table 7-45: Sewer Network Rehabilitation Measures - Ruwa

Item	Unit	2020	2030
Sewer reticulation pipes Replacement			
ND 150 PVC	m	5,328	10,657
ND 200 PVC (OD 225)	m	256	512
ND 250 PVC (OD 280)	m	1,820	3,640
ND 315 PVC	m	205	409
ND 400 PVC	m	290	580
ND 450 PVC	m	76	152
Construction of manholes	nos.	23	46
Rehabilitation of Manhole cover and frame	nos.	319	319
New Manhole Covers only	nos.	638	638

7.5.4.2 Rehabilitation of Sewage Pump Stations

In Ruwa, the modifcations proposed to the sewerage system mean that the existing sewage pumps stations are to be decommissioned rather than rehabilitated. Certain decommissioning works are required in the short term and there will be no long term works on sewage pump stations.

Table 7-46: Rehabilitation of Sewage Pump Stations - Ruwa

Item	Unit	2020	2030
Renyaro SPS			
Grade and Gravel Access Road	m	50	
New Site Fencing (Clearvu)	m	142	
New Gate	No.	1	
Demolition of unused structures	nos	2	
Landscaping and grassing or gravelling	nos	1,050	
Removal of contaminated material to spoil	nos	210	
Construction of skip hard standing for rakings	m^2	24	
Chilemba SPS			
Grade and Gravel Access Road	m	85	
New Site Fencing (Clearvu)	m	184	
New Gate	No.	1	
Demolition of unused structures	nos	2	
Landscaping and grassing or gravelling	nos	2,091	

Item	Unit	2020	2030
Removal of contaminated material to spoil	nos	418	
Construction of skip hard standing for rakings	m^2	24	
Ruwa Main SPS			
Grade and Gravel Access Road	m	-	
Repairs and painting to site walling	m	240	
New Gate	nos.	1	
Demolition of unused structures	nos	-	
Landscaping and grassing or gravelling	nos	875	
Removal of contaminated material to spoil	nos	175	
Construction of skip hard standing for rakings	m^2	-	

7.5.4.3 Rehabilitation of Wastewater Treatment Plants

Ruwa historically discharged sewage to the Adelaide ponds. These are located on land controlled by Epworth and this land has been earmarked for redevelopment. Thus the ponds are now to be decommissioned.

Table 7-47: Ponds De-commissioning Works - Ruwa

Item	Unit	2020	2030
RUWA Stabilisation Pond			
Dewatering and drying out	Sum	1	
Sludge excavation and removal	m^3	15,741	
Dozing of walls and lanscaping level	m^3	28,320	
Demolition of unused structures	nos	2	

7.5.5 E – Extension of Sewerage Services

7.5.5.1 Protection of Green Sykes Dam

The catchment area of the Green Sykes dam contains areas currently proposed for housing development. Ruwa should revisit this planning and ensure that the whole catchment area of Green Sykes is protected against any development that may damage water quality in the dam. Zoning within the Green Sykes dam catchment should be limited to agricultural and agricultural small holding and housing developments should be prevented.

7.5.5.2 Extension of Sewer Reticulation System to new areas

Considerable growth is expected in Ruwa in three separate areas to the North East and South of the Town. In addition it is a key part of the proposal for Ruwa that it will decommission all of its sewage pump stations and its ponds.

In the long term it is proposed that Ruwa will construct an outfall sewer to the existing line between Donny Brook and Lyndhurst Farm joining to the Harare South Trunk Sewer. In the short term this final connectionw will not be available so an interim pond treatment system is required. These ponds will be located at the lowest area in the proposed expanded town of Ruwa and therefore, considerable investment is required in main sewers.

The main sewer network for Ruwa has been modelled using the expected flows at the 2030 time horizon to identify sewer lines which may need to be augmented or upgraded to accommodate the expansion of the town. It should be noted that the entire current network appears adequate for normal flows with the current population. The modelling has identified the following investments required within Ruwa.

Short Term Investment Measures

Table 7-48: Short Term Sewerage Investment Measures - Ruwa

ID	Model Nodes	Investment Required	Reason for Investment
EXISTING MAINS UPGRADES/ AUGMENTATION			
1	J116 to J73	Replace 175m of DN300 with DN450 RC	Allow for flows arising from northerly expansion of Ruwa into Tarisa Farm
2	J73-J65-J59	Replace 650m of DN300 with DN525 RC	Allow for flows arising from northerly expansion of Ruwa into Tarisa Farm
3	J59-J57	Replace 215m of DN525 215 with DN675 RC	Crossing of Mutare Road will accommodate Ruwa's northerly and easterly expansions
NEW MAINS			
A	J58-J228	3165m of DN750 RC	New sewer line from the location of the existing Ruwa Main SPS to the lowest point in Ruwa. This line will also provide gravity sewer of the expansion areas of Ward 7 and Sunway City.
B	J87 (Relnyaro SPS) to J29	1228m of DN315 uPVC	Links the existing SPS to the gravity sewage system
C	J106 (existing Chilemba SPS) to J33	50m of DN250 uPVC	Links the existing SPS to the gravity sewage system
D	J31 to J32	435m of DN250 uPVC	Link the low points east and west of Ward 5.
E	J32 to J228	3210m of DN400 uPVC	Link the lowest point in ward 4 to the lowest point in ward 7. This line

ID	Model Nodes	Investment Required	Reason for Investment
			completes the new gravity network required in Ruwa to allow for the decommissioning of all SPS. From the end of this link Sewage will be pumped to the new temporary ponds in the northern part of Dagbreek farm

Long Term Investment Measures

The short term measures described above will remove Ruwa's reliance on sewage pumping and add capacity in certain critical sections which will become overloaded because of existing development. Long term measures are required to accommodate increased flows from new development areas.

Table 7-49: Long Term Sewerage Investment Measures - Ruwa

ID	Model Nodes	Investment Required	Reason for Investment
EXISTING MAINS UPGRADES/ AUGMENTATION			
1	J84 - J86 - J83	1640 of DN225 uPVC laid parallel to existing DN225	Additional flows arising from expansion into Mara Farm
2	J57-J58	1780m of DN525 RC laid parallel to existing DN525	Additional flows arising from expansion into Mara Farm
NEW MAINS			
A	J304 -J302-J84	2250m of DN200 uPVC	Expansion into Mara Farm
B	J306-J305—J84	2250 of DN200 uPVC	Expansion into Mara Farm
C	J302-J301-J300-J44	3075m of DN200 uPVC	Expansion into Athalney Farm area
E	J228 to J229	4550m of DN825	Main outfall from Ruwa to the existing but as yet not commissioned main sewer line between Donny Brook and Lyndhurst Farm.

The expansions in sewage coverage will lead to considerable increases in the number of connections to the sewer network.

Table 7-50: Sewerage Investment requirements in new development Areas - Ruwa

Item	Unit	2020	2030
Pipes			
ND 100 PVC	m	24,700	47,800
ND 160 PVC	m	10,300	19,900
Construction of manholes	nos.	700	1,354
Sewer service connections			
ND 100	nos.	4,200	8,000

7.5.6 New Ruwa Wastewater Treatment Plant

The decommissioning of the Adelaide ponds will leave Ruwa with no Sewage Treatment system until the commissioning of the HSTS which is not expected in the short term. Therefore as a short term investment measure it will be necessary to construct a new WWTW for Ruwa. It is proposed that a pond/ irrigation system will be used and will be constructed at the Northern Part of Dagbreek farm. Ruwa have already commenced planning for a new WWTW although their proposed location is north of the river. In this proposal a location south of the river was selected so as not to interfere with land that could be used for housing development. Final decision on location can be made at feasibility study stage.

Table 7-51: Proposed Temporary Sewage Treatment and Disposal - Ruwa

Item	Unit	Qty
Pump station from south of Ruwa to head of ponds		
Sewage Pumps 600m3/hr @15	No.	3
Booster Pump Suction and Discharge Ppipework	No.	3
Booster Pump Station Building	m2	60
Booster Pump Station Ancilliaries	Sum	1
Force Main 1000m ND500 GRP	m	1,200
Civil Works in Pond Construction 9MLD Stream	Stream	2
Pond System Pipework	Stream	2
Inlet Works	Stream	2
Ancilliary Buildings	Stream	2
Wastewater Slow Rate (irrigation) disposal system		
Irrigation Set Up	Ha	250
Irrigation Pumps and Equipment	Ha	250

7.6 F – Accompanying Measures

Accompanying measures are aimed at improving the operations of the councils so that water and sanitation services are provided efficiently and sustainably. The table below summarises the main components that constitute accompanying measures.

Table 7-52: Accompanying Measures

Component	Sub-components	Remarks
Technical operations management	• Establishment of meter control, testing and repair workshop • Procurement of tools and equipment for operations and maintenance • Provision of vehicles for operation and maintenance teams • Provision of vacuum tankers for septic tank emptying	These measures will provide equipment and tools to the technical sections, which will improve their capacity to provide services
Information Communication Technology Infrastructure	• Supply of server • Supply and install Local Area Networking • Supply and install Wide Area Networking • Supply and install generator power back-up • Supply personal computers complete with software, UPS, etc. • Supply laptop computers • Supply heavy duty printer (dot-matrix) • Supply laser printers • Supply and if appropriate install auxiliary equipment	Information infrastructure for data processing, reporting and archiving
Commercial operations management	• Review/Improvement of billing and commercial operations (consultancy) and comprehensive billing database cleanup. • Socio-economic surveys and customer awareness campaigns	Thorough review of commercial operations aimed at improving revenue collection
Management, commercial and technical information systems	• Procurement and installation of billing and customer services software • Procurement and installation of management information software • Procurement of commercial operations software (various) • Procurement and installation of accounting and payroll software • Procurement and installation of GIS based Network Information Systems software • Procurement and installation of other software (asset management,	Software applications for commercial and technical operations

Component	Sub-components	Remarks
	hydraulic modelling etc)	
Professional services - Institutional Support	• Advice, guidance and support in the development of institutional frameworks towards an autonomous utility • Assessment of capacity, competency and development of a comprehensive training program • Specific training courses (various)	Professional services aimed at building capacity for the water utility
Professional services - Feasibility, Design and Supervision	• Engineering Services	Engineering services necessary for the implementation of investment measures

CHAPTER 08: INSTITUTIONAL CAPACITY ASSESSMENT

8 INSTITUTIONAL CAPACITY ASSESSMENT

8.1 Legal and Policy Framework

On a national level, the main legislation that regulates the access to water and the development and management thereof is provided for in the Water Act. This was overhauled to its current version referred to as the Water Act 1998, which replaces the Water Act 1976. It has been strengthened by the National Water Policy, 2013 of the Ministry of Water Resources Development and Management.

In general terms, the 1976 Water Act prioritised water allocations to commercial farms and other enterprises with commercial interests through the issuing of indefinite water rights. This effectively favoured a representative population of about 1% and neglected the remaining population. The Water Act 1998 sought to rectify the allocation of the national water resource more equitably and recognises the notion that the access to water for primary use is a basic right. The Water Act 1998 (CAP 20:24) provides the following main features:

- Water rights have been replaced with water use permits. The permits are issued for a limited period and can only be renewed subject to water availability and evidence of efficient use. The previous Act provided water rights without limitation of time and issued on a first come, first serve basis and were part of the title deed;
- The priority principle (favouring commercial use) has been done away with.
- Water can no longer be privately owned.
- Water is to be viewed from the complete hydrological perspective, i.e. groundwater and surface water are treated as part of one hydrological system, i.e. recognising the presence of ground water as an equal resource, which was previously ignored.
- Stakeholder-driven institutions have been formed that will have more say on water allocation and general water management on a day-to-day basis.
- Greater consideration of the environment, with environmental water use now recognized as a legitimate user.
- More control over pollution, with the “polluter pays” principle being introduced.

Relevant extracts from the Water Act 1998 (CAP 20:24) are provided in the following table.

Table 8-1: Key elements of the Water Act 1998

Section	Title	Quotes from the Water Act 1998	Investment Master Plan Strategy
12(1)	Preparation of outline plans	For the purpose of ensuring the optimum development and utilization of the water resources of Zimbabwe, the National Water Authority, and the catchment council concerned, shall prepare an outline water development plan for every river system.	Availability of raw water against projected demand projections to be considered, guided by river basin development plans on the supply side.
13(2)	Contents of outline plan	The National Water Authority shall clearly indicate in an outline plan the priorities in the utilization and allocation of water, taking into account policy guidelines	Uses of raw water available guided by outline development plan.
33(1)	Application for permit	No person shall abstract water for any purpose other than primary purposes	Application to be made/issued by Local Board

Section	Title	Quotes from the Water Act 1998	Investment Master Plan Strategy
		except in terms of a permit.	
35	Authority to sink boreholes	The written authority of the catchment council to sink, alter or deepen a borehole… be obtained before making an application for a permit	Ensure that authorities to sink boreholes have been/will be obtained.
36	Period of validity of permit	A permit shall be valid for a period of twenty years or such shorter or longer period as a catchment council, with the approval of the Secretary, may fix.	Planning horizon to consider span of water abstraction approvals.
43	Records of amount of water abstracted to be maintained	A catchment council may require the holder of a permit issued in terms of this Part— (a) to provide and install a meter or other measuring device for measuring and recording the amount of water abstracted; and (b) to submit to the catchment council in the prescribed form at such intervals as the catchment council may require, returns indicating the amount of water abstracted	Monitoring, record keeping and control of raw water intake must be provided for.
60	Conferring of powers of catchment councils to urban councils	The Minister may, after consultation with the Minister responsible for local government and the urban council concerned, and after considering the financial resources available to that council— (a) subject to such conditions as he thinks fit to impose, confer on the urban council any of the powers of a catchment council in terms of this Part; and (b) amend or withdraw the powers conferred in terms of paragraph (a).	Possibility of transferring raw water management to the Local Board.
`69	Permits for discharge or disposal into water	Notwithstanding section sixty-eight, the National Water Authority, upon an application by any interested person and subject to prescribed standards of quality	

Apart from this, the Water Act 1998 (Section 20) provides the basis for the establishment of the Zimbabwe National Water Authority (ZINWA) as detailed in the separate National Water Authority Act, which also guides and regulates the formation of the supervisory entities; Catchment Councils and Sub-Catchment Councils as outlined with their functions in the following table.

Table 8-2: Key Establishments Responsible for Resource Development and Management

Name	Functions
Zimbabwe National Water Authority (ZINWA) created under the Zimbabwe national Water Authority Act	a) Advise the Minister on the formulation of national policies and standards: • Water resource planning, management and development; • Water quality, pollution control and environmental protection; • Hydrology and hydrogeology; • Dam safety and borehole drilling; • Water pricing. b) Assist, participate or advise on the planning and development of water resources. c) Exploit, conserve and manage water resources. • to promote an equitable, efficient and sustainable allocation and distribution of water resources;

Name	Functions
	• providing, in both the short and the long term, adequate water on a cost effective basis; • take appropriate measures to minimise drought of flooding; d) Promote an equitable, efficient and sustainable allocation and distribution of water resources; e) Encourage and assist the local authorities in the discharge of their functions; f) Ensure that Catchment Councils discharge their functions in accordance with the Water Act 1998; g) Encourage and assist Catchment Councils to develop water resources; h) Operate and maintain any water works owned or managed by the Authority; i) At a fee, provide assistance, personnel, training, information; j) Undertake research; k) Hydrological and geo-hydrological surveys, maps; l) Promote mechanisms for cooperative management of international resources;
Catchment Councils (CC's) established under Water Act 1998, section 20(1)	Established for the management of seven demarcated catchment areas to: a) prepare a catchment management (outline) plan, in consultation with ZINWA, for the river system; b) grant permits for water use; c) regulate and supervise water use; d) supervise the performance of SCCs; e) Resolve conflicts within their areas of jurisdiction.
Sub-Catchment Councils (SCC's) established under the Water Act 1998 Section 24	Facilitate water management on a smaller scale to: a) regulate and supervise the implementation of permits, including groundwater use; b) monitor water flows and use, in accordance with allocations by the CC; c) provide representatives for the CC; d) promote catchment protection; e) monitor water discharge; f) assist in data collection and participate in catchment planning; g) Collect rates and fees for all permits issued.

With the changes provided through the promulgation of aforementioned legislation and establishment of new authorities outlined above, the Water Act 1998 also constituted part of the water sector reform, which took place in parallel with land settlement reforms. The water sector reform process was also driven by international calls for more efficient and sustainable management embracing environmental, technical and financial aspects of sustainability. The support for Zimbabwe's water sector reform emanated from concerns of inadequate water availability coupled with unsatisfactory efficiency levels and inconsistencies between legislation and the requirements for water.

Some explanations to the disappointing performance of the water sector, despite the revised legislation and newly formed organisational framework are provided in a joint report from the University of Zimbabwe and ZINWA[1]:

- Conflicting policies – the water reform was being launched at the same time as the land reform process. Although the objectives were similar in redistributing the resources to the same people in each reform, the land reform took place at a speed

1 H. Makurira and M. Mugumo: Water Sector Reforms in Zimbabwe: The importance of policy and institutional coordination on implementation (Chapter 14), ref. http://www.fao.org/forestry/11736-034e5c33d2c2b2c1704994cfabd4f7014.pdf

that the water sector could not keep pace, loosing track of who is located where and holds what permit.

- Weak institutional linkages; The Water Act assumes that water institutions created under the Water Act are consulted before use of the natural resource, however there is little evidence that this is done.
- Insufficient funding resulting from donor withdrawals at a time when the water sector reform was being implemented. The CC's were supposed to be implemented with the assistance of donor funding, however, without the planned and necessary financial backing the CC's could not take off as intended. With the implementation of the land reform and uncertainties regarding continuing occupancy, existing occupiers ceased or reduced their payments for water permits and contributions to the Water Fund set up as part of the Water Act 1998 and intended, with additional contributions from the government's budget, to develop the water sector as directed by the minister. Unfortunately, new settlers did not necessarily abide by the principles of "user pays" and "polluter pays". Thus, the inflows into the Water Fund were meagre and required investments into the water sector were not possible as intended.
- Lack of capacity within key institutions including ZINWA, Ministry of Water and Rural Development could not offer the necessary professional expertise since several key positions were vacant. The much needed Water Fund would have gone a long way to fill these posts. Apart from this, staff remunerations were low and unattractive for staff working in these institutions.
- The lack of enforcing critical elements of the Water Act 1998 contributes to inadequate inflow of funds to sustain ZINWA.

The recently endorsed National Water Policy (2013) provides an opportunity for a renewed start of implementing the water sector reform. The document echoes the Water Act 1998 in many respects. This medium and long term investment plan recognises this policy and at the same time is considered to be an integral part of implementing the National Water Policy. Whilst all aspects, including technical considerations of the National Development Plan are detailed in Chapter 7, relevant legislative, institutional and organisational issues are extracted as shown in the following table.

Table 8-3: Key institutional and organisational principles of the National Water Policy

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
6.2.2.	Integrated water resources management (IWRM)	IWRM is intended to bring about improved equity of access to water, greater efficiency of water use, environmental protection and greater sustainability for the benefit of current and future generations.	Consideration of **IWRM principles** in the planning of investment measures.
6.2.10	Water institutions and decentralisation	The private sector and civil society have an important role to play in the water sector. Government ministries or departments or local authorities should restrict themselves to and focus on policy making, establishing regulatory regimes that provide incentives for achieving goals and sanction for serious failures and that they leave operations to parastatals and private sector based on sufficient autonomy to control outcomes	**Private sector** can play a role in service provision. Operations can be undertaken by **parastatals and private sector**.

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
6.2.11	Water in growth and development	Planning will take into account the long-term needs of the economy, national strategic interests, regional integration and social/environmental impacts. Economic feasibility is vital: This means that the level of development of the infrastructure must be defined by what the country as a whole can afford to operate and maintain. It is important however to concentrate on a recovery programme in order to restore services to acceptable levels	Investment plans must consider **economic feasibility** and infrastructure services must be **affordable.**
6.2.13	Water pricing	To achieve efficiency, water prices will be based on the user pays and polluter pays principles and socially acceptable to different interest groups in the water sector. Subsidies will be targeted to users who are not in a position to pay the full cost of the service provider or where national interests would be compromised. Water pricing will reflect the full costs of provision of water for all uses (capital and recurrent costs), except for primary water where the price will at least reflect the operation and maintenance costs. The price will take into account user viability. Water pricing will be used as a demand management instrument to encourage efficient use of scarce water resources. Water pricing should be based on the quantity of water used by volume to manage demand Water billing will revert back to being clear, transparent and based on actual volumetric readings and income derived will be applied to the costs of providing water, otherwise the 'user pays' principle collapses together with the services The payment of water service bills by public consumers including government institutions is vital for viability of water service providers. Regulations will be drawn up to permit recovery of unpaid bills directly from PSIP allocations of the institutions involved	User pays and polluter pays principle. **Subsidies are the exception** only for users not able to pay for services. Water pricing is used as **demand management** instrument. Billing shall be done on **volumetric readings.** Payment of water services from public consumers including government institutions is vital.
6.5.2	Service authorities and service providers	Urban local authorities are responsible for ensuring the welfare of urban residents through the provision of efficient and affordable water supply and sanitation services. However, a distinction is made between the responsibility of urban authorities to ensure that services are provided and the actual operation of services which may be more efficiently undertaken by a dedicated service provider as a function delegated by the local authority	Local authorities are responsible for efficient and affordable water supply services and are free to delegate services to a dedicated **service provider**.
6.5.5	Financing	Revenue derived from water sales will be applied to the costs of providing water services in order to maintain consumer confidence and not compromise cost recovery and the 'user pays principle'.	Local authorities shall apply **ring fencing** to revenue collected from water and sanitation services and ensure that such revenue is used for

Section	Title	Quotes from the NWP document	Investment Master Plan Strategy
		Local Authorities should undertake cost accounting and ring-fence revenue from water sales. Tariffs should be set to achieve full cost recovery.	service provision.
		Government will provide interim subsidies to Urban Authorities through PSIP and donor financing that will be coordinated within a Water Sector Investment Framework to finance rehabilitation and expansion of infrastructure during the recovery period. Long-term financing during the normalized growth phase will be the responsibility of ULAs	**Tariffs should be set to achieve full cost recovery**.

Other important legislation guiding the management of the water resources are:

- *Council by-laws* gazetted in the 1972[2] still form the basis of operations with respect to water supply and sewerage service provisions. Over time sections thereof have been amended, in particular the tariff for water supply and sewerage collection/treatment services through various statutory instruments readily available at the council[3]. Less readily available are the original by-laws and it is obvious that little reference and in most cases little knowledge on their content is reflected by council personnel in their day-to-day operations. This is confirmed with the lack of litigations against defaulters and offenders of the by-laws and Epworth is no exception. General sensitisation and possible review of this fundamental legal framework needs to be looked into to encourage greater obedience to comply with the same.
- *Public Finance Management Act (CAP 22:19) of 2009;* as part thereof, the councils have been instructed by the Ministry of Finance to ring-fence the revenues and expenditures for water and sewerage service operations. In line with the National Water Policy it encourages the councils to isolate the daily operations in the form of a more autonomous organisation. However, realistically this step toward decentralisation of water and sewerage service operations has not and cannot take place presently as there is need to cross-fund and subsidise other council activities such as health, education, road maintenance and cleaning, etc. As long as the other mandatory services of the council are unable to operate sustainably, ring fencing is not possible. This opens the need to involve line ministries of the financially ailing services to provide subsidies or other funding as is understood to have been the case before the economic downturn.
- *Labour Act (CAP 28:01)*; provides the basis of employment, remuneration, and termination as well as trade union matters, codes of conduct and disciplinary , As described in section 4A the purpose of the act is to:
    - advance social justice and democracy in the workplace by—
        - giving effect to the fundamental rights of employees provided for under Part II;

2 Government Notice 608 of 1972.

3 2013 tariffs published through statutory instrument No 46 of 2013, Epworth (incorporated area) (Amendment) By-Laws, 2013 (No. 19).

- providing a legal framework within which employees and employers can bargain collectively for the improvement of conditions of employment;
- the promotion of fair labour standards;
- the promotion of the participation by employees in decisions affecting their interests in the work place;
- Securing the just, effective and expeditious resolution of disputes and unfair labour practices.

- *Directives;* It is understood from the councils that the Minister for Local Government issued a directive not to disconnect any household connection supplying water to the premises on the basis that water is a human right. This in itself, but exacerbated by the currently depressed economic situation, has encouraged non-payment for outstanding debts. While the basis of the directive is understood and generally followed, it substantially infringes on the council's ability to operate sustainably, plunging it into a downward spiral of decreasing ability to effectively finance the water and sewerage service operations causing declining service delivery capacities, which in turn strengthen the consumer's argument not to make payments.

  Following the general elections of August 2013 a directive was issued to write-off all accumulated debt accrued from water and sewerage charges relating to domestic use with effect from 01.09.2013.

In summary, the council is bound to a variety of national and local legislations that are partially implemented due to either conflicts between some legal requirements, inability to comply and ignorance to their existence. The proper implementation of the existing legal framework, notwithstanding the need for some critical amendments to be carried out to support the basis for effective delivery of services, this should affect the institutional and organisational re-organisation of the councils with respect to water and sewerage services.

8.2 Institutional Framework

The current organisational structure for water and sewerage services in Epworth, Norton Ruwa, Chitungwiza and Harare is integrated in the overall Municipal Council's structures, resulting in the operational involvement of several departments and sections, viz:

- Department of Engineering Services: technical matters relating to daily development, daily operation and maintenance/repair activities, drawing on specific sections:
  - Water section;
  - Sewerage section; and
  - Planning.
- Department of Financial Services: meter reading, billing, collection, customer care, budgeting, external payments (suppliers on cash terms and credit), internal payments (payroll), management and control of debt and credit, performed by:
  - Revenue section;
  - Expenditure section; and
  - Information Communication Technology (ICT) section;

- Department of Central Administration contributing with aspects of human resource, legal matters and general administration and security supported by various sections:
    - Administration;
    - Welfare;
    - Legal section; and
    - Human resources.

This presents a complex and scattered organisational setup for the planning, operation and maintenance of water and sewerage facilities. Apart from the structure, the main shortcomings in relation to the specific operation of water and sewerage services were noted to be:

- Unclear job-titles and job descriptions;
- Work overlaps and in the existence of several vacancies, work gaps;
- Unclear and/or disregard for responsibilities, particularly at lower levels, leading to the necessity to micro-manage and director's and immediate subordinates over-burdened with responsibilities;
- Cumbersome reporting lines between sections and more so, between departments, officially requiring the involvement of heads of section and possibly heads of department on operational issues between officers on lower levels (e.g. revenue officers compiling monthly reports including production figures from the technical section [Engineer's Department]);
- Prioritisation and decision making typically involves several departments, causing delay, particularly if these are not unanimous amongst the parties involved;
- Low literacy levels, notably prevalent at the supervisory level and below.
- Poor revenue collection which leads to poor performance of the utility. The little revenue that is collected is consumed by staffing costs leaving nothing for maintenance.

Some of the resulting challenges reported were, lack of preventive maintenance, poor/no recapitalisation of assets including consumer water meters, delays in procurement leading to delays in repairs, uncertain availability of chemicals and other inputs, Poor standard of comprehensive reports from which well-founded management decisions can be made, delays in payment of payroll leading to poor work morale and declining work ethics.

The Council operates a joint fiscal system for all its activities, which proved to be satisfactorily as long as deficit-making activities (e.g. health) were subsidised with regular and adequate subsidies. However, these grants are reported to have shrunk significantly and are not received regular any longer. This has resulted in a situation whereby any surpluses generated automatically cross-subsidise deficit operations and denying, amongst others the surplus-making activities to carry out preventive maintenance and recapitalise themselves. This has undermined the ability of otherwise surplus-making activities to operate sustainably. It is believed that this situation has led to a directive from the Ministry of Finance to ring fence all council activities. As much as the Council attempts to comply thereto, it is realistically unable, since the volume of subsidy has reduced while the activities still need to be performed as part of the Council's mandate. The implications were

and still are that any surpluses generated are taken to deficit operations and the overall financial performance of the Council is reduced, which in turn exacerbates the challenges outlined in the foregoing. This fundamental issue needs to be addressed to comply with the directive as well as allowing the break even and surplus activities to remain financially buoyant. Harare City on the hand has a separate department, Harare Water that reports directly to the Town Clerk. Harare Water's revenue is not exactly ring fenced. Revenue collection is through the City Treasurer who issues combined bills for water, rates and refuse collection. There is an agreed percentage of the collected revenue that is passed to Harare Water's account.

Having recognised the aforementioned general shortcomings there is need to address several main topics:

1. **Organisational structure** – to streamline activities and create a leaner more efficient set up with regard to daily operations including decision making, reporting and responsibilities. In previous years, local authorities in Zimbabwe functioned well and provided good service in both water supply and sewerage using the same organisational structure that still exists today. Whereas there is need to streamline the scattered organisational structure to achieve higher levels of organisational efficiency, the existing structure can be made to function by empowering staff to do their work and motivating them.
2. Separation of accounts to **ring fence** the funds received for water and sewerage operations;
3. **Job descriptions** – to clearly specify reporting lines, responsibilities, functions and result based tasks. Once drawn up and approved by management, these need to be read and accepted to ensure they are followed;
4. **Training** in specific fields directly relating to the tasks assigned, but excluding general educational and basic qualifications.

8.3 Organisational Capacity Assessment

This section provides a brief overview of the existing capacity for provision of water supply and sanitation in Harare, Chitungwiza, Ruwa, Epworth and Norton. It describes staff numbers and skill levels and other relevant measures of capacity and competence to undertake the necessary tasks effectively.

8.3.1 Harare Water

The City of Harare is mandated to supply water to approximately 2.5 million people, including residents of satellite towns of Chitungwiza, Norton, Ruwa, Epworth and other settlements on the periphery of the City. This mandate has been delegated to the technical department within the council known has Harare Water

Harare Water is faced with various challenges that include water quantity, water quality and financial issues. Owing to lack of adequate investment in the water and sewerage infrastructure for the past 15 years, the infrastructure has been deteriorating and most of the equipment is now obsolete. The City is therefore experiencing perpetual water supply shortages due to the demand that has outstripped supply and frequent breakdowns in the aged infrastructure and power supply challenges.

Harare Water is also experiencing challenges in the provision of wastewater disposal services to its residents due to the dilapidated sewerage and wastewater treatment infrastructure.

The City of Harare is run by an elected council. The town clerk is the chief executive of the Council. Figure 8.1 shows the top structure of Harare City.

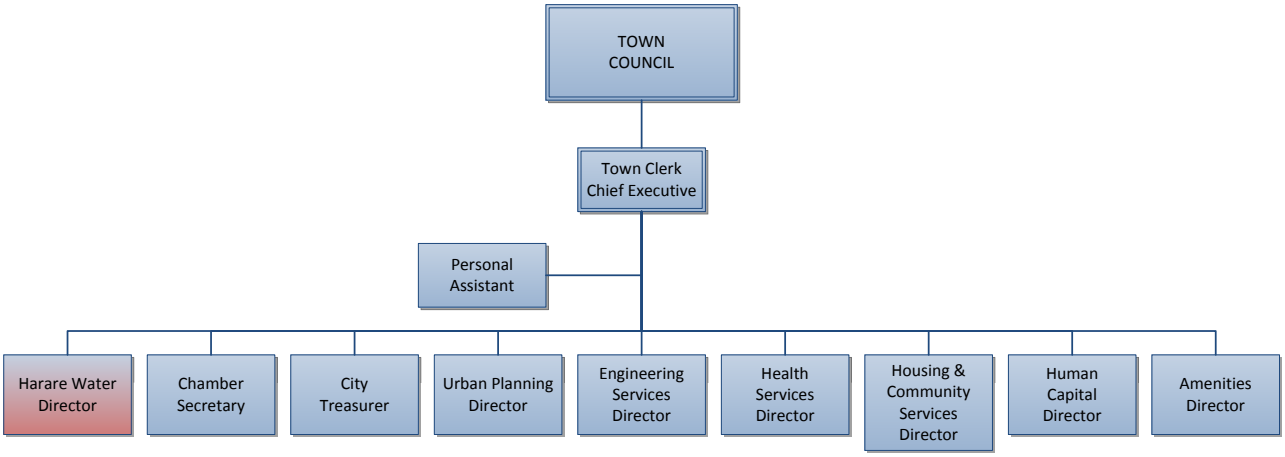


Figure 8-1: City of Harare Top Structure

Harare Water is a department within the City which is semi-autonomous. Its finances are controlled by the City Treasurer. Revenue collection is through the City Treasurer who issues combined bills for water, rates and refuse collection. There is an agreed percentage of the collected revenue that is passed to Harare Water's account.

Harare Water has seven divisions, each headed by a manager (Finance and Administration, Production, Distribution and customer services, Waste Water, Maintenance, Quality Assurance, and Planning and Technical Services) and three independent sections headed by officers (Human Capital, Information systems and Auditing). Figure 8.2 shows the top Harare Water structure.

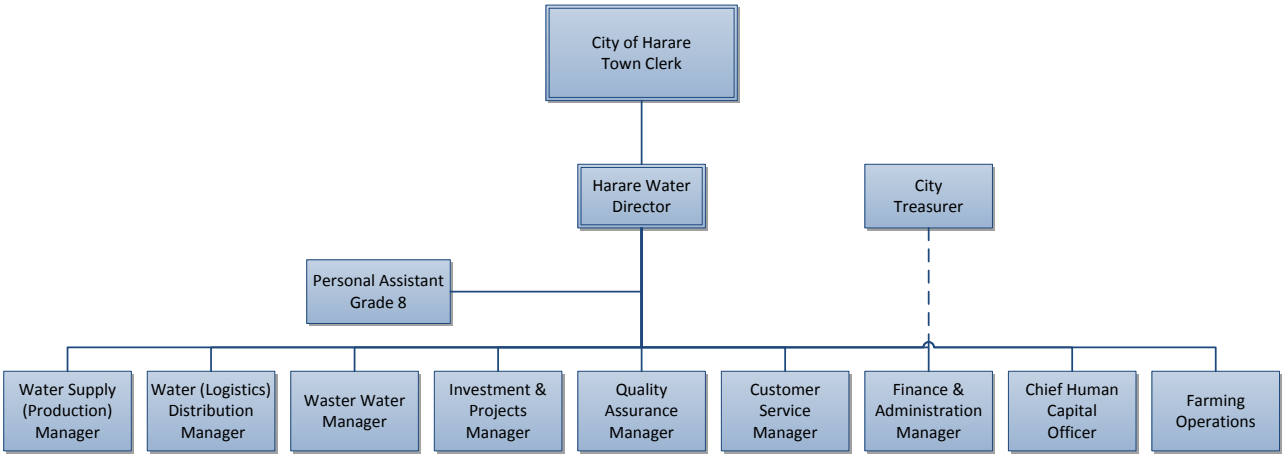


Figure 8-2: Harare Water Top Structure

Total Estimated Current Staffing (2014-2018)

The staffing for the existing WSS department is summarised in the following Table 8.4. This shows that the total current establishment is 2,338 and that the majority of the staff (more than 60%) is in the technical sections (Production, Distribution, Workshops, Wastewater and Quality control) while the Commercial and Financial Section and the overall management and ICT make up the balance.

Table 8-4: Harare Water Staffing Levels

Section	Establishment	In-post	Vacant Positions
Executive	9	9	0
Human Capital	10	7	3
Finance	34	17	17
Production	292	184	108
Distribution	1,017	646	371
Wastewater	775	564	211
Quality Assurance	62	23	39
Maintenance	111	41	70
PTS	22	3	19
Audit	3	2	1
IT	3	1	2
Total	**2,338**	**1,497**	**841**

Whereas, the current establishment look good in terms of numbers, the actual numbers of staff on the ground is 1497 (64% of the establishment). This explains why the services are poor, that there is not enough staff to cover as per the establishment.

Considering that there were 190,761 connections in 2011, the current staffing level per 1000 connections is around 7.8 while the staffing levels would have been 12.3 per 1000 connections using established numbers. The work load on the current staff is heavier than the commonly used benchmark of 10/1000 connections. However, it should be borne in mind that certain functions would still be provided by the Council (e.g. HR, Audit and legal), which will raise the number of staff per 1000 connections further up.

8.3.2 Chitungwiza Municipality

Overview

Chitungwiza was formed in 1978 from three townships: Seke, Zengeza, and St Marys located about 30 km south of Harare. Due to its proximity to the capital, it is sometimes referred to as a dormitory town with residents commuting to and seeking employment in Harare,

The Town is run by a council consisting of 25 Councillors including the executive Mayor. The Councillors are elected into office by a public ballot in the 25 wards of the city for a term of 4 years, who are the policy makers for that period. The executive board comprises of council managerial staff headed by the Town Clerk responsible for implementing council policies. The executive board is answerable to the Minister of Local Government.

The main mandate of the council is to provide public services relating to basic and social services to the residents of the city within the boundaries of the municipality:

- Water supply and sewerage services;
- Health: clinical services;
- Housing (estates);
- Works and roads;
- Traffic and parking meters;
- Street sweeping;
- Refuse collection;
- Security and rangers;
- Firefighting;
- Parks and recreation grounds;
- Cemetery.

These wide range of services are provided by council owned assets, managed and operated by its structure with an establishment of 1,735 and actual employment of 1,722[4]. The overall organisational structure is summarised in the following chart, showing 5 departments and two groups of separate divisions, the first divisions for audit, public relations and IT, the second responsible for Human resources. All departments named divisions report to the Mayor through the Town Clerk.

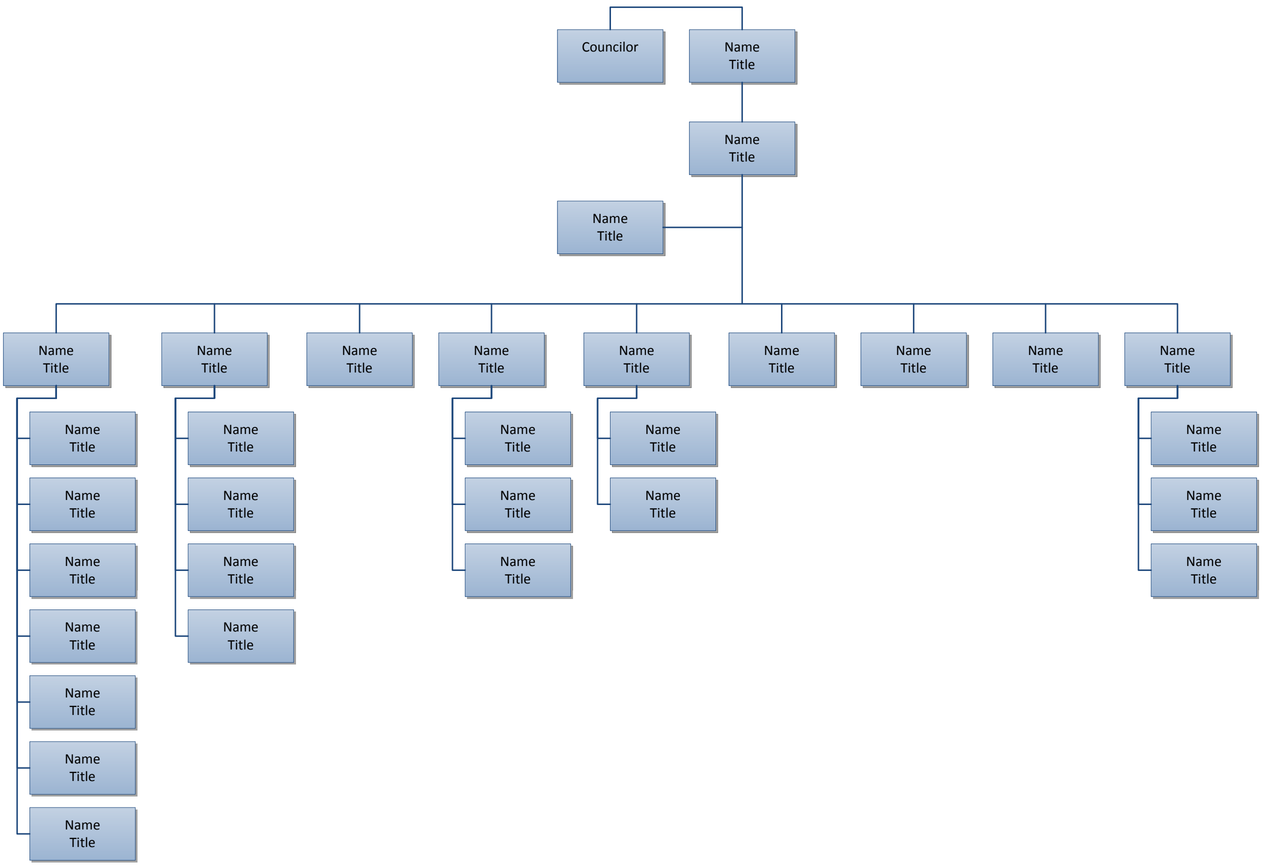


Figure 8-3: Organisational structure of Chitungwiza Council

4 HR Officer Chitungwiza

It is worth noting that almost all positions are filled (99 %) with permanent employees and the council does not engage any casual workers.

Apart from technical facilities (e.g. water treatment works, sewerage works, workshops) Chitungwiza Council offers its services to the public through five offices: Head office, Seke North, Seke South, St. Mary's and Zengeza.

The activities related to the management and operation of water and sewerage services is spread across several departments as shown in the table below.

Table 8-5: Departmental Responsibilities for Chitungwiza Water and Sewerage

Department	Section	Activities	Persons Involved
Works	Water	Water Production, storage and distribution	• Director of Works • Principal Engineer - Water • Supervisor • Foreman • Operators
	Sewerage	Sewerage collection	• Director of Works • Superintendent (specialised equipment) • Foreman • Operators • Workers
		Sewerage treatment	• Director of Works • Principal Engineer – Sewerage Treatment • Supervisors • Laboratory Technician • Electrician • Fitter (machine) • Operators
IT Division	IT Division	Billing	• Town Clerk • IT Manager • System Support Administrator • Technician • Data Clerk
Finance	Revenue	Collection	• Revenue Manager • Revenue Officers • Cashiers
	Procurement	Procurement	• Supply Chain Manager • Procurement Officer • Stores Controller • Clerks
	Accounting	Accounts	• Financial Manager • Financial Accountant • Accounts Clerks

The structural organisation main departments involved in the provision of water and sewerage services are shown individually for Works Department, Finance Department and IT Division. The boxes shaded blue represent positions fully or significantly involved in the operation of the water and sewerage services.

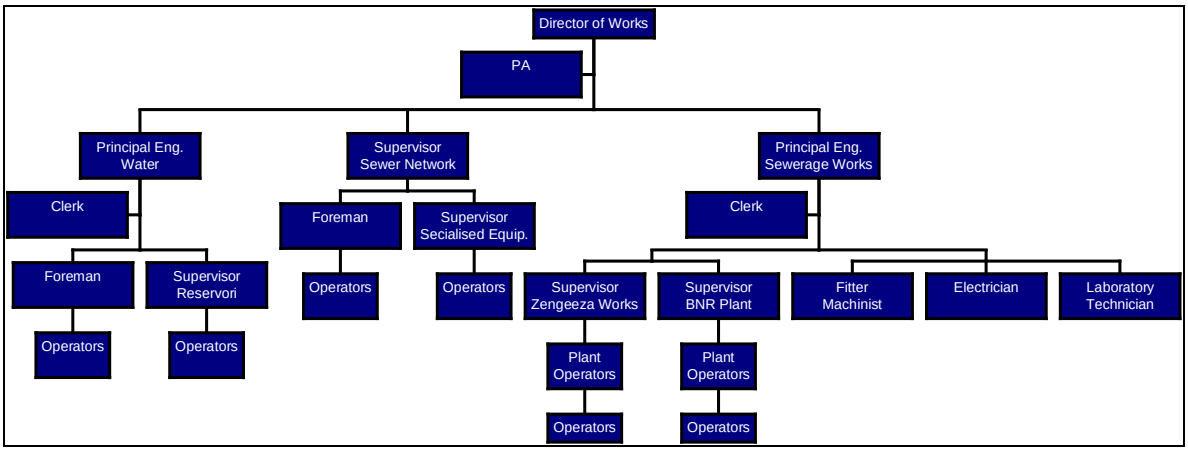


Figure 8-4: Organisational structure of Engineering Department (Water & Sewerage only)

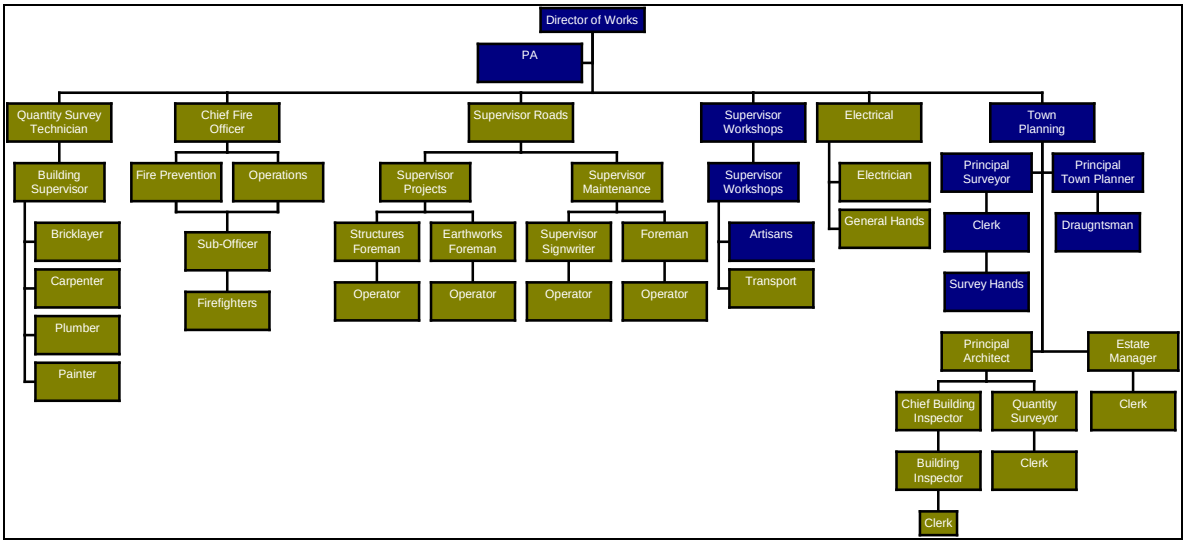


Figure 8-5: Organisation structure of Engineering Department (other functions)

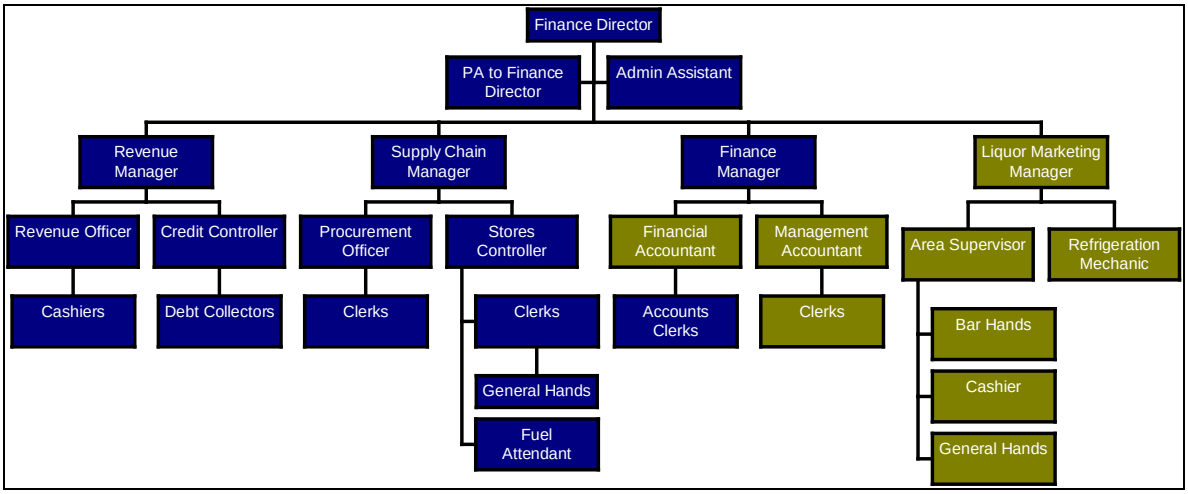


Figure 8-6: Organisational structure of Chitungwiza Finance Department

From the organisation charts above it is evident that the functions related to water and sewerage services are spread across different departments and sections of the council's existing organisation structure.

Institutional Assessment

The Works Department headed by the Director of Works is responsible for a number of services. Part of these services is positioned under the Water distribution and sewerage collection and treatment works. The responsibilities for water distribution and sewerage treatment are with two Principal Engineers while the sewerage network is headed by a Superintendent.

The water distribution section comprises of a supervisor for the reservoirs, a foreman and operators under this position. In addition a clerk is available to provide administrative support. This team is responsible for the general maintenance of the network and ensuring that the water is distributed to the customers.

The official establishment of the sewerage network headed by the Superintendent comprises a foreman, a supervisor for specialised equipment and operators to carry out cleaning and repair of the sewerage network. However, the actual current position varies in that there is no Principal Engineer.

The Principal Engineer for the sewage treatment works is supported by a supervisor for Zengeza treatment works, another supervisor for the BNR plant, an electrician, laboratory technician, a machinist (fitter) and operators, responsible for the operation and maintenance of the two sewage treatment works. In addition a clerk is available for general administration.

This organisational setup, as also depicted in the official organisation charts provides for service delivery of water and sewerage services as evidenced with reports of past performance (prior to 2000). However in recent years limitations and challenges are experienced, some of which are partly attributable to the current organisational architecture subjected to a different economic environment for which it was originally not designed for.

In view of the current dilapidated state of the infrastructure, in particular the clear water storage reservoirs the sewage pumping stations, and waste water treatment works the staffing levels still appear to be high despite recent efforts to reduce these.

Although the support for and provision of services in relation to water and sewerage has been confronted with serious challenges, the importance of these sections should not be underestimated considering the public health implications if not provided in adequate quantity and quality and the potential revenues earned from the service. It should therefore be given a greater priority by the council.

The operational units identified as relevant for the provision of water and sewerage services are:

- Storage and distribution / Reticulation,
- Waste water collection;
- Waste water treatment;
- Maintenance,
- Data collection and Billing,

- Revenue Collection,
- Management.

Water Storage and Distribution

The potable water received by customers in Chitungwiza is produced by Harare Water, specifically by the Prince Edward water treatment works with augmentation from Morton Jaffray water works. Therefore, the main function of Chitungwiza Council is the storage and distribution of the water received. Since Harare Water is not supplying adequate volumes of water to Chitungwiza, it is a challenge for the council to fulfil its mandate of providing potable water to all its residents.

Water storage and distribution is performed under an experienced Principal Engineer and assisted by a Supervisor for the reservoirs and two Foremen, one for Seke area and the other for Zengeza and St. Mary's. Reporting to them are 60 operators; 55 for the network maintenance and the remaining 5 to operate the storage reservoirs.

Furthermore, the team lacks much needed ultrasound equipment to detect and monitor leakages in the pumping main from the bulk meter at Prince Edward treatment works to the storage reservoirs north of Makoni Shopping Centre.

The personnel engaged in the water distribution section directly impact on the delivery of water produced to the consumers and is primarily involved in the water management through pressure control, repair of breakdowns and reduction of water losses. Unfortunately it is largely underequipped with regard to equipment and tools to detect leaks and effect repairs. This detrimentally affects billing, unaccounted for water, the willingness to pay for this service by consumers and hence revenue collection.

Sewage Collection and Treatment

Sewage collection is divided into two drainage areas, namely, drainage area 1 from St. Mary's, Manyame Park, Zengeza 1 and parts of Zengeza 5, which drains into 3 pumping stations for subsequent transmission to Zengeza sewage treatment works and drainage area 2 for: Seke, parts of Zengeza 2, Zengeza 5, Zengeza 3 and Zengeza 4, which drains by gravity, which gravitates directly to the same sewage treatment works.

Although the official organisation charts provide for a Principal Engineer in charge of sewage treatment and a Superintendent responsible for the sewerage network, the former is currently held by a Superintendent and the position intended for a Superintendent is currently vacant. Thus, the sewage treatment is headed by a Superintendent, who also takes charge of the sewerage network.

The currently consolidated functions of sewerage network and sewer treatment are supported by two sections.

The first section, responsible for sewerage reticulation comprises 4 *assistant* forem**en,** and 8 line supervisors and 64 operators. In addition this section has one supervisor for specialised equipment with an additional 8 operators.

The second section, in charge of sewer treatment consists of one Superintendent with 10 works attendants. In addition, this section has one electrician and one assistant for Electrical works. Furthermore the section has a Laboratory Technician and an Assistant. It also has a Fitter (Machinist) and an Assistant.

This section is supported by 112 works operators.

Maintenance

This essentially refers to workshop personnel, equipment and materials. As stated above, both water and waste water workshops have no qualified Journeyman. Currently the workshop is largely underequipped and experiences challenges in the repair of flow meters and effect preventative maintenance to pumping plant and equipment as well as basic repairs to infrastructure such as valves and flow meters.

Data Collection, Billing and Revenue Collection

This core activity is performed by the Financial Department in collaboration with the Information Communication Technology (ICT) section that is headed by an ICT Manager supported by a system support administrator, 2 Technicians and one Data Clerk. The field work (mainly meter reading) and customer interface (receipting and receiving customer queries) is handled by 6 supervisors who coordinate a team of 50 to 60 meter readers provided by the Housing Department. In addition to the ICT staff, there are 8 Data Clerks who digitise the data into the billing system. Apart from this, there are 50 cashiers and their assistants located at the four satellite offices and the head office; Seke North, Seke South, St. Mary's and Zengeza. The coordination of the cashiers is carried out by a revenue accountant who reports to an assistant revenue director, both at the head office. The revenue collection is further supported and assisted by a team of Principal Credit Controller and 8 Credit Controllers from the Chamber Secretary's Department.

In view of the large number of non-functional consumer meters and the anticipated adoption of technologies to streamline meter reading and data entry, the current establishment responsible for billing is regarded as high.

The billing for water and sewerage services is combined with others; fees, rents and levies through an all-encompassing billing and accounting software; Pastel-Sage Evolution run on an HP ProLiant G7 server, procured in 2011, connected to a combined wired and Wi-Fi LAN.

Table 8.9: Chitungwiza Municipality Monthly billing cycle activities

Step	Activity	Personnel	Number	Department
1	Planning/coordination	Supervisor	6	Housing
2	Meter Reading	Meter readers	50 – 60	Housing
3	Data capture	Data entry clerks	8	Finance
4	Billing/printing	IT Manager System admin Hardware tech.	1 1 2	Town Clerk (IT section)
5	Collection	Cashier & assistant	50	Finance
6	Debt Collection	Principal credit controller Credit control clerks	1 8	Chamber. Sec (credit control section)

The Satellite offices are connected through a fibre optic connection. A summary of the main activities, the personnel involved, their department and number of personnel is provided in the following table.

Whereas there is a monthly activity schedule that provides a clear monthly cycle of the above activities, there is scope to improve on the overall effectiveness if additional activities

are included; disconnection / reconnections, meter servicing and repairs of the tertiary distribution network (house connections) checking for unauthorised water consumptions. This will require closer cooperation with the Engineering Department that performs technical operation and maintenance activities as well as formalised multi-skilling.

Further to the current monthly activity schedule, the potential benefits of the following amendments and additions should be investigated:

- Staggering of the monthly cycle in a way that each operational area starts its monthly activity schedule at a different time and that a particular activity (e.g. meter reading) can be performed throughout the month. This should not negate efforts to introduce the aforementioned multi-skilling of personnel;
- Introduce more efficient methods of data collection and transfer to a software best capable of storing and processing data related to water and sewerage services;
- Introduce system-generated reminders and demand notes (warnings) in response to non-payment, which could be issued through letter, e-mail, short message service (SMS) and/or other appropriate modes of communication to the consumer;
- Introduce alternative modes of payment, in particular the possibility of payment via the mobile phone as offered by at least one mobile phone provider in Zimbabwe;
- Introducing a comprehensive MIS that can provide relevant information not only to management but operators and consumers.

With regard to the consolidation and streamlining of information, the current LAN, WAN and server provides a first step. However investments would be required to expand the WAN network to the anticipated new area, Nyatsime as well as providing a LAN in the offices of the new area. In addition some 31 personal computers (PC) and a backup server were reported as a necessary investment.

Apart from the above listed opportunities, there are other possibilities of improving the effectiveness and efficiency of the billing and revenue collection systems, which are covered in more detail in Chapter 9.

Management

Heads of departments are responsible for defining and implementing policies and coordinating the available resources in the most effective and efficient way to achieve pre-set performance targets. Management is also responsible for the review and adjustment of performance targets in line with strategic development goals (e.g. metering) and realistic capacities.

Under the current organisational arrangements the management for water and sewer4age services is split and performed by different Departments; Engineering Services, Finance Department, Housing and Chamber Secretary. The apparent challenges experienced with regard to performance (technical and financial), setting policies relevant and specific to water and sewerage operations, coordination of technical, financial and human resources and prioritisation of strategic goals may, at least in part, be attributed to the currently fragmented management responsible for water and sewerage services. Whilst the overall responsibility is vested under the Department of Engineering Services, this excludes important functions provided by the Finance Department and Housing.

General observations and challenges

From discussions with various council management personnel, the Chitungwiza Council appears to be suffering from similar symptoms as experienced in other councils in Zimbabwe [5]. While the central government has continuously promoted a process of decentralisation of responsibility to the local authorities in the fields of health, education, water, sanitation, roads and other public and community services, it has not decentralised the financial resources including slowing down or cessation of financial grants that accompany these responsibilities. Furthermore, it was reported that the central government has in the past not settled large outstanding amounts for services rendered by the local authorities contributing to the poor financial performance of the councils. This in turn has led to declining service delivery over the years.

Local authorities are not able to set charges without the approval of their line ministry and "zero-rate increases" (since 2009) have become a common feature. It is clear that the priority of the line ministry differs to the council's desire to set cost-covering tariffs. In view of the zero-rate increases, despite increases of input costs, the Council is confronted with increasing difficulties of operating a budget with minimal or no increases. Even with modest or negligible budget increases the council is increasingly unable to cover operational costs. This general situation has led to an increasing dependency on overdrafts and/or non-payment of creditors as well as non-payment of salaries. With this background it is not surprising that service delivery has fallen to its lowest levels in history for most services.

With respect to water and sewerage service delivery, the impetus of change is anticipated to be provided by a change of the organisational structure.

8.3.3 Epworth Local Board

Epworth is run by a council consisting of 8 Councillors including the executive Mayor. The Councillors are elected into office by a public ballot in the 7 wards of the Local Board for a term of 4 years, who are the policy makers and members of the Local Board council for that period. The executive board comprises of council managerial staff headed by the Town Clerk responsible for implementing council policies. The executive board is answerable to the Minister of Local Government. Epworth Local Board constitutes one parliamentary constituency seat.

The council's main mandate is to provide public services relating to basic and social services to the residents of the city within the boundaries of the municipality:

- Water supply and sewerage services;
- Works and roads;
- Health: clinical services;
- Education:
- Housing (estates);
- Refuse collection;
- Security and rangers;
- Firefighting;
- Parks and recreation grounds;

5 From: https://sites.google.com/site/cityofchitungwiza/governmentinchitungwiza

- Swimming pool (not functional);
- Stadium;
- Theatre (in form of a wall);
- Library;
- Cemetery.

This wide range of services is provided by council owned assets managed and operated by its structure with a total establishment of around 450[6]. The overall organisational structure is summarised in the following chart, showing 2 departments (Treasurer's and Engineer's departments) and the Internal Auditor reporting directly to the Town Clerk.

Epworth does not have water production/treatment or wastewater treatment facilities. It receives its water mainly from Harare Water supplemented by a few individual boreholes. The present supply from the Harare Water is not reliable.

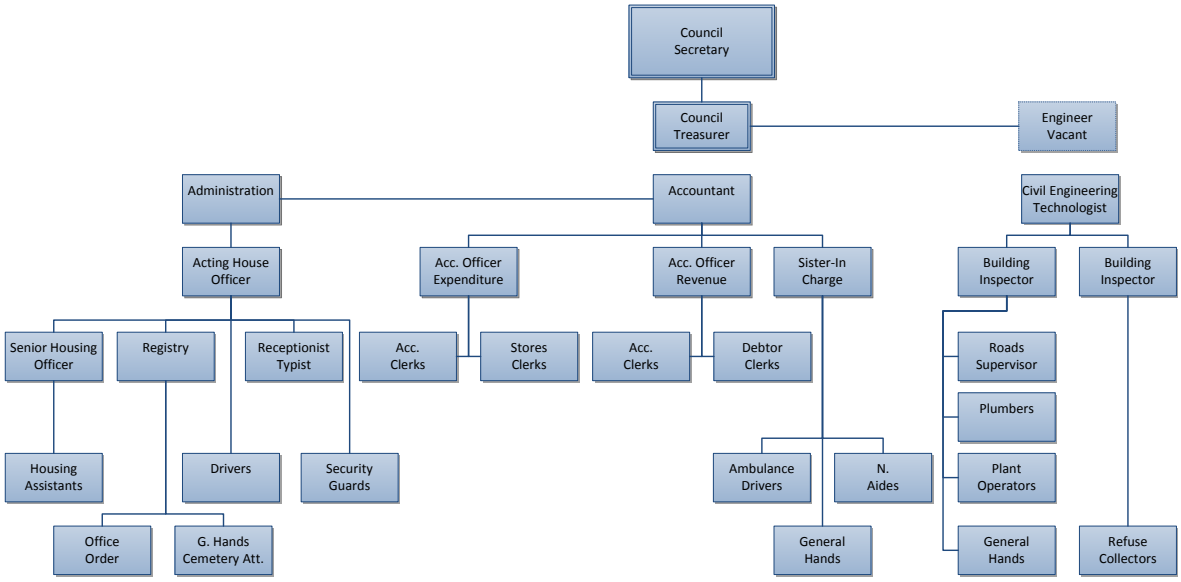


Figure 8-7: Organisational structure of Epworth Local Board Council

The activities related to the management and operation of water and sewerage services is spread across the two departments. The structural organisation of the main departments involved in the provision of water and sewerage services are shown individually for Department of Engineering Services and Department of Financial Services.

There are eighteen (18) workers involved in water supply and sewerage services comprising six (6) meter readers under the housing section of Financial Services Department and three (3) plumbers under the Engineering Services Department. There are also nine (9) workers who work on both roads and also on water and sewerage and are housed in the Engineering Services Department. The Local Board would like to have roads as a priority to set the location where the water services will pass

6 Based on information from the HRO of 18 total employed on water and sewerage services and there are 5 vacancies, for the Engineer, Town Planner, Environmental Health Officer and field supervisors; total establishment is estimated at 450.

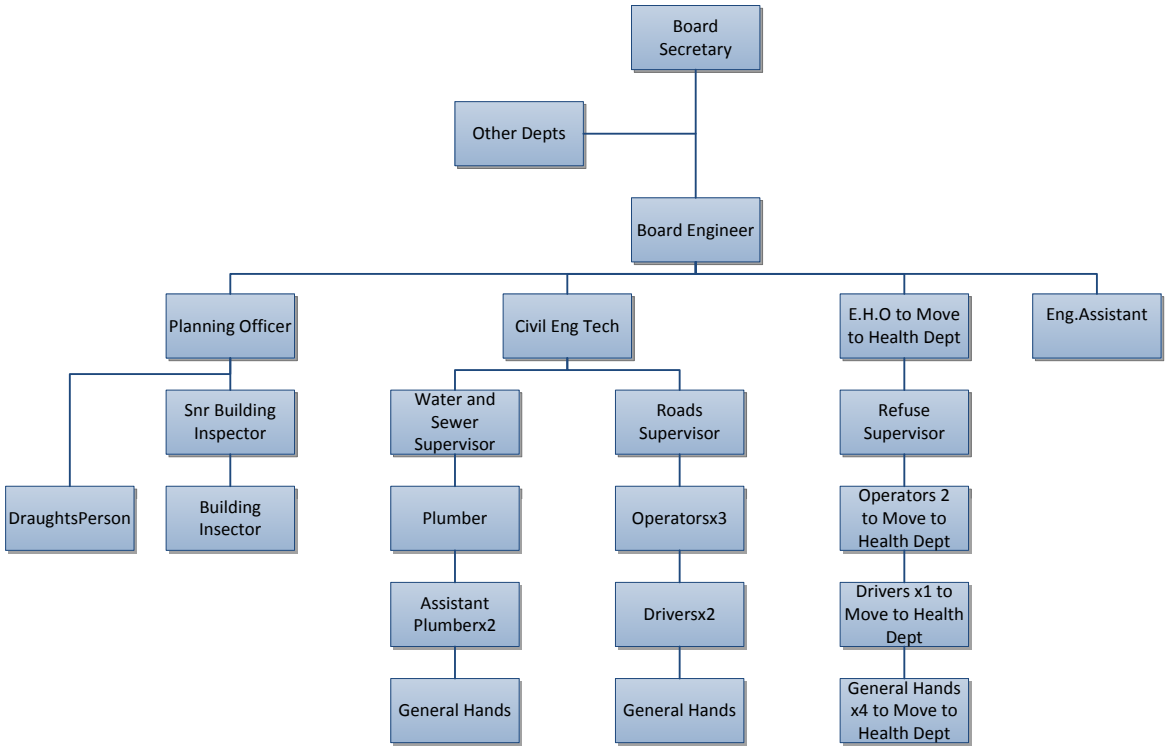


Figure 8-8: Organisational structure of Epworth Engineering Department

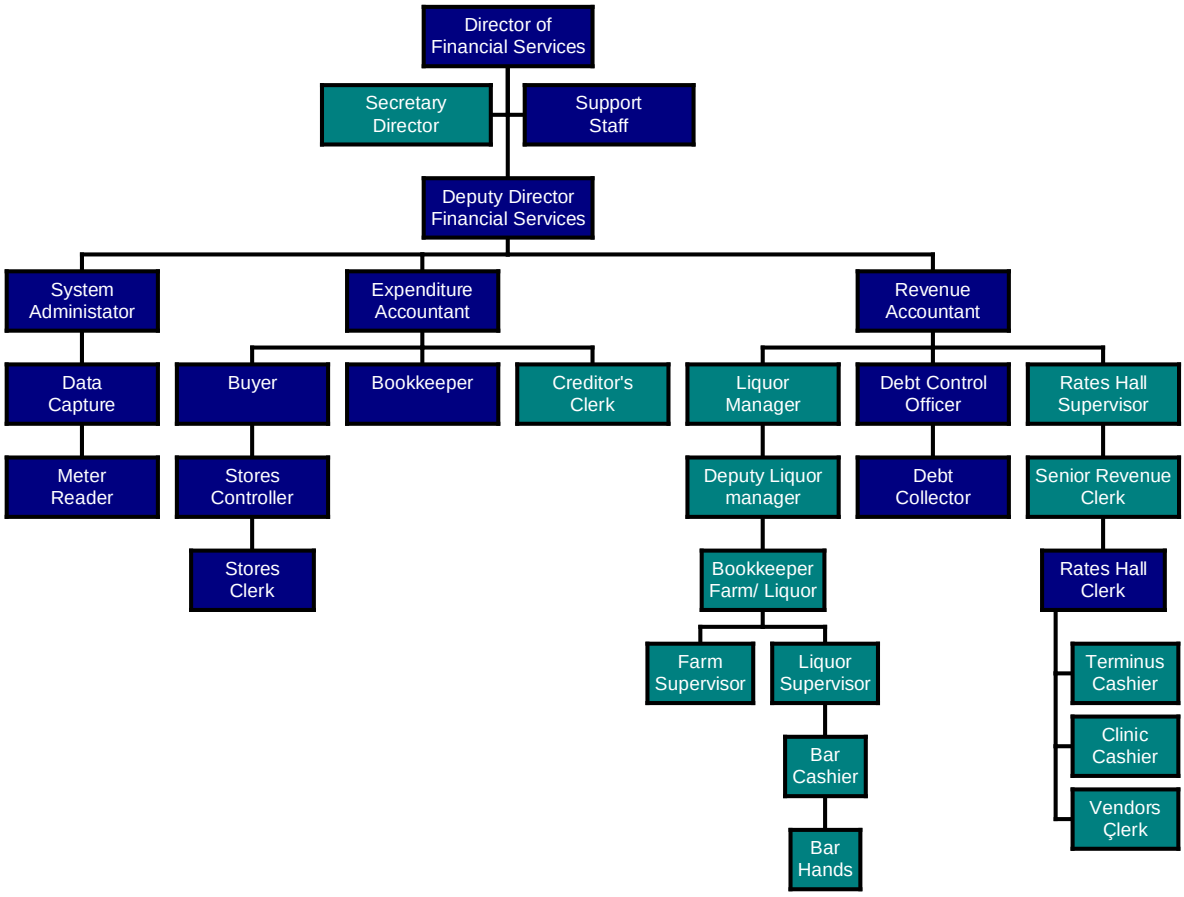


Figure 8-9: Organisational structure of Epworth Finance Department

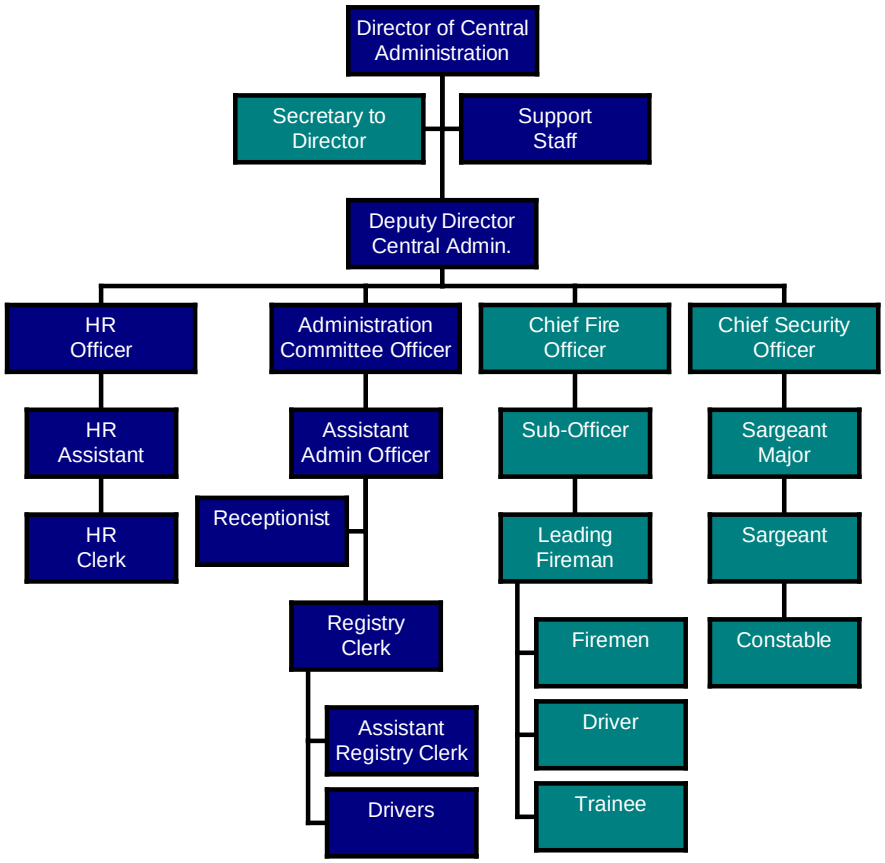


Figure 8-10: Organizational structure of Epworth Central Administration

The fragmented structure in relation to the provision of water and sewerage services presented in the separate organisation charts for the departments for Engineering Services, Financial Services and Central Administration is consolidated in the following table, sorted by the main activities relating to the provision of water and sewerage services.

Table 8-6: Staffing Associated with Water and Sewerage Management and Operations

STAFFING ASSOCIATED WITH WATER AND SEWERAGE MANAGEMENT AND OPERATIONS								
JOB TITLE	DEPARTMENT	ACTIVITY	No. PER-MANENT STAFF	No. CASUAL/ TEMP STAFF	No. VACANT	TOTAL ESTAB-LISH-MENT	GRADE	COMMENT
Director for Engineering Services	Engineering	Overall management			1	1		
CET	Engineering	Coordination	1			1	DL4	
Revenue Accountant	Finance	Revenue collectic	1			1	CL3	Cross cutting
Plumbers	Engineering	Water supply	3			3	CL2	
Water Supply Foreman	Engineering	Water supply				0		
Water Supply Fitter	Engineering	Water supply				0		
Plumbers (low density)	Engineering	Water supply				0		
Sewer Cleaning Foreman	Engineering	Sewerage services				0		
Billing supervisors	Finance	Billing				0		
Debt collection officer	Finance	Revenue collection				0		
Secretaries	Engineering	Support	1			1	BL3	
Waterworks Supervisor	Engineering	Water supply				0		
Sewer Cleaning Supervisor	Engineering	Sewerage services				0		
Sewer Disposal Supervisor	Engineering	Sewerage services				0		
Data capture	Finance	Billing				0		
Buyer						0		
Store controller			1			1	BL3	Cross cutting
Storekeeper	Finance	Support				0		
Waterworks Operator	Engineering	Water supply				0		
Assistant Plumber	Engineering	Water supply				0		
Water Supply Fitter Assistant	Engineering	Water supply				0		
Drivers	Central Administi	Support	6			6	BL1	
Guards	Central Administi	Support				0		
Fault Clerk	Engineering	Support				0		
Waterworks Pump Attendant	Engineering	Water supply				0		
Sewer Cleanting Attendant	Engineering	Sewerage services				0		
Meter readers	Finance	Meter reading	6			6	BL1	
Debt collectors	Finance	Revenue collectic	1			1	BL3	
Sewer Cleaner/General Hands	Engineering	Sewerage service	5			5	A2	
Building Inspectors	Engineering		2			2	CL3	
TOTAL			27			27		

Notwithstanding that not all personnel in the above table are fully deployed in water and sewerage activities[7], a total of 27 permanently employed staff or 6% out of the total 450 permanent staff employed by the council are engaged in activities related to the provision of water and sewerage services. Only 1 employee was on temporary terms. Positions of three (3) chief officers are vacant. These are Director for Engineering Services, Town Planner and Environmental Health Officer. A breakdown of the personnel establishment by department is shown in the following table.

By far the most important contributor to the overall personnel establishment for the water and sewerage service activities is the Engineering Department. As such, the water and sewerage services are mainly provided and driven by this department. Nonetheless, the other two involved departments also play important roles and thus there is need to streamline the scattered organisational structure to achieve higher levels of institutional efficiency and ring fencing, which is addressed in later

Table 8-7 shows the number of staff employed by the council excluding the medical services section.

7 For example; the drivers are part of a pool that is used by all departments and other activities not related to water and/or sewerage, thus the total figures in the table are somewhat overstated.

Table 8-7: Epworth Local Board Personnel Establishment by Department

Activity	Central Admin	Engineering	Finance	Total
Billing		1	1	2
Coordination	1	3	1	5
Meter Reading	6			6
Management	2		2	4
Revenue Collection			2	2
Sewerage Services		5		5
Support	22	7	8	37
Water Supply		3		3
Total	**31**	**19**	**14**	**64**

8.3.4 Norton Town Council

Norton is run by a town council consisting of Councillors, the Town Secretary, the internal auditor, the general administration and the private secretary. The main mandate of the council is to provide public services relating to basic and social services to the residents of the city within the boundaries of the municipality. The council has the following departments:

- Engineering department including: Water supply and sewerage services; Works and roads
- Health:
- Education:
- Housing;

Norton does not have water treatment works but it has sewerage works and workshops. It receives its water mainly from Harare Water; however, the supply is not reliable. The organisation of the council is as shown in the Figures below.

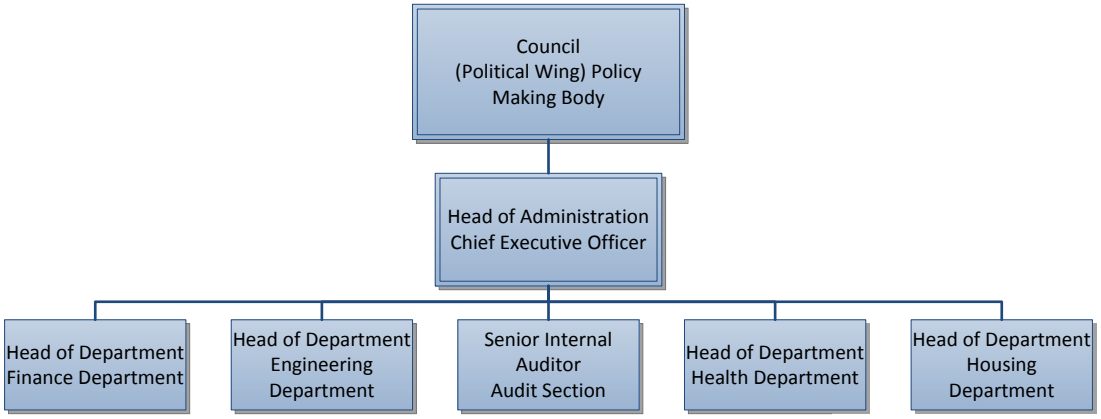


Figure 8-11: Norton Town Council Top Structure

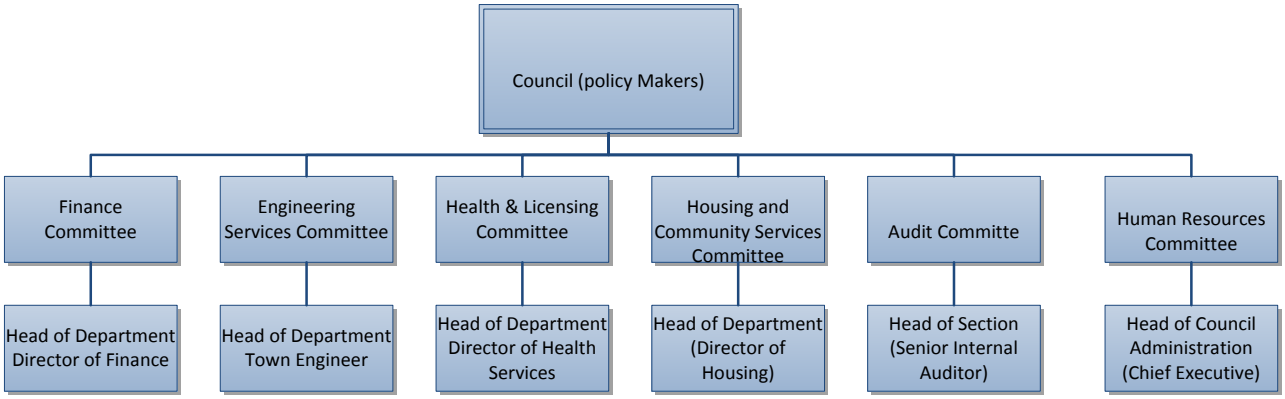


Figure 8-12: Organisational structure of the Local Town Council

The activities related to the management and operation of water and sewerage services is within the Engineering Department, supported by the finance department and the central administration. The structural organisation of the Engineering Department is shown in the figure below.

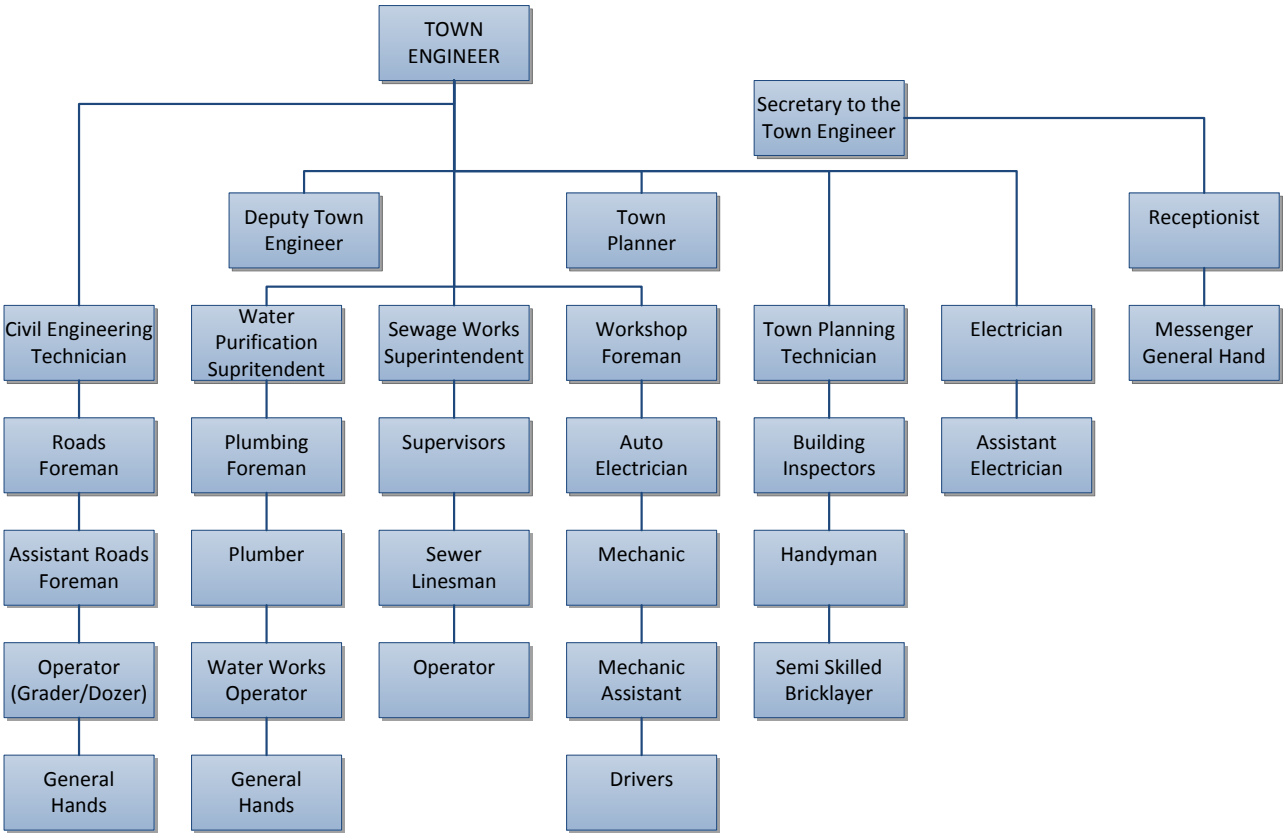


Figure 8-13: Organisational structure of the Norton Engineering Department

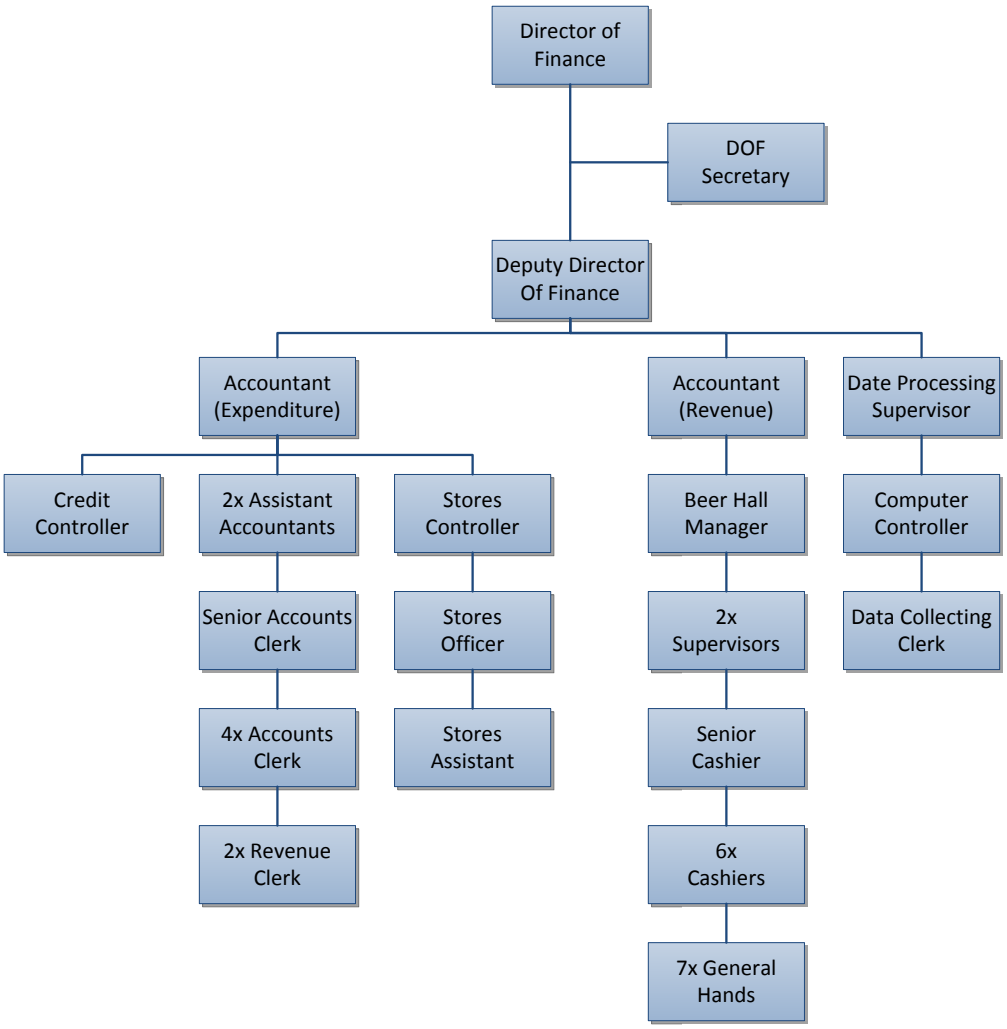


Figure 8-14: Organisational structure of the Norton Finance Department

There are One Hundred and Forty Nine (149) workers involved in water supply and sewerage services comprising Twenty Five (25) workers from the Finance Department Seventy-one (71) workers from the central administration (these are not directly involved in the water supply and include guards and drivers) and the rest of the workers from the engineering department.

The fragmented structure in relation to the provision of water and sewerage services presented in the separate organisation charts for the departments for Engineering Services, Financial Services and Central Administration is consolidated in the following table, sorted by the main activities relating to the provision of water and sewerage services.

Table 8-8: Norton Town Council Consolidated Staff on Water and Sewerage Services

JOB TITLE	DEPARTMENT	ACTIVITY	No. PERMANENT STAFF	No. CASUAL STAFF	No. VACANT	TOTAL ESTABLISHMENT	GRADE
Director of Engineering Services	Engineering	Overall Management	1	0	0	1	15
Deputy Director for Engineering	Engineering	Coordination	0	0	1	1	14
WASH Engineer	Engineering	Coordination	0	0	0	0	N/A
Systems	Finance	Billing	1	0	0	1	13

JOB TITLE	DEPARTMENT	ACTIVITY	No. PERMANENT STAFF	No. CASUAL STAFF	No. VACANT	TOTAL ESTABLISHMENT	GRADE
Administrator							
Credit Controller	Finance	Revenue Collection	0	0	1	1	12
Accountant	Finance	Revenue Collection	1	0	1	2	13
Water & Waste Water Technician	Engineering	Coordination	0	0	0	0	N/A
Water Works Superintendent	Engineering	Water Supply	1	0	0	1	12
Sewerage Superintendent	Engineering	Sewerage Services	1	0	0	1	12
Plumbing Foreman	Engineering	Water Supply	0	0	1	1	11
Plumber	Engineering	Water Supply	1	0	1	2	9
Plumbing Assistant	Engineering	Water Supply	0	0	2	2	7
Water Linesmen	Engineering	Water Supply	8	0	0	8	6
Sewerage Foreman	Engineering	Sewerage Services	1	0	0	1	
Sewer Linesmen	Engineering	Sewerage Services	12	0	2	14	6
Sewer Operators	Engineering	Sewerage Services	17	0	3	20	6
Receptionist/ typist	Engineering	Support	1	0	0	1	7
Stores Controller/ Buyer	Finance	Support	1	0	0	1	13
Computer Operator	Finance	Billing	1	0	0	1	10
Data Capture Clerk	Finance	Billing	1	0	0	1	9
Sewer Disposal Supervisor	Engineering	Sewerage Services	0	0	0	0	N/A
Drivers	Central Administration	Support	1	0	0	1	7
Guards	Central Administration	Support	69	0	1	70	6
Fault Clerk	Engineering						
Meter Readers	Finance	Meter Reading	13	0	5	18	6

Notwithstanding that not all personnel in the above table are fully deployed in water and sewerage activities a total of 79 permanently employed staff out of the total 149 permanent staff employed by the council are engaged in activities related to the provision of water and sewerage services. There were no temporary staff members. Positions of eighteen (18) chief officers are vacant. These are the Deputy Director of Engineering, One (1) Credit Controller, One (1) Accountant, one (1) plumbing foreman, one (1) plumber, two (2) plumbing assistants, two (2) sewer linesmen, three (3) sewer operators, one (1) guard and five (5) meter readers.

By far the most important contributor to the overall personnel establishment for the water and sewerage service activities is the Engineering Department. As such, the water and sewerage services are mainly provided and driven by this department. Nonetheless, the other two involved departments also play important roles and thus there is need to

streamline the scattered organisational structure to achieve higher levels of institutional efficiency and ring fencing.

8.3.5 Ruwa Local Board

Ruwa is run by a town council consisting of Councillors, the town secretary, the internal auditor, the general administration and the private secretary. The main mandate of the council is to provide public services relating to basic and social services to the residents of the city within the boundaries of the municipality:

- Water supply and sewerage services;
- Works and roads;
- Health: and amenities;
- Education:
- Housing – the building inspectorate;

Figure 8-15 below shows the organisational structure of the Ruwa Town Council.

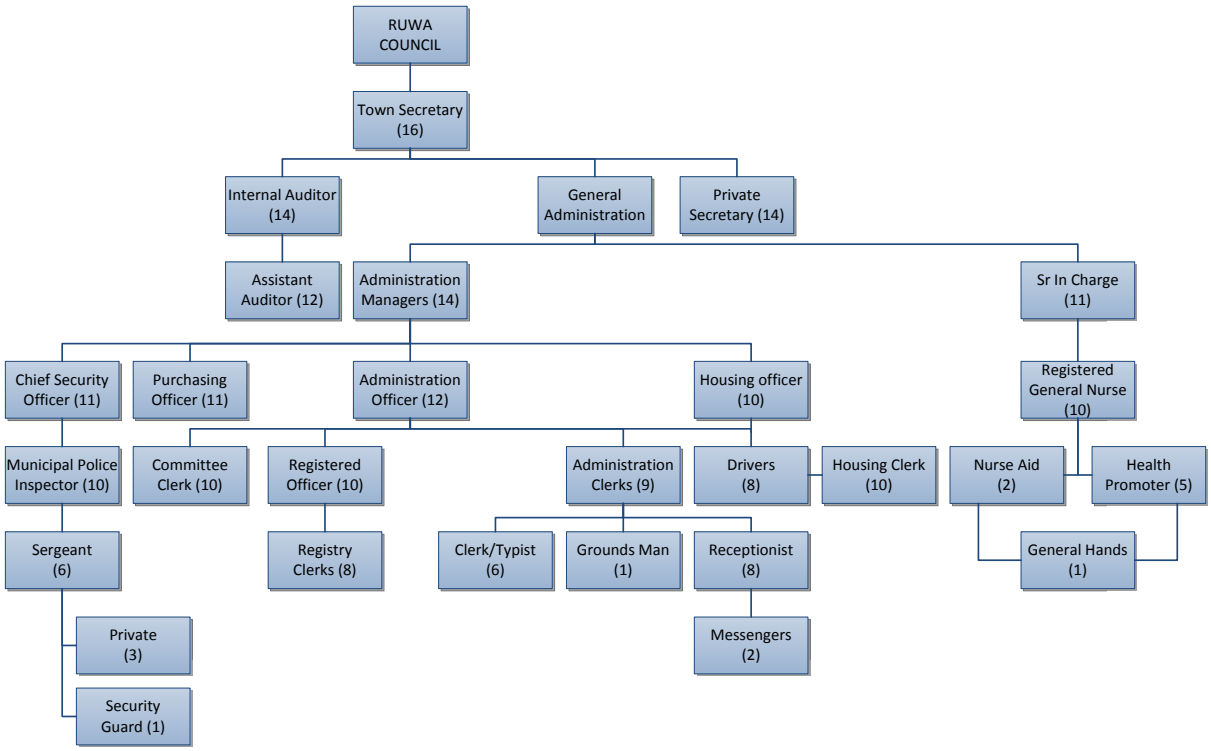


Figure 8-15: Organisational structure of the Ruwa Town Council with grades

The activities related to the management and operation of water and sewerage services is spread across two departments. The structural organisation of the main departments involved in the provision of water and sewerage services are shown individually for Department of Engineering Services and Department of Financial Services.

There are sixty six (66) workers involved in water supply and sewerage services comprising 26 workers from the Financial Services Department and the rest of the workers fall under the engineering department.

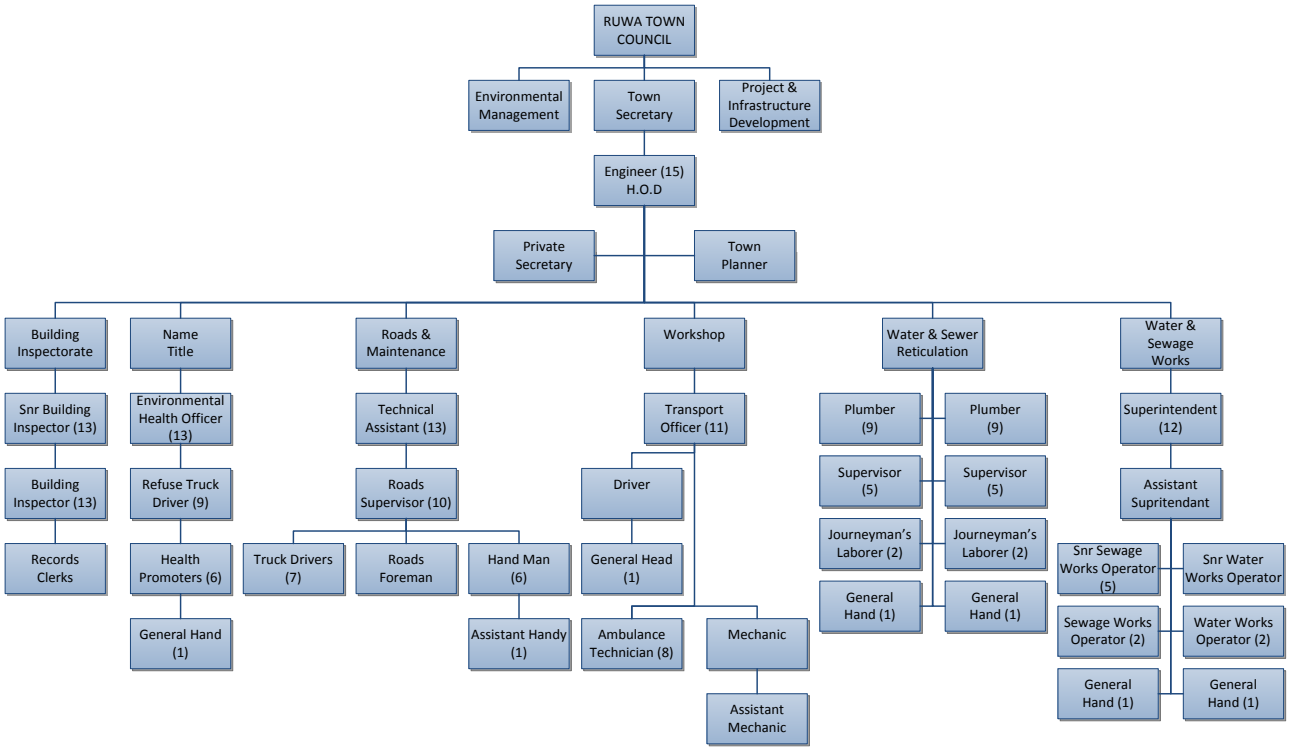


Figure 8-16: Organisational structure of Ruwa Works and Engineering Department

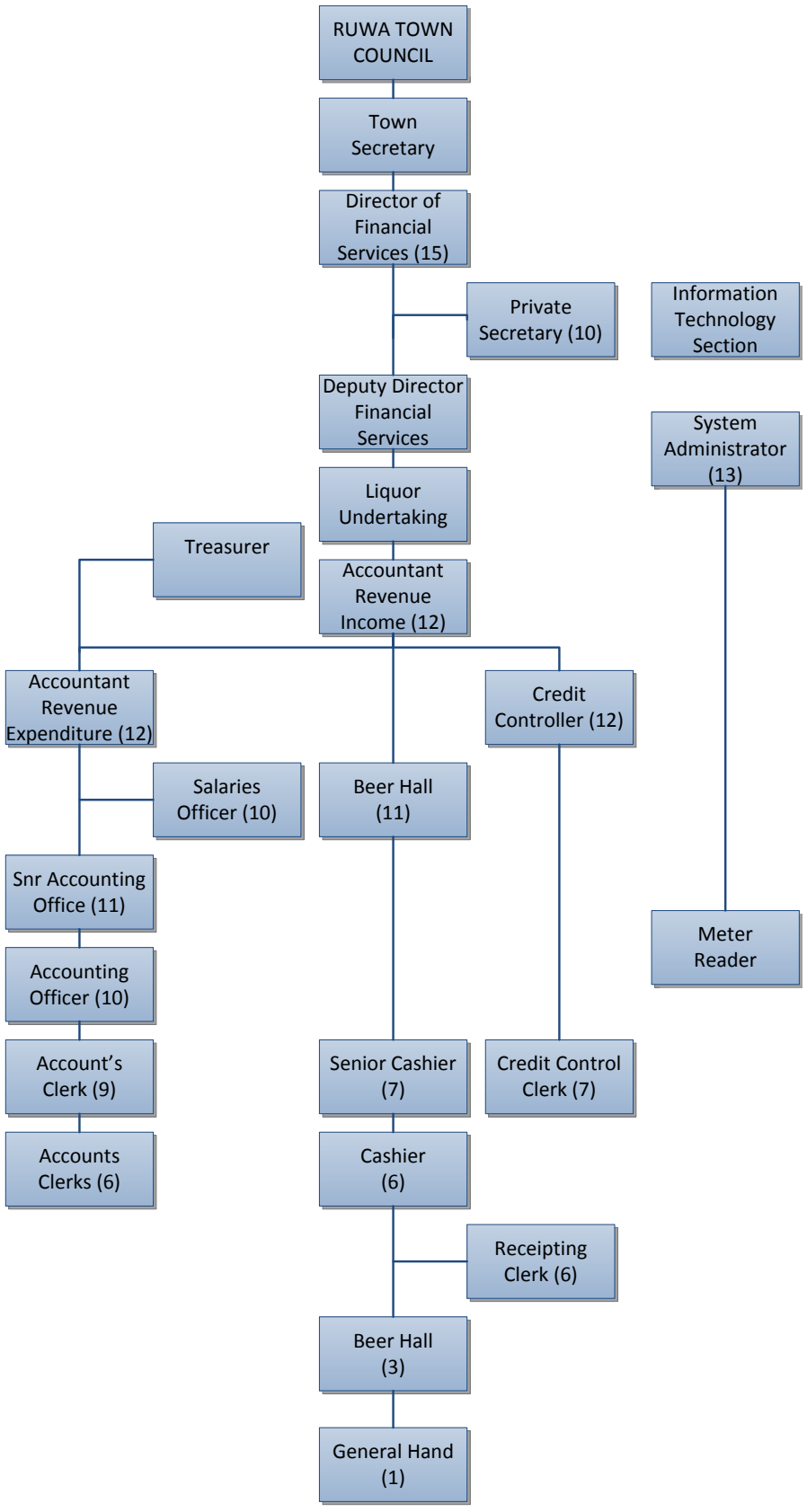


Figure 8-17: Ruwa Local Board Organisational structure of Finance Department

The fragmented structure in relation to the provision of water and sewerage services presented in the separate organisation charts for the departments for Engineering Services, Financial Services and Central Administration is consolidated in the following table, sorted by the main activities relating to the provision of water and sewerage services.

Table 8-9: Staffing Associated with Water and Sewerage Management and Operations

JOB TITLE	DEPARTMENT	ACTIVITY	No. OF PERMANENT STAFF	No. OF TEMPORARY STAFF	No. VACANT	PROPOSED POST
Town Engineer	Engineering	Overall management	1			
Deputy Director Works	Engineering	Coordination	0		1	
Environmental Health Officer	Engineering	Coordination	1			
Systems Administrator	Finance	Billing	1			
Finance Director	Finance	Revenue Collection	1			
Deputy Director Finance	Finance	Revenue Collection	1			
Revenue Accountant	Finance	Revenue Collection	1			
Water and Sewer Works Superintendent	Engineering	Water Supply	1			
Senior Plumber	Engineering	Sewerage Services	1		6	
Plumbers (high density)	Engineering	Water Supply	0			6
Assistant Water and sewerage works attendant	Engineering	Water Supply	1			
Sewer Cleaning Foreman	Engineering	Sewerage Services	0		2	2
Plumbers (low density)	Engineering	Water Supply	0			3
Secretaries	Engineering	Support	1			
Secretaries	Finance	Support	1			
Stores Controller	Finance	Support	1			
Water Works Foreman	Engineering	Water Supply	0	0	0	4
Sewer Cleaning Supervisor	Engineering	Sewerage Services	1			1
Water Works Operator	Engineering	Water Supply	10-2 staff			12
Assistant Plumber	Engineering	Water Supply	0		9	9
Sewage Works Operator	Engineering	Water Supply	11			
Pond	Engineering	Water Supply	0		1	
Messenger of Court and Lawyer	Finance	Revenue Collection	2+5 staff			
General hands/water			0		3	
General Hands			14			
Meter Readers	Finance	Meter Reading	11		1	
Cashiers	Finance	Revenue Collection	2			

Notwithstanding that not all personnel in the above table are fully deployed in water and sewerage activities a total of 66 permanently employed staff out of the total 103 permanent staff employed by the council are engaged in activities related to the provision of water and

sewerage services. There were no temporary staff members. Positions of twenty three (23) chief officers are vacant. These are the Deputy Director of Works, Six (6) Senior Plumbers, two (2) Sewer Cleaning Foremen, nine (9) assistant Plumbers, one (1) pond, three (3) general hands, and one (1) meter reader.

The water and sewerage services are mainly provided and driven by the Engineering Department with support from the other departments. Thus there is need to streamline the scattered organisational structure to achieve higher levels of institutional efficiency and ring fencing, which is addressed in later.

8.4 Proposed Organisational Structure for Greater Harare Metropolitan Utility

In this section the envisaged organisational structure for the greater Harare Water Utility is presented. The headquarters for the utility will be in Harare where also the largest consumers are. The satellite towns of Chitungwiza, Epworth, Norton and Ruwa will have semi-autonomous branches sharing the legal, audit and human capital services from the headquarters.

The entity would be fully responsible for all aspects of an operation responsible for providing water and sewerage services, owned and guided by the various Councils. In comparison to the department in one council, this organisational arrangement takes over the responsibility of all investment budget aspects, human resource management, audit, legal matters and any other function that was provided under the Council's WSS department.

The concept of a utility is to enhance the commercial principles of providing the services of water supply and sewerage collection and treatment, as would be appropriately contained in the new entity's memorandum and articles of association, in a technically and financially sustainable manner. Essentially the existing sections would remain in place, though partly expanded as outlined in the following:

- Technical section comprising two main units:
    - Water supply unit responsible for the production, storage and distribution of potable water; and
    - Sewerage unit in charge of collection and treatment of sewage; plus
    - Investment planning unit responsible for the early planning of both re-investments (of e.g. consumer meters) and new expansion works to cope with increasing demand for services and confirm and implement the investment plans;
    - Electrical and mechanical unit providing expertise and support functions to the water and sewerage units;
- Commercial, Financial and Administration section with two sub-sections for commercial and financial/administrative aspects respectively:

  Commercial sub-section in charge of revenue generating and collection activities through:
    - The data entry and billing unit responsible for the timely generation of water and sewerage invoices; and

- Collection unit that takes care of receipting, posting and banking of the monies collected for water and sewerage only (i.e. not for other council services);
- Customer relations/service unit that is dedicated to address (record and follow up) issues raised by consumers. This unit would be closely knit with the new connections unit that also provides a customer interface;

Financial and Administration sub-section in charge of planning and managing expenditures required for daily operations. This section harbours the following units:

- The planning unit that coordinates the drawing up of strategic and business plans as well as compiling of annual operational budgets. The unit would furthermore take up the responsibility of financial reporting and liaison during annual audits;
- The more operational expenditure unit responsible for (approved) budget procurements and expenditures including reimbursements to the council for expenses incurred on behalf of the new department (including payroll). This unit would also be in charge of bank reconciliations, credit control and cash flow management.
- Human resources unit to take over the function previously provided by the Council. It's activities would include the recruitment and termination processes, contractual and welfare issues as well as the preparation of the payroll;
- Administration unit to manage office supplies, utilities, insurance, security, transport, communication and any corporate social responsibility matters that may be deemed appropriate;

- Information and technology section providing cross cutting support for the planning, management and maintenance of hardware and software used by all main sections.
- In addition, legal and audit support functions would be provided by appropriately employed officers and if deemed necessary separate units may be defined as to be confirmed through a separate and detailed organisational development consultant.

Thus, compared to the department, the WSS utility has no direct links to the Council and all functions necessary to provide the water supply and sewerage services are carried out by the new entity. Essentially the independent utility would take over the long-term financial issues (investment budget), administrative issues including human resource. Other functions the new entity will take over are in relation to audit and legal matters. The expanded staff for the utility is as follows:

• Harare Head Office and Harare Branch	1,933
• Epworth Branch	33
• Norton Branch	157
• Ruwa Branch	82
• Chitungwiza Branch	208
TOTAL	**2,413**

The structure to support this establishment is presented in Appendix 8, Tables A8.2 to A8.6

CHAPTER 09: INVESTMENT COST ESTIMATES

9 INVESTMENT COST ESTIMATES

9.1 Introduction

This chapter presents the methodology and approach used for estimating the investment costs. It also discusses the principles that guided the creation of the priority list for the investment measures.It ends with summaries of the estimated investments necessary to improve and extend water and sewerage services in the towns that constitute Greater Harare up to 2030.

The investment measures have been grouped into six broad categories that reflect the problem areas and'value chain' for providing water and sewerage services. The categorisation also considered the ease of creating project packages for implementation from the investment plan.

9.2 Unit Rates

Unit rates for individual investment items are a very important building block towards estimating investment costs. Given the recent economic downturn in Zimbabwe coupled with uncertainty over the future economic outlook for the country, it is difficult to estimate accurate unit rates. The possibility of cost escalation due to perceived political risk has been taken into account.

For major procured components such as pipes, pumps valves etc. quotations have been obtained from reputable manufacturer's agents in the region and these have been developed into rates with the addition of transport, handling charges, profit and overhead charges and installation costs.

For the major overall works component of pipe installations and civil works involving earthworks,the rates have generally been worked up from first principals using basic earthworks rates from the higher end of the market spread (Market is US$2.5 to US$6.5/m3 and US$6.5 is used as the basis). To these basic earthworks, rates additions are made for shoring of excavations, haulage of materials etc.

For investment items where works are similar to recent tenders under the UWSSRP Phase 1 works currently under execution, the rates tendered by the contractors have been used. In all cases the median rate of contractors' bid prices has been used in estimate preparation and not the lowest.

The rates from the contractors were also compared with similar works in the region. As expected, the rates used by the phase 1 contractors are higher than the regional averages, possibly because of perceived political risks, and logistical difficulties in clearing imports.

In general, the unit rates cover the following:

- Supply of the items,
- Installation of the items,
- Ancillaries and related works to ensure the proper function of the items,
- 15% to cover perceived political risk and other risks.

The rates do not include VAT and other taxes. We assume that the council is a registered VAT agent of ZIMRA, as such it does not pay VAT (claims VAT on all goods purchased).

We further assume that import duty will be waived on all materials and equipment that will be imported for the purpose of these investments.

The rates calculated above are for the present year. We have assumed an inflation rate of 2% for calculating future rates for the medium and long term.

9.3 Prioritization Principles

9.3.1 Introduction

The water and sanitation facilities in Harare and its satellite towns have been neglected in the last couple of decades. Very little investment has gone into rehabilitation or extension of the systems, hence huge investments are required to restore the facilities to nominal capacity and extend services to meet demand necessitated by population and economic growth. Given the current political and economic situation in Zimbabwe, there may not be enough funds to finance all the identified investment measures in one project. Hence prioritization and evaluation to identify measures with the highest economic and social returns is an important element of this investment plan. The following subsections outline the principles guiding the prioritization. We have grouped the investment measures into three broad priority categories.

The highest priority will be given to investment measures aimed at ensuring that the utility meets its basic public health and service obligations by getting the most out of the existing facilities. The second priority will be given to measures that will help the councils meet all environmental obligations, while the last priority will include measures that will respond to the increasing demand for services due to population and economic growth.

9.3.2 Priority 1 – Investments for Restoration of Existing Facilities

The highest priority will be given to the measures outlined in the table below. From the list it should be noted that the 'minimum Service measures 'and 'coverage restoration measures' for water and the 'critical environmental interventions' for sewerage must be the immediate priority as providing safe drinking water to all and preventing sewage spills in residential areas are fundamental to public health.

Table 9-1: 1st Priority Investment Measures

Investment Measures	Remarks
Water - Minimum Service Measures	Provide water kiosks in all areas with no supply and where the cost of restoring or establishing a reliable 24 hour supply in the short to medium term will be prohibitive.
Water - Coverage Restoration Measures	NRW identification through a programme of bulk meter, block valves and pressure reducing valve installation combined with proper zoning of the secondary and tertiary network so that an accurate water balance can be obtained. Night flow monitoring programmes should be initiated to identify areas where leaks are likely heaviest. Repair and replacement programme on primary distribution pipelines. Metering will indicate where large leaks are occurring and a targeted replacement programme can then be initiated.

Investment Measures	Remarks
	Repair and replacement programme on secondary distribution pipelines. Metering will indicate where large leaks are occurring and a targeted replacement programme can then be initiated. Burst management response programme. Create teams with necessary equipment to quickly respond to bursts and use public relations campaign to enrol the help of the public in reporting bursts.
Water Demand Management Measures	General demand management through: (i) restoration of 100% domestic and commercial metering for water. In areas where 24 hour supply cannot be achieved metering cannot go ahead; (ii) Renewal of house connections; (iii) installation of pressure reducing valves to lower tertiary distribution network pressures (iii) Public Education measures. It is normal for a small number of large customers to represent a large proportion of utility revenue. Meter replacement programmes should target this group as a priority. Demand management in areas not currently getting 24 hour supply. This would involve three stages: (i) Increasing network pressures but managing these to reasonable levels with pressure reducing valves; (ii) Installing flow limiters and meters (iii) Restoring 24 hour supply. The flow limiters will keep demand down allowing 24 hours of supply. Metering can only take place in areas where the network pressures never fall to zero. The use of flow limiting devices flattens the peaks in the daily demand curve, making it easier to keep network pressures positive at all times. Roll out of metering should be planned to occur on an area by area basis. An area may only be selected for metering once major leaks have been repaired, it has 24 hour supply and the network has stabilised.
Water – Database Clean-up	Prior to embarking on a programme of individual customer metering (and possibly parallel to it) a complete overhaul of customer database and billing database is required. This should be considered as a revenue raising measure by ensuring all customers are known, are being billed and will get a meter or have their existing meter replaced when the metering programme commences. The database cleanup exercise requires considerable field work in identifying the location of all consumer meters and known unmetered connections, geo-referencing these and linking the connection to the appropriate account number. A concurrent desk exercise should review the locations of meters on satellite photography with the actual layout of stands to identify any stand which does not have an associated meter/ connection in the

Investment Measures	Remarks
	database and may therefore be getting water for free.
Water – Tertiary Network Rehabilitation	Once supplies have been restored and primary and secondary distribution system leaks have been reduced there will be more water arriving in the tertiary networks, sufficient to achieve 24 hour supply and 100% customer metering. Data from block and customer meters will then make it possible to determine which areas of the distribution system are leaking most. From this will follow (a) targeted replacement of tertiary distribution pipework (b) targeted replacement of house connections
Water - Initial Coverage Expansion Measures	These measures allows the utility to bring on extra customers and raise revenue. The additional water needed must be obtained from NRW savings. (a) Priority expansions into areas with least overhead in terms of additional distribution system. These are areas where the distribution system is already constructed but supplied with little or no water. These are new customers which can be added at minimal additional cost. (b) Secondary expansion into new service areas where tertiary infrastructure has been provided by developers and the Utility needs to add only secondary distribution. City planning authorities should only allow new developments n areas where these criteria are met. High cost/ low density areas should be targeted to maximize revenue increases and minimize additional load on the sewerage system.
Sewage - Critical Interventions - Environmental	Coverage Restoration. Rehabilitation of sewers in areas where water supplies are revived. This is to prevent sewage spills in areas of population. To include: (i) de- choking of blocked sewers in areas where newly restored water supply causes blockages. Equipments should be provided for this; (ii) replacement of sections of sewer in areas of most infiltration and or collapses. This is a maintenance reduction and cost saving measure. Restoration of trunk sewers. This is to prevent sewage spills upstream of sewage works. (i) replacement of key sections of blocked sewer; (ii) capacity enhancements (new parallel lines) on low gradient sections of main and trunk sewer lines running at or above capacity Restoration of sewage pumping. (i) minimal emergency interventions in sewage pump stations to restore screening and pumping equipment;(ii) replacement of sections of sewage force main susceptible to bursts. Restoration of treatment capacity at existing sewage treatment plants in the following order of priority: (i) screening, inlet works and diversion facilities; (ii) primary treatment and sludge handling

Investment Measures	Remarks
	facilities; (iii) secondary treatment facilities (iv) Irrigation and disposal facilities
Sewage – Initial coverage expansion measures	This will expand sewage coverage into areas where developers or council have already installed sewer lines but these are not hooked up or commissioned. This should be done in areas where water supply has been reconnected or expanded and will allow council to start to bill for sewage also. This will therefore be a revenue raising method. Works will include; (a) short lengths of main sewer to connect the area to the trunk system (b) installation of missing sewage pump stations
Water – Next Stage of Demand Management Measures	When networks are stabilized, customers metered and the billing system is functional the utility can gain more information about customers use of water. This will lead to new demand management initiatives including: (a) identification of wards with high consumption and running education programmes to encourage customers in those areas to reduce consumption; (b) improve the tariff band structure to discourage very high consumption; (c) identify industries with heavy consumption patterns and work with them to reduce their water demand through recycling, demand management etc.

At the end of this set of interventions the city will be getting the most from its existing assets and customers and will have a strong revenue base through which it can start to address capital intensive expansion measures.

As well as the capital investment measures described above there should be a similar priority given to public health in those areas that are outside of the Sewerage Boundary, where householders do not have a sewage connection. Provision of safe drinking water in these areas will alleviate the disease burden but other measures will also be required:

Education measures – safe drinking water	Once the city has restored its supplies by way of public standpipes or water kiosks the population should be educated to use these safe sources in preference to their (often closer) shallow wells.
Education measures – safe sanitation	Further education programmes should teach people better practices in building and managing their pit latrines and pour flush systems to lower the likelihood of these spilling raw sewage onto properties.
Disease monitoring	Initiate programmes working with local clinics tocontinuously map diseases linked to poor sanitation. This will allow for rapid and targeted intervention when a disease outbreak linked to poor sanitation occurs.
Targeted construction of toilet facilities	In some areas, generally those prone to flooding, the pit latrines commonly constructed will not suffice and may lead to sewage spills. Generally these are also the communities least able to invest

	in better sanitation. In these area programmes of construction of composing toilets parallel to education programmes in their use will be required and will need to be publicly funded.

Itis assumed that the measures described above will not be a one off but all of these efforts will continue on an ongoing basis through good maintenance, meter replacement, ongoing database audits etc.

9.3.3 Priority 2 – Investments to meet all environmental obligations

The second priority will be given to the measures aimed at enabling the councils to meet all their environmental obligations as outlined in the table below. It is assumed that the revenue improvements realised from the implementation of the first priority measures will enable the councils manage operate the sewage treatment and disposal facilities more sustainably.

Table 9-2: 2nd Priority Investment Measures

Investment Measures	Remarks
Sewage – Expand Sewage Treatment Capacity	It is likely that with the completion of all or most of the measures above the City's sewage treatment plants will be functional but heavily overloaded, with significant flows bypassing the secondary and tertiary treatment. At this stage the treatment capacity deficit can be addressed by expanding full treatment capacity to meet demand at all works in the Manyame Catchment and construction of the HSTS project
Sewage – Eradicate sewer bottlenecks.	These measures and the measures above, do not include any significant increase in water supply into the city and therefore in general the capacity of the main and trunk sewers should not be challenged. However there may be certain small sections of main and trunk sewers which are acting as bottlenecks. This may include: (a) replacement of collapsed or partly collapsed lines, (b) replacement of mains with larger diameter or improving gradients to improve velocities in areas where silting occurs, (c) increasing line capacity in short sections of line with low fall by doubling up the line or by short length line replacements with larger diameters.
Sewage – Sewerage System Expansion	Expand secondary and tertiary sewerage to high and medium density areas previously provided with water but without sewage coverage. This should be limited to areas within the sewerage boundary.

9.3.4 Priority 3 – Investments to Meet Increasing Needs of the City

The third priority measures are those aimed at expanding capacity and extending service infrastructure to cater for increased demand fuelled by population and economic growth. These measures are outlined in the table below.

Table 9-3: 3rd Priority Investment Measures

Investment Measures	Remarks

Investment Measures	Remarks
Water – Supply Increases	Bring on new sources of supply to meet the expansion of the city after all available water savings from demand management and NRW reduction have been used up:i.e (a) implementation of the Kunzvi project (b) primary distribution system restructuring and enlargements to cater for increased water from Kunzvi
Sewage – Maintain Environmental Standards	As new water supply sources come on line the capacity of WWTWs will be challenged. New treatment streams and BNR modules will need to be added on an ongoing basis.
Water – Supply Area Coverage Increases	The secondary water supply network will be expanded into new areas, not currently provided with water supply. This will allow new areas to be released for development.
Sewage – Serviced Area Coverage Increases	New trunk sewers to areas of new water supply coverage. These areas will only be within the City sewage boundary
Water – Improved Storage	The city has well over 24 hours of storage capacity at present. Many cities operate effectively with significantly less than this but it is a desirable figure. With the increases in supply availability the storage tie will decrease and in many satellite areas increased coverage may reduce local storage time to just a few hours. Thus a major storage increase will be required to create a minimum of 24 hours storage throughout the system.

9.4 Investment Cost Estimates

The detailed cost estimates for all the investment components are presented in the Appendix. The investment plan has been structured according to the prioritization principles outlined above. 1st and 2nd priority measures have been put under the medium term project (2017/18), while 3rd priority measures could be implemented under the long term project (2026/27). We assume that more refined project packaging will be done at the feasibility study level once a decision has been taken to implement.

9.4.1 Harare

For Harare the total required investment between now and 2030 is US$1,759 million split US$664 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and US$1,095 million in longer term investments in expansion.

In the short term the majority of the expenditure is on repair and rehabilitation to existing water networks.

In the long term the Kunzvi scheme and the Harare South Trunk Sewer and its associated new treatment facilities dominate the cost estimates.

Of the ‘expansion’ measures there is an approximately 60:40 split between expansion in tertiary water and sewer networks, traditionally carried out by private developers and primary and secondary infrastructure provided by the utility.

The total programme represents an investment of $3,000 per connection[1] with the repair, rehabilitation and environmental intervention (Priorities 1 and 2) measures costing $2,500 per existing connection whilst expansions will cost approximately US$3,430 per connection added.

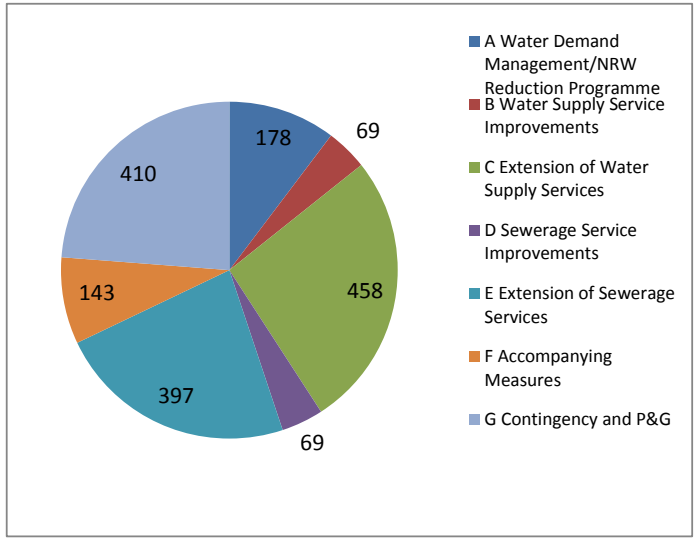
The investments are summarised in the tables on the following pages.

[1] Calculation uses [Total Investment/ estimated total no of connections in 2030]

Figure 9-1: Overview of Investment Programme - Harare

Summary of Harare Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	178	96	82
B	Water Supply Service Improvements	69	21	48
C	Extension of Water Supply Services	458	139	318
D	Sewerage Service Improvements	69	40	29
E	Extension of Sewerage Services	397	119	278
F	Accompanying Measures	143	68	76
G	Contingency and P&G	410	145	264
Total		**1,723**	**628**	**1,095**



Summary of Harare Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Investments for Restoration of Existing Facilities	430	232	197
2	Priority 2 – Investments to meet all environmental obligations	274	142	132
3	Priority 3 – Investments to Meet Increasing Needs of the City	1,020	254	766
Total		**1,723**	**628**	**1,095**
	Reticulation to new development areas	634	152	482
		37%	24%	44%

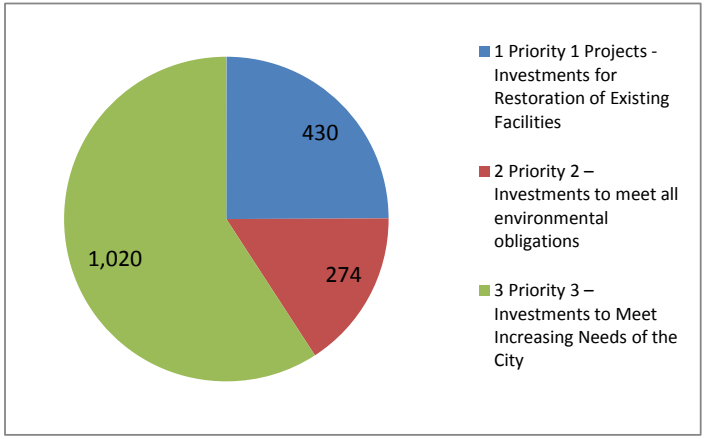


Figure 9-2: Summary of Investment Programme - Harare

Investment Components and Capital Expenditure Programme - HARARE

Item	Category	Ref. No.	Component	Source	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	**Water Demand Management/NRW Reduction Programme**					-	-	-	23,904,070	23,904,070	23,904,070	23,904,070	15,271,195	263,875	1,847,125	12,327,125	12,327,125	12,327,125	12,327,125	5,608,898	4,025,649	5,608,898	177,550,419
		A.1	Rehabilitation/replacement of treated water transmission network	field investigations results and consultaions with council	1	-	-	-	2,462,760	2,462,760	2,462,760	2,462,760	2,462,760	-	-	-	-	-	-	-	-	-	12,313,800
		A.2	Rehabilitation/replacement of water distribution network	pilot area investigations results and consultaions with council	1	-	-	-	20,541,310	20,541,310	20,541,310	20,541,310	11,908,435	263,875	1,847,125	12,327,125	12,327,125	12,327,125	12,327,125	5,608,898	4,025,649	5,608,898	160,736,619
		A.3	NRW Reduction programme	pilot area investigations results and consultaions with council	1	-	-	-	900,000	900,000	900,000	900,000	900,000	-	-	-	-	-	-	-	-	-	4,500,000
B	**Water Supply Service Improvements**					-	-	-	10,506,427	10,506,427	-	-	-	-	-	-	-	23,924,151	23,924,151	-	-	-	68,861,156
		B.1	Rehabilitation of MORTON JAFRAY WTW including source works	Condition assessments	1	-	-	-	5,482,469	5,482,469	-	-	-	-	-	-	-	15,436,713	15,436,713	-	-	-	41,838,363
		B.2	Rehabilitation of PRINCE EDWARDS WTW including source works	Condition assessments	1	-	-	-	1,506,029	1,506,029	-	-	-	-	-	-	-	3,389,776	3,389,776	-	-	-	9,791,610
		B.3	Rehabilitation of WARREN Control station	Condition assessments	1	-	-	-	1,171,728	1,171,728	-	-	-	-	-	-	-	4,329,205	4,329,205	-	-	-	11,001,865
		B.4	Rehabilitation of ALEXANDER PARK Booster Station	Condition assessments	1	-	-	-	546,202	546,202	-	-	-	-	-	-	-	768,457	768,457	-	-	-	2,629,318
		B.5	Rehabilitation of LETOMBO Booster Station	Condition assessments	1	-	-	-	800,000	800,000	-	-	-	-	-	-	-	-	-	-	-	-	1,600,000
		B.6	Rehabilitation of storage Reservoirs including lift stations	Condition assessments	1	-	-	-	1,000,000	1,000,000	-	-	-	-	-	-	-	-	-	-	-	-	2,000,000
C	**Extension of Water Supply Services**					7,774,489	7,774,489	7,774,489	8,444,489	8,444,489	49,621,335	49,621,335	57,680,032	15,833,187	15,833,187	15,833,187	15,833,187	55,134,854	55,134,854	55,134,854	15,833,187	15,833,187	457,538,830
		C.1	Proposed Kunzvi Water Supply Scheme	1999 Study report by GKW Consult/BCHOD, hydraulic modelling	2	-	-	-	-	-	41,846,845	41,846,845	41,846,845	-	-	-	-	8,635,000	8,635,000	8,635,000	-	-	151,445,535
		C.2	Construction of new storage reservoirs	design guidelines, water demand	3	-	-	-	-	-	-	-	-	-	-	-	-	30,666,667	30,666,667	30,666,667	-	-	92,000,000
		C.3	Extension of distribution system in expansion areas	design guidelines, population projections	3	7,774,489	7,774,489	7,774,489	7,774,489	7,774,489	7,774,489	7,774,489	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	15,833,187	212,753,295
		C.4	Other new bulk water management facilities	Discusions with local authority	3	-	-	-	670,000	670,000	-	-	-	-	-	-	-	-	-	-	-	-	1,340,000
D	**Sewerage Service Improvements**					-	-	-	13,517,894	13,517,894	6,355,567	6,355,567	6,355,567	-	-	-	-	11,516,153	11,516,153	-	-	-	69,134,794
		D.1	Rehabilitation of Firle WWTW	Condition assessments	2	-	-	-	2,939,615	2,939,615	-	-	-	-	-	-	-	5,741,811	5,741,811	-	-	-	17,362,851
		D.2	Rehabilitation of Crowborough WWTW	Condition assessments	2	-	-	-	2,554,007	2,554,007	-	-	-	-	-	-	-	3,759,808	3,759,808	-	-	-	12,627,629
		D.3	Rehabilitation of Hatcliff WWTW	Condition assessments	2	-	-	-	302,046	302,046	-	-	-	-	-	-	-	385,556	385,556	-	-	-	1,375,204
		D.4	Rehabilitation of AVONLEA Sewage Pump Stations	Condition assessments	2	-	-	-	230,029	230,029	-	-	-	-	-	-	-	181,565	181,565	-	-	-	823,187
		D.5	Rehabilitation of BUDIRIRO Sewage Pump Station	Condition assessments	2	-	-	-	242,500	242,500	-	-	-	-	-	-	-	509,881	509,881	-	-	-	1,504,762
		D.6	Rehabilitation of MT PLEASANT NE Sewage Pump Station	Condition assessments	2	-	-	-	285,899	285,899	-	-	-	-	-	-	-	279,899	279,899	-	-	-	1,131,595
		D.7	Rehabilitation of NEW MARLBOROUGH Sewage Pump Station	Condition assessments	2	-	-	-	127,717	127,717	-	-	-	-	-	-	-	132,567	132,567	-	-	-	520,568
		D.8	Rehabilitation of BORROWDALE BROOK Sewage Pump Station	Condition assessments	2	-	-	-	318,430	318,430	-	-	-	-	-	-	-	361,983	361,983	-	-	-	1,360,824
		D.9	Rehabilitation of CHISIPITE Sewage Pump Station	Condition assessments	2	-	-	-	162,085	162,085	-	-	-	-	-	-	-	163,085	163,085	-	-	-	650,340
		D.10	Replacement/Upgrading of existing sewer network	Condition assessments	1	-	-	-	6,355,567	6,355,567	6,355,567	6,355,567	6,355,567	-	-	-	-	-	-	-	-	-	31,777,835
E	**Extension of Sewerage Services**					7,208,614	7,208,614	7,208,614	41,557,764	41,557,764	7,208,614	7,208,614	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	52,629,240	52,629,240	50,816,740	17,432,629	17,432,629	397,262,221
		E.1	Decommissioning of Sewage Treatment Works	Environmental guidelines, council recommendation	3	-	-	-	613,750	613,750	-	-	-	-	-	-	-	1,812,500	1,812,500	-	-	-	4,852,500
		E.2	Rehabilitation/ Commissioning of Existing Lyndhurst Farm Sewer	Hydraulic calculations	3	-	-	-	-	-	-	-	-	-	-	-	-	384,648	384,648	384,648	-	-	1,153,944
		E.3	Trunk Sewer Extensions in Southern Suburbs (Ward 1)	Hydraulic calculation	3	-	-	-	-	-	-	-	-	-	-	-	-	1,173,636	1,173,636	1,173,636	-	-	3,520,907
		E.4	Harare South Trunk Sewer	Hydraulic calculation	3	-	-	-	-	-	-	-	-	-	-	-	-	10,467,794	10,467,794	10,467,794	-	-	31,403,383
		E.5	Harare South Sewage Pump Station and Force Main	Hydraulic calculation	3	-	-	-	1,050,000	1,050,000	-	-	-	-	-	-	-	3,722,333	3,722,333	3,722,333	-	-	13,267,000
		E.6	Harare South Wastewater Treatment Works	Process & Hydraulic calculations	3	-	-	-	3,885,400	3,885,400	-	-	-	-	-	-	-	17,635,700	17,635,700	17,635,700	-	-	60,677,900
		E.7	Expansion of Crowborough WWTW	wastewater flow estimates	3	-	-	-	28,800,000	28,800,000	-	-	-	-	-	-	-	-	-	-	-	-	57,600,000
		E.8	Extension of sewer reticulation system in new development areas	population projection data	3	7,208,614	7,208,614	7,208,614	7,208,614	7,208,614	7,208,614	7,208,614	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	17,432,629	224,786,587
F	**Accompanying Measures**					1,498,310	5,498,310	5,498,310	15,933,064	13,793,064	12,708,959	12,708,959	9,673,942	3,352,969	3,511,294	4,559,294	4,559,294	15,553,152	15,553,152	11,156,049	3,729,146	3,887,471	143,174,742
		F.1	Technical operations management	Consultations with council	1	-	-	-	1,200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	1,200,000
		F.2	Information Communication Technology Infrastructure	Consultations with council	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		F.3	Commercial operations management	Consultations with council	1	-	-	-	800,000	-	-	-	-	-	-	-	-	-	-	-	-	-	800,000
		F.4	Management, commercial and technical information systems	Consultations with council	1	-	-	-	140,000	-	-	-	-	-	-	-	-	-	-	-	-	-	140,000
		F.5	Professional services - Institutional Support	Consultations with council	1	-	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	-	-	-	-	-	-	-	-	-	-	24,000,000
		F.6	Professional services - Feasibility, Design and Supervision	Previous experience	0	1,498,310	1,498,310	1,498,310	9,793,064	9,793,064	8,708,959	8,708,959	9,673,942	3,352,969	3,511,294	4,559,294	4,559,294	15,553,152	15,553,152	11,156,049	3,729,146	3,887,471	117,034,742
				Contractors' P&G and Physical contingencies		5,244,086	5,244,086	5,244,086	34,275,726	34,275,726	30,481,355	30,481,355	33,858,798	11,735,392	12,289,529	15,957,529	15,957,529	54,436,033	54,436,033	39,046,172	13,052,013	13,606,150	409,621,597
				Total		21,725,500	25,725,500	25,725,500	148,139,435	145,999,435	130,279,899	130,279,899	140,272,163	48,618,051	50,913,764	66,109,764	66,109,764	225,520,707	225,520,707	161,762,714	54,072,623	56,368,335	1,723,143,760
				Cumm. Total		21,725,500	47,451,000	73,176,501	221,315,935	367,315,370	497,595,269	627,875,169	768,147,331	816,765,383	867,679,146	933,788,910	999,898,673	1,225,419,380	1,450,940,087	1,612,702,801	1,666,775,424	1,723,143,760	

Prioritised Investment Summary - Harare

Priority	Description			Sub Total	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Investments for Restoration of Existing Facilities**					-	4,000,000	4,000,000	65,250,793	63,110,793	47,876,474	47,876,474	31,358,804	382,619	2,678,331	17,874,331	17,874,331	52,564,349	52,564,349	8,132,903	5,837,191	8,132,903	429,514,644
				Works and Goods	1	-	4,000,000	4,000,000	46,906,064	44,766,064	34,259,637	34,259,637	21,626,762	263,875	1,847,125	12,327,125	12,327,125	36,251,275	36,251,275	5,608,898	4,025,649	5,608,898	304,329,410
				Engineering Professional Services		-	-	-	4,076,606	4,076,606	3,025,964	3,025,964	2,162,676	26,387	184,712	1,232,712	1,232,712	3,625,128	3,625,128	560,890	402,565	560,890	27,818,941
				P&G and Contingency		-	-	-	14,268,122	14,268,122	10,590,873	10,590,873	7,569,367	92,356	646,494	4,314,494	4,314,494	12,687,946	12,687,946	1,963,114	1,408,977	1,963,114	97,366,293
2	**Priority 2 – Investments to meet all environmental obligations**					-	-	-	10,385,374	10,385,374	60,677,925	60,677,925	60,677,925	-	-	-	-	29,219,172	29,219,172	12,520,750	-	-	273,763,618
				Works and Goods	2	-	-	-	7,162,327	7,162,327	41,846,845	41,846,845	41,846,845	-	-	-	-	20,151,153	20,151,153	8,635,000	-	-	188,802,495
				Engineering Professional Services		-	-	-	716,233	716,233	4,184,685	4,184,685	4,184,685	-	-	-	-	2,015,115	2,015,115	863,500	-	-	18,880,249
				P&G and Contingency		-	-	-	2,506,814	2,506,814	14,646,396	14,646,396	14,646,396	-	-	-	-	7,052,904	7,052,904	3,022,250	-	-	66,080,873
3	**Priority 3 – Investments to Meet Increasing Needs of the City**					21,725,500	21,725,500	21,725,500	72,503,268	72,503,268	21,725,500	21,725,500	48,235,433	48,235,433	48,235,433	48,235,433	48,235,433	143,737,186	143,737,186	141,109,061	48,235,433	48,235,433	1,019,865,498
				Works and Goods	3	14,983,104	14,983,104	14,983,104	50,002,254	50,002,254	14,983,104	14,983,104	33,265,816	33,265,816	33,265,816	33,265,816	33,265,816	99,129,094	99,129,094	97,316,594	33,265,816	33,265,816	703,355,516
				Engineering Professional Services		1,498,310	1,498,310	1,498,310	5,000,225	5,000,225	1,498,310	1,498,310	3,326,582	3,326,582	3,326,582	3,326,582	3,326,582	9,912,909	9,912,909	9,731,659	3,326,582	3,326,582	70,335,552
				P&G and Contingency		5,244,086	5,244,086	5,244,086	17,500,789	17,500,789	5,244,086	5,244,086	11,643,035	11,643,035	11,643,035	11,643,035	11,643,035	34,695,183	34,695,183	34,060,808	11,643,035	11,643,035	246,174,431

9.4.2 Chitungwiza

For Chitungwiza the total required investment between now and 2030 is US$162 million split US$72 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and US$90 million in longer term investments in expansion.

The majority of the expenditure is on repair and rehabilitation to existing water networks. Significant ‘new’ works are limited to the distribution system as much of the investment required in expanded water and sewage treatment is undertaken by Harare as the first phase of the Harare South Trunk Sewer will cater for Chitungwiza's needs.

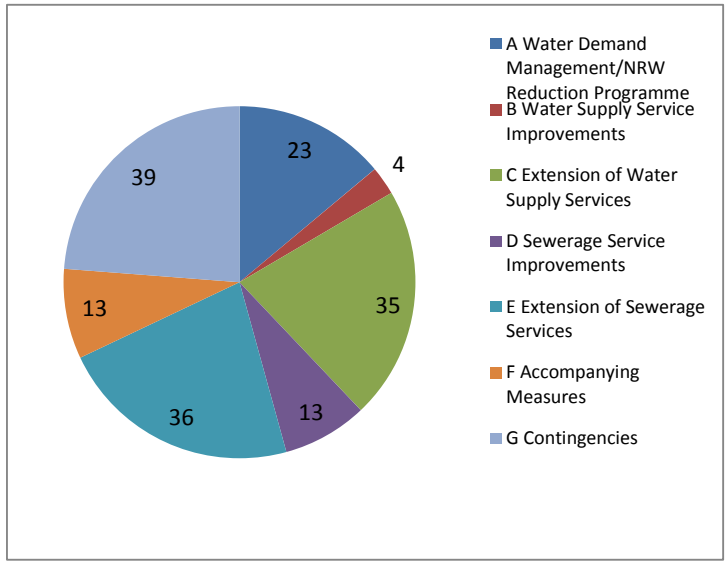
The total programme represents an investment of $1,850 per connection with the repair, rehabilitation and environmental intervention (Priorities 1 and 2) measures costing $1,200 per existing connection whilst expansions will cost approximately US$2,800 per connection added.

The investments are summarised in the tables on the following pages.

Figure 9-3: Overview of Investment Programme - Chitungwiza

Summary of Chitungwiza Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	23	11	12
B	Water Supply Service Improvements	4	4	-
C	Extension of Water Supply Services	35	18	17
D	Sewerage Service Improvements	13	7	5
E	Extension of Sewerage Services	36	8	28
F	Accompanying Measures	13	7	6
G	Contingencies	39	17	22
Total		**162**	**72**	**90**



Summary of Chitungwiza Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Repair and Rehabilitation and Restoration of Service	41	25	17
2	Priority 2 Projects - Meet Environmental Commitments	18	10	8
3	Priority 3 Projects - Water and Sanitation Coverage Expansions	103	37	65
Total		**162**	**72**	**90**
	Reticulation in new development areas	69	13	57
		43%	17%	63%

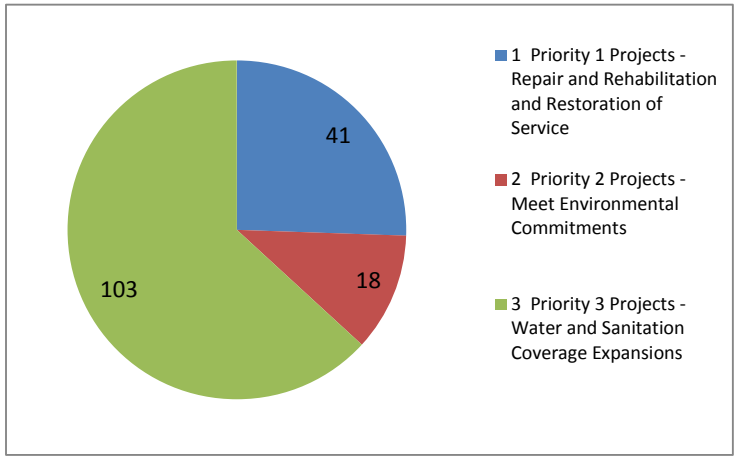


Figure 9-4: Summary of Investment Programme - Chitungwiza

Figure Investment Components and Capital Expenditure Programme - CHITUNGWIZA

Item	Category	Ref. No.	Component	Source	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	**Water Demand Management/NRW Reduction Programme**					-	-	-	5,484,598	5,484,598	-	-	132,815	132,815	132,815	9,092,815	132,815	170,315	170,315	552,635	552,635	552,635	22,591,803
		A.1	Rehabilitation/replacement of water distribution network	pilot area investigations results and consultaions with council	1	-	-	-	7,088	7,088	-	-	-	-	-	-	-	-	-	-	-	-	14,175
		A.2	Replacement/Installation of section valves	pilot area investigations results and consultaions with council	1	-	-	-	253,210	253,210	-	-	-	-	-	-	-	-	-	-	-	-	506,420
		A.3	Installation of bulk meters	Field investigations and consultations with the council	1	-	-	-	37,500	37,500	-	-	-	-	-	-	-	37,500	37,500	-	-	-	150,000
		A.4	Rehabilitating/Installation of pressure reducing valves	Field investigations and consultations with the council	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		A.5	Replacement of service connections	Field investigations and consultations with the council	1	-	-	-	156,800	156,800	-	-	-	-	-	-	-	-	-	-	-	-	313,600
		A.6	Replacement of service water meters	pilot area investigations findings and consultaions with council	1	-	-	-	4,480,000	4,480,000	-	-	132,815	132,815	132,815	9,092,815	132,815	132,815	132,815	552,635	552,635	552,635	20,507,608
		A.7	NRW Reduction programme	Meter testing results	1	-	-	-	550,000	550,000	-	-	-	-	-	-	-	-	-	-	-	-	1,100,000
B	**Water Supply Service Improvements**					-	-	-	2,122,805	2,122,805	-	-	-	-	-	-	-	-	-	-	-	-	4,245,610
		B.1	Rehabilitation of Source Works	Condition assessments	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		B.2	Rehabilitation of existing water treatment facilities	Condition assessments	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		B.3	Rehabilitation of Pump Stations	Condition assessments	1	-	-	-	25,000	25,000	-	-	-	-	-	-	-	-	-	-	-	-	50,000
		B.4	Replacement/rehabilitation of existing transmission and primary distribution mains	Field investigations and consultations with the council	1	-	-	-	2,062,805	2,062,805	-	-	-	-	-	-	-	-	-	-	-	-	4,125,610
		B.5	Rehabilitation of storage tanks	Condition assessments	1	-	-	-	35,000	35,000	-	-	-	-	-	-	-	-	-	-	-	-	70,000
C	**Extension of Water Supply Services**					348,477	348,477	348,477	7,975,333	7,975,333	348,477	348,477	1,101,521	1,101,521	1,101,521	1,101,521	1,101,521	4,101,521	4,101,521	1,101,521	1,101,521	1,101,521	34,708,267
		C.1	Extension of water abstraction and treatment facilities	Water demand calculations hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		C.2	Construction of new Pump Stations	Hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		C.3	Installtion of new transmission and primary mains	population projection data and hydraulic analysis	3	-	-	-	3,174,356	3,174,356	-	-	-	-	-	-	-	-	-	-	-	-	6,348,711
		C.4	Construction of new storage tanks	design guidelines	3	-	-	-	4,400,000	4,400,000	-	-	-	-	-	-	-	3,000,000	3,000,000	-	-	-	14,800,000
		C.5	Extension of distribution system in expansion areas	design guidelines	3	211,049	211,049	211,049	211,049	211,049	211,049	211,049	667,117	667,117	667,117	667,117	667,117	667,117	667,117	667,117	667,117	667,117	8,148,519
		C.6	Installation of service connections in expansion areas	population projection data	3	4,614	4,614	4,614	4,614	4,614	4,614	4,614	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	178,127
		C.7	Installation of service water meters in expansion areas	population projection data	3	132,815	132,815	132,815	132,815	132,815	132,815	132,815	419,821	419,821	419,821	419,821	419,821	419,821	419,821	419,821	419,821	419,821	5,127,910
		C.8	Other new bulk water management facilities	Field investigations and consultations with the council	1	-	-	-	52,500	52,500	-	-	-	-	-	-	-	-	-	-	-	-	105,000
D	**Sewerage Service Improvements**					-	-	-	3,613,363	3,613,363	-	-	-	-	-	-	-	2,696,250	2,696,250	-	-	-	12,619,227
		D.1	Rehabilitation of wastewater treatment facilities	Condition assessments	2	-	-	-	3,453,277	3,453,277	-	-	-	-	-	-	-	2,696,250	2,696,250	-	-	-	12,299,055
		D.2	Rehabilitation of sewage pump stations	Condition assessments	2	-	-	-	75,000	75,000	-	-	-	-	-	-	-	-	-	-	-	-	150,000
		D.3	Rehabilitation/replacement of existing sewer network	pilot area investigations results and consultaions with council	2	-	-	-	85,086	85,086	-	-	-	-	-	-	-	-	-	-	-	-	170,172
E	**Extension of Sewerage Services**					885,023	885,023	885,023	1,856,770	1,856,770	885,023	885,023	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	2,797,547	36,114,123
		E.1	Extension of sewage treatment facilities	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		E.2	Extension of sewage pumping stations	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		E.3	Construction of new sewer trunk mains	Hydraulic analysis	3	-	-	-	971,747	971,747	-	-	-	-	-	-	-	-	-	-	-	-	1,943,493
		E.4	Extension of sewer reticulation system in new development areas	population projection data and hydraulic analysis	3	586,840	586,840	586,840	586,840	586,840	586,840	586,840	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	1,854,995	22,657,830
		E.5	Installation of sewer service connections in new development areas	population projection data	3	298,183	298,183	298,183	298,183	298,183	298,183	298,183	942,552	942,552	942,552	942,552	942,552	942,552	942,552	942,552	942,552	942,552	11,512,800
F	**Accompanying Measures**					123,350	1,650,150	123,350	2,968,287	2,105,287	123,350	123,350	403,188	403,188	403,188	1,299,188	403,188	976,563	976,563	445,170	445,170	445,170	13,417,703
		F.1	Technical operations management		1	-	-	-	430,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	430,000
		F.2	Information Communication Technology Infrastructure		1	-	258,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	258,800
		F.3	Commercial operations management		1	-	-	-	350,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	350,000
		F.4	Management, commercial and technical information systems		1	-	-	-	83,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83,000
		F.5	Professional services - Institutional Support		1	-	1,268,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,268,000
		F.6	Professional services - Feasibility, Design and Supervision		0	123,350	123,350	123,350	2,105,287	2,105,287	123,350	123,350	403,188	403,188	403,188	1,299,188	403,188	976,563	976,563	445,170	445,170	445,170	11,027,903
																							-
				Contingencies		431,725	431,725	431,725	7,368,504	7,368,504	431,725	431,725	1,411,159	1,411,159	1,411,159	4,547,159	1,411,159	3,417,971	3,417,971	1,558,096	1,558,096	1,558,096	38,597,660
				Total		1,788,576	3,315,376	1,788,576	31,389,659	30,526,659	1,788,576	1,788,576	5,846,230	5,846,230	5,846,230	18,838,230	5,846,230	14,160,167	14,160,167	6,454,970	6,454,970	6,454,970	162,294,393
				Cumm. Total		1,788,576	5,103,952	6,892,528	38,282,187	68,808,846	70,597,422	72,385,998	78,232,228	84,078,458	89,924,688	108,762,918	114,609,148	128,769,315	142,929,483	149,384,453	155,839,423	162,294,393	

Contractor's P&G and Physical contingencies	10%	of physical works (A+B+C+D+E)
Physical contingencies	35%	of physical works (A+B+C+D+E)
Inflation	0%	

Prioritised Investment Summary - Chitungwiza

Priority	Description			Sub Total	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Repair and Rehabilitation and Restoration of Service**					-	1,526,800	-	11,969,859	11,106,859	-	-	192,581	192,581	192,581	13,184,581	192,581	246,956	246,956	801,321	801,321	801,321	41,456,298
				Works and Goods	1	-	1,526,800	-	8,522,903	7,659,903	-	-	132,815	132,815	132,815	9,092,815	132,815	170,315	170,315	552,635	552,635	552,635	29,332,213
				Engineering Professional Services		-	-	-	765,990	765,990	-	-	13,281	13,281	13,281	909,281	13,281	17,031	17,031	55,264	55,264	55,264	2,694,241
				P&G and Contingency		-	-	-	2,680,966	2,680,966	-	-	46,485	46,485	46,485	3,182,485	46,485	59,610	59,610	193,422	193,422	193,422	9,429,844
2	**Priority 2 Projects - Meet Environmental Commitments**					-	-	-	5,239,377	5,239,377	-	-	-	-	-	-	-	3,909,563	3,909,563	-	-	-	18,297,879
				Works and Goods	2	-	-	-	3,613,363	3,613,363	-	-	-	-	-	-	-	2,696,250	2,696,250	-	-	-	12,619,227
				Engineering Professional Services		-	-	-	361,336	361,336	-	-	-	-	-	-	-	269,625	269,625	-	-	-	1,261,923
				P&G and Contingency		-	-	-	1,264,677	1,264,677	-	-	-	-	-	-	-	943,688	943,688	-	-	-	4,416,729
3	**Priority 3 Projects - Water and Sanitation Coverage Expansions**					1,788,576	1,788,576	1,788,576	14,180,424	14,180,424	1,788,576	1,788,576	5,653,649	5,653,649	5,653,649	5,653,649	5,653,649	10,003,649	10,003,649	5,653,649	5,653,649	5,653,649	102,540,216
				Works and Goods	3	1,233,501	1,233,501	1,233,501	9,779,603	9,779,603	1,233,501	1,233,501	3,899,068	3,899,068	3,899,068	3,899,068	3,899,068	6,899,068	6,899,068	3,899,068	3,899,068	3,899,068	70,717,390
				Engineering Professional Services		123,350	123,350	123,350	977,960	977,960	123,350	123,350	389,907	389,907	389,907	389,907	389,907	689,907	689,907	389,907	389,907	389,907	7,071,739
				P&G and Contingency		431,725	431,725	431,725	3,422,861	3,422,861	431,725	431,725	1,364,674	1,364,674	1,364,674	1,364,674	1,364,674	2,414,674	2,414,674	1,364,674	1,364,674	1,364,674	24,751,087

9.4.3 Epworth

For Epworth the total required investment between now and 2030 is US$64 million split US$16 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and US$47 million in longer term investments in expansion.

The majority of the expenditure is on projects to meet environmental commitments which includes for commissioning the Epworth sewer network and connecting it to the Harare South Trunk Sewer. Significant 'new' works are limited to the distribution system as much of the investment required in expanded water and sewerage treatment is undertaken by Harare.

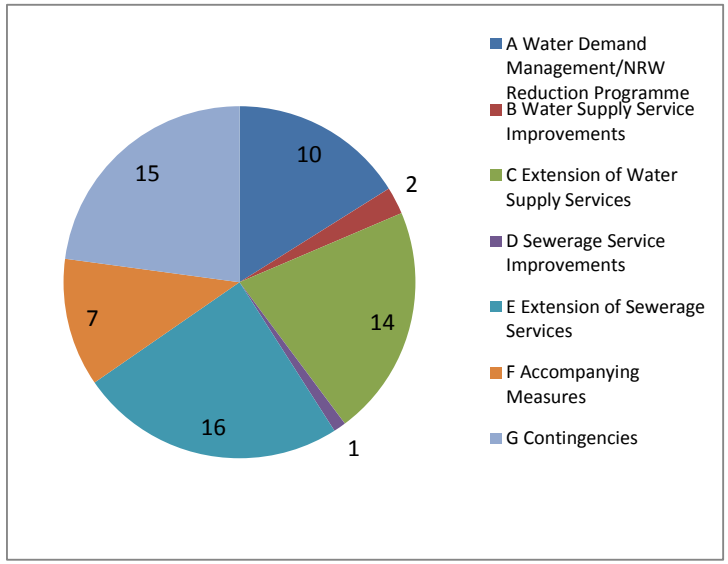
The total programme represents an investment of $2,000 per connection with the repair, rehabilitation and environmental intervention (Priorities 1 and 2) measures costing $1,000 per existing connection whilst expansions will cost approximately US$3,100 per connection added.

The investments are summarised in the tables on the following pages.

Figure 9-5: Overview of Investment Programme - Epworth

Summary of Epworth Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	10	6	4
B	Water Supply Service Improvements	2	2	-
C	Extension of Water Supply Services	14	1	12
D	Sewerage Service Improvements	1	-	1
E	Extension of Sewerage Services	16	-	16
F	Accompanying Measures	7	4	3
G	Contingencies	15	3	11
Total		**64**	**16**	**47**



Summary of Epworth Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Repair and Rehabilitation and Restoration of Service	21	15	6
2	Priority 2 Projects - Meet Environmental Commitments	-	-	-
3	Priority 3 Projects - Water and Sanitation Coverage Expansions	43	2	41
Total		**64**	**16**	**47**
	Reticulation in new development areas	36	2	34
		56%	11%	71%

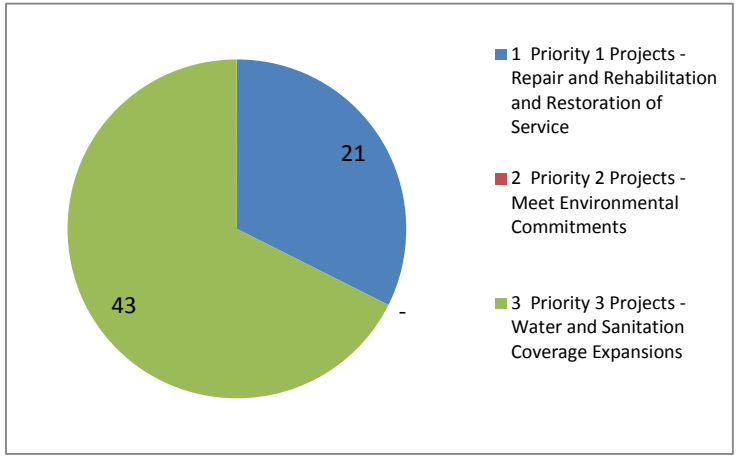


Figure 9-6: Summary of Investment Programme - Epworth

Investment Components and Capital Expenditure Programme - EPWORTH

Item	Category	Ref. No.	Component	Source	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	**Water Demand Management/NRW Reduction Programme**					-	-	-	3,066,600	3,066,600	-	-	43,429	43,429	43,429	2,593,429	43,429	283,679	283,679	253,314	253,314	253,314	10,227,641
		A.1	Rehabilitation/replacement of water distribution network	field inspections, consultations with council and investigations in other towns	1	-	-	-	465,000	465,000	-	-	-	-	-	-	-	-	-	-	-	-	930,000
		A.2	Replacement/Installation of section valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	49,350	49,350	-	-	-	-	-	-	-	-	-	-	-	-	98,700
		A.3	Installation of bulk meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	70,750	70,750	-	-	-	-	-	-	-	70,750	70,750	-	-	-	283,000
		A.4	Rehabilitating/Installation of pressure reducing valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	7,000	7,000	-	-	-	-	-	-	-	7,000	7,000	-	-	-	28,000
		A.5	Replacement of service connections	field inspections, consultations with council and investigations in other towns	1	-	-	-	1,154,500	1,154,500	-	-	-	-	-	-	-	162,500	162,500	-	-	-	2,634,000
		A.6	Replacement of service water meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	1,275,000	1,275,000	-	-	43,429	43,429	43,429	2,593,429	43,429	43,429	43,429	253,314	253,314	253,314	6,163,941
		A.7	NRW Reduction programme	field inspections, consultations with council and investigations in other towns	1	-	-	-	45,000	45,000	-	-	-	-	-	-	-	-	-	-	-	-	90,000
B	**Water Supply Service Improvements**					-	-	-	791,650	791,650	-	-	-	-	-	-	-	-	-	-	-	-	1,583,300
		B.1	Water Kiosk Programme	Condition assessments	1	-	-	-	791,650	791,650	-	-	-	-	-	-	-	-	-	-	-	-	1,583,300
C	**Extension of Water Supply Services**					185,527	185,527	185,527	185,527	185,527	185,527	185,527	945,610	945,610	945,610	945,610	945,610	2,292,010	2,292,010	1,000,610	945,610	945,610	13,502,588
		C.1	Primary and Secondary Distribution System Expansion	Discusions with local authority	3	-	-	-	-	-	-	-	-	-	-	-	-	1,318,900	1,318,900	-	-	-	2,637,800
		C.2	Extension of distribution system in expansion areas	Design guidelines, hydraulic modelling	3	185,527	185,527	185,527	185,527	185,527	185,527	185,527	945,610	945,610	945,610	945,610	945,610	945,610	945,610	945,610	945,610	945,610	10,754,788
		C.3	Other new bulk water management facilities	Hydraulic Modelling	1	-	-	-	-	-	-	-	-	-	-	-	-	27,500	27,500	55,000	-	-	110,000
D	**Sewerage Service Improvements**					-	-	-	-	-	-	-	-	-	-	-	-	364,215	364,215	-	-	-	728,430
		D.1	Rehabilitation/replacement of existing sewer network		3	-	-	-	-	-	-	-	-	-	-	-	-	364,215	364,215	-	-	-	728,430
E	**Extension of Sewerage Services**					-	-	-	-	-	-	-	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	2,238,489	2,238,489	1,381,352	1,381,352	1,381,352	15,527,794
		E.1	Epworth Outfall to Lyndhyrst Farm Line	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	316,681	316,681	-	-	-	633,361
		E.2	Epworth Wards 3 and 4 Expansion	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	540,456	540,456	-	-	-	1,080,913
		E.3	Extension of sewer reticulation system in new development areas	Population growth calculations	3	-	-	-	-	-	-	-	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	13,813,520
F	**Accompanying Measures**					18,553	498,553	138,553	2,690,978	832,378	18,553	18,553	237,039	237,039	237,039	492,039	237,039	517,839	517,839	263,528	258,028	258,028	7,471,575
		F.1	Technical operations management		1	-	-	-	230,000	-	-	-	-	-	-	-	-	-	-	-	-	-	230,000
		F.2	Information Communication Technology Infrastructure		1	-	-	-	176,600	-	-	-	-	-	-	-	-	-	-	-	-	-	176,600
		F.3	Commercial operations management		1	-	-	-	1,500,000	-	-	-	-	-	-	-	-	-	-	-	-	-	1,500,000
		F.4	Management, commercial and technical information systems		1	-	-	-	140,000	-	-	-	-	-	-	-	-	-	-	-	-	-	140,000
		F.5	Professional services - Institutional Support		1	-	480,000	120,000	240,000	428,000	-	-	-	-	-	-	-	-	-	-	-	-	1,268,000
		F.6	Professional services - Feasibility, Design and Supervision		0	18,553	18,553	18,553	404,378	404,378	18,553	18,553	237,039	237,039	237,039	492,039	237,039	517,839	517,839	263,528	258,028	258,028	4,156,975
			Contractor's P&G and Physical contingencies			64,934	64,934	64,934	1,415,322	1,415,322	64,934	64,934	829,637	829,637	829,637	1,722,137	829,637	1,812,437	1,812,437	922,346	903,096	903,096	14,549,414
			Total			269,014	749,014	389,014	8,150,076	6,291,476	269,014	269,014	3,437,066	3,437,066	3,437,066	7,134,566	3,437,066	7,508,670	7,508,670	3,821,150	3,741,400	3,741,400	63,590,742
			Cumm. Total			269,014	1,018,028	1,407,042	9,557,118	15,848,595	16,117,609	16,386,623	19,823,689	23,260,755	26,697,822	33,832,388	37,269,454	44,778,124	52,286,793	56,107,943	59,849,343	63,590,742	

Engineering Services	10%	of physical works (A+B+C+D+E)
Contractor's P&G and Physical contingencies	35%	of physical works (A+B+C+D+E)
Inflation	0%	

Prioritised Investment Summary - Epworth

Priority	Description			Sub Total	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Repair and Rehabilitation and Restoration of Service**					-	480,000	120,000	7,881,063	6,022,463	-	-	62,971	62,971	62,971	3,760,471	62,971	451,209	451,209	447,055	367,305	367,305	20,599,964
				Works and Goods	1	-	480,000	120,000	6,144,850	4,286,250	-	-	43,429	43,429	43,429	2,593,429	43,429	311,179	311,179	308,314	253,314	253,314	15,235,541
				Engineering Professional Services		-	-	-	385,825	385,825	-	-	4,343	4,343	4,343	259,343	4,343	31,118	31,118	30,831	25,331	25,331	1,192,094
				P&G and Contingency		-	-	-	1,350,388	1,350,388	-	-	15,200	15,200	15,200	907,700	15,200	108,913	108,913	107,910	88,660	88,660	4,172,329
2	**Priority 2 Projects - Meet Environmental Commitments**					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				Works and Goods	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				Engineering Professional Services		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				P&G and Contingency		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	**Priority 3 Projects - Water and Sanitation Coverage Expansions**					269,014	269,014	269,014	269,014	269,014	269,014	269,014	3,374,095	3,374,095	3,374,095	3,374,095	3,374,095	7,057,461	7,057,461	3,374,095	3,374,095	3,374,095	42,990,778
				Works and Goods	3	185,527	185,527	185,527	185,527	185,527	185,527	185,527	2,326,962	2,326,962	2,326,962	2,326,962	2,326,962	4,867,214	4,867,214	2,326,962	2,326,962	2,326,962	29,648,813
				Engineering Professional Services		18,553	18,553	18,553	18,553	18,553	18,553	18,553	232,696	232,696	232,696	232,696	232,696	486,721	486,721	232,696	232,696	232,696	2,964,881
				P&G and Contingency		64,934	64,934	64,934	64,934	64,934	64,934	64,934	814,437	814,437	814,437	814,437	814,437	1,703,525	1,703,525	814,437	814,437	814,437	10,377,084

9.4.4 Norton

For Norton the total required investment between now and 2030 is US$100 million split US$42 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and US$57 million in longer term investments in expansion.

The majority of the expenditure is required in priority 3 projects to expand water and sewerage coverage to new areas. There is also significant investment required in sanitation as the town requires a rehabilitation of its existing sewage works, a new disposal system and a new future sewage treatment works. Costs in Norton are also generally higher than in other towns because the new developments are spread out and require significant investment in primary and secondary water and sewerage systems.

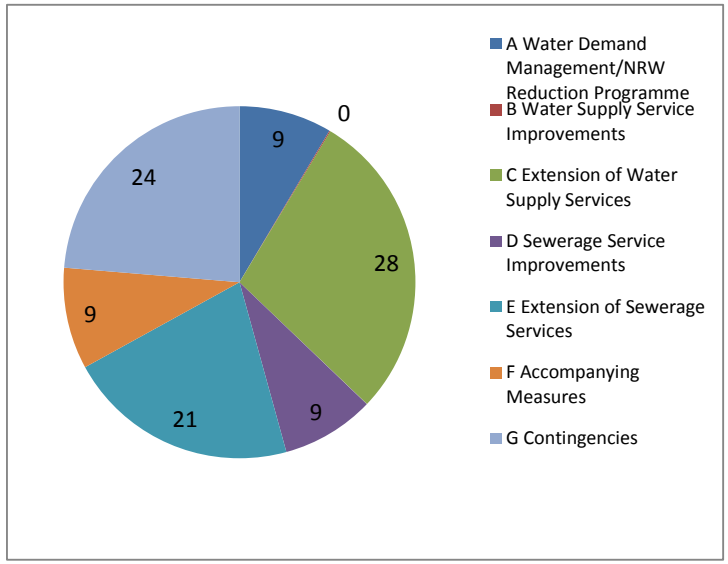
The total programme represents an investment of $3,600 per connection with the repair, rehabilitation and environmental intervention (Priorities 1 and 2) measures costing $3,700 per existing connection whilst expansions will cost approximately US$3,600 per connection added.

The investments are summarised in the tables on the following pages.

Figure 9-7: Overview of Investment Programme - Norton

Summary of Norton Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	9	5	4
B	Water Supply Service Improvements	0	0	0
C	Extension of Water Supply Services	28	10	18
D	Sewerage Service Improvements	9	8	1
E	Extension of Sewerage Services	21	5	16
F	Accompanying Measures	9	5	4
G	Contingencies	24	10	14
Total		**100**	**43**	**57**



Summary of Norton Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Repair and Rehabilitation and Restoration of Service	15	9	6
2	Priority 2 Projects - Meet Environmental Commitments	12	11	1
3	Priority 3 Projects - Water and Sanitation Coverage Expansions	72	22	50
Total		**100**	**42**	**57**
	Reticulation to new development areas	33	11	22
		33%	27%	38%

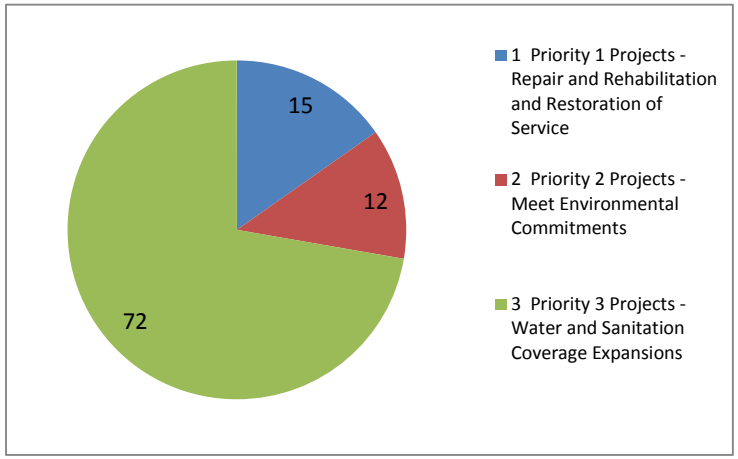


Figure 9-8: Summary of Investment Programme - Norton

Investment Components and Capital Expenditure Programme - NORTON

Project

Item	Category	Ref. No.	Component	Source	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	**Water Demand Management/NRW Reduction Programme**					-	-	-	2,272,175	2,272,175	-	-	122,211	122,211	122,211	1,867,211	122,211	380,661	380,661	287,818	287,818	287,818	8,525,179
		A.1	Rehabilitation/replacement of water distribution network	field inspections, consultations with council and investigations in other towns	1	-	-	-	231,250	231,250	-	-	-	-	-	-	-	-	-	-	-	-	462,500
		A.2	Replacement/Installation of section valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	116,475	116,475	-	-	-	-	-	-	-	-	-	-	-	-	232,950
		A.3	Installation of bulk meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	79,700	79,700	-	-	-	-	-	-	-	79,700	79,700	-	-	-	318,800
		A.4	Rehabilitating/Installation of pressure reducing valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	35,000	35,000	-	-	-	-	-	-	-	35,000	35,000	-	-	-	140,000
		A.5	Replacement of service connections	field inspections, consultations with council and investigations in other towns	1	-	-	-	892,250	892,250	-	-	-	-	-	-	-	143,750	143,750	-	-	-	2,072,000
		A.6	Replacement of service water meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	872,500	872,500	-	-	122,211	122,211	122,211	1,867,211	122,211	122,211	122,211	287,818	287,818	287,818	5,208,929
		A.7	NRW Reduction programme	field inspections, consultations with council and investigations in other towns	1	-	-	-	45,000	45,000	-	-	-	-	-	-	-	-	-	-	-	-	90,000
B	**Water Supply Service Improvements**					-	-	-	38,400	38,400	-	-	-	-	-	-	-	14,000	14,000	-	-	-	104,800
		B.1	Rehabilitation of Existing Water Tanks	Condition assessments	1	-	-	-	38,400	38,400	-	-	-	-	-	-	-	14,000	14,000	-	-	-	104,800
C	**Extension of Water Supply Services**					400,842	400,842	400,842	3,992,654	3,992,654	400,842	400,842	539,130	539,130	539,130	539,130	539,130	7,082,235	7,082,235	539,130	539,130	539,130	28,467,025
		C.1	Expansion of Primary and Secondary Distribution		3	-	-	-	3,551,813	3,551,813	-	-	-	-	-	-	-	1,343,105	1,343,105	-	-	-	9,789,835
		C.2	Construction of new storage reservoirs	Design guidelines, hydraulic modelling	3	-	-	-	-	-	-	-	-	-	-	-	-	5,200,000	5,200,000	-	-	-	10,400,000
		C.4	Extension of Distribution System in Expansion areas	Discusions with local authority	3	400,842	400,842	400,842	400,842	400,842	400,842	400,842	539,130	539,130	539,130	539,130	539,130	539,130	539,130	539,130	539,130	539,130	8,197,190
		C.5	Other new bulk water management	Hydraulic Modelling	1	-	-	-	40,000	40,000	-	-	-	-	-	-	-	-	-	-	-	-	80,000
D	**Sewerage Service Improvements**					-	-	-	3,916,289	3,916,289	-	-	-	-	-	-	-	367,950	367,950	-	-	-	8,568,477
		D.1	Rehabilitation of Norton WWTW	Condition assessments	2	-	-	-	1,701,333	1,701,333	-	-	-	-	-	-	-	-	-	-	-	-	3,402,667
		D.2	New Pumps and Force Main to New SR Irrigation System	Condition assessments	2	-	-	-	1,341,884	1,341,884	-	-	-	-	-	-	-	78,000	78,000	-	-	-	2,839,768
		D.3	Establishment of New Slow Rate Irrigation Disposal System	Conceptual Designs	2	-	-	-	630,700	630,700	-	-	-	-	-	-	-	225,250	225,250	-	-	-	1,711,900
		D.4	Rehabilitate Existing Sewage Pump Stations	Condition assessments	2	-	-	-	91,121	91,121	-	-	-	-	-	-	-	15,500	15,500	-	-	-	213,243
		D.5	Rehabilitation/replacement of existing sewer network	Data from Norton Town Council	2	-	-	-	151,250	151,250	-	-	-	-	-	-	-	49,200	49,200	-	-	-	400,900
E	**Extension of Sewerage Services**					703,386	703,386	703,386	703,386	703,386	703,386	703,386	947,830	947,830	947,830	947,830	947,830	4,374,167	4,374,167	947,830	947,830	947,830	21,254,673
		E.1	New Norton WWTW (anaerobic/ Facultative Ponds)	Conceptual Designs	3	-	-	-	-	-	-	-	-	-	-	-	-	2,216,654	2,216,654	-	-	-	4,433,308
		E.2	New Secondary Sewerage Wards 12 and 13	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	703,925	703,925	-	-	-	1,407,850
		E.3	New Secondary Sewerage Chegutu Expansion Area	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	505,758	505,758	-	-	-	1,011,515
		E.4	Extension of sewer reticulation system in new development areas	Wastewater flow calculations & hydraulic analysis	3	703,386	703,386	703,386	703,386	703,386	703,386	703,386	947,830	947,830	947,830	947,830	947,830	947,830	947,830	947,830	947,830	947,830	14,402,000
F	**Accompanying Measures**					110,423	590,423	230,423	2,649,273	1,551,673	110,423	110,423	160,917	160,917	160,917	335,417	160,917	1,223,876	1,223,876	177,478	177,478	177,478	9,312,330
		F.1	Technical operations management		1	-	-	-	430,000	-	-	-	-	-	-	-	-	-	-	-	-	-	430,000
		F.2	Information Communication Technology Infrastructure		1	-	-	-	176,600	-	-	-	-	-	-	-	-	-	-	-	-	-	176,600
		F.3	Commercial operations management		1	-	-	-	350,000	-	-	-	-	-	-	-	-	-	-	-	-	-	350,000
		F.4	Management, commercial and technical information systems		1	-	-	-	83,000	-	-	-	-	-	-	-	-	-	-	-	-	-	83,000
		F.5	Professional services - Institutional Support		1	-	480,000	120,000	486,000	428,000	-	-	-	-	-	-	-	-	-	-	-	-	1,514,000
		F.6	Professional services - Feasibility, Design and Supervision		0	110,423	110,423	110,423	1,123,673	1,123,673	110,423	110,423	160,917	160,917	160,917	335,417	160,917	1,223,876	1,223,876	177,478	177,478	177,478	6,758,730
				Contingencies		386,480	386,480	386,480	3,932,855	3,932,855	386,480	386,480	563,210	563,210	563,210	1,173,960	563,210	4,283,567	4,283,567	621,172	621,172	621,172	23,655,556
				Total		1,601,130	2,081,130	1,721,130	17,505,031	16,407,431	1,601,130	1,601,130	2,333,297	2,333,297	2,333,297	4,863,547	2,333,297	17,726,455	17,726,455	2,573,428	2,573,428	2,573,428	99,888,041
				Cumm. Total		1,601,130	3,682,259	5,403,389	22,908,420	39,315,852	40,916,982	42,518,111	44,851,409	47,184,706	49,518,003	54,381,550	56,714,848	74,441,303	92,167,758	94,741,186	97,314,613	99,888,041	

Engineering Services	10%	of physical works (A+B+C+D+E)
Contractor's P&G and Physical contingencies	35%	of physical works (A+B+C+D+E)
Inflation	0%	

Prioritised Investment Summary - Norton

Priority	Description			Sub Total	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Repair and Rehabilitation and Restoration of Service**					-	480,000	120,000	4,933,934	3,836,334	-	-	177,206	177,206	177,206	2,707,456	177,206	572,258	572,258	417,336	417,336	417,336	15,183,069
				Works and Goods	1	-	480,000	120,000	3,876,175	2,778,575	-	-	122,211	122,211	122,211	1,867,211	122,211	394,661	394,661	287,818	287,818	287,818	11,263,570
				Engineering Professional Services		-	-	-	235,058	235,058	-	-	12,221	12,221	12,221	186,721	12,221	39,466	39,466	28,782	28,782	28,782	870,998
				P&G and Contingency		-	-	-	822,701	822,701	-	-	42,774	42,774	42,774	653,524	42,774	138,131	138,131	100,736	100,736	100,736	3,048,493
2	**Priority 2 Projects - Meet Environmental Commitments**					-	-	-	5,678,619	5,678,619	-	-	-	-	-	-	-	533,528	533,528	-	-	-	12,424,292
				Works and Goods	2	-	-	-	3,916,289	3,916,289	-	-	-	-	-	-	-	367,950	367,950	-	-	-	8,568,477
				Engineering Professional Services		-	-	-	391,629	391,629	-	-	-	-	-	-	-	36,795	36,795	-	-	-	856,848
				P&G and Contingency		-	-	-	1,370,701	1,370,701	-	-	-	-	-	-	-	128,783	128,783	-	-	-	2,998,967
3	**Priority 3 Projects - Water and Sanitation Coverage Expansions**					1,601,130	1,601,130	1,601,130	6,751,258	6,751,258	1,601,130	1,601,130	2,156,092	2,156,092	2,156,092	2,156,092	2,156,092	16,611,782	16,611,782	2,156,092	2,156,092	2,156,092	71,980,462
				Works and Goods	3	1,104,227	1,104,227	1,104,227	4,656,040	4,656,040	1,104,227	1,104,227	1,486,960	1,486,960	1,486,960	1,486,960	1,486,960	11,456,401	11,456,401	1,486,960	1,486,960	1,486,960	49,641,698
				Engineering Professional Services		110,423	110,423	110,423	465,604	465,604	110,423	110,423	148,696	148,696	148,696	148,696	148,696	1,145,640	1,145,640	148,696	148,696	148,696	4,964,170
				P&G and Contingency		386,480	386,480	386,480	1,629,614	1,629,614	386,480	386,480	520,436	520,436	520,436	520,436	520,436	4,009,741	4,009,741	520,436	520,436	520,436	17,374,594

9.4.5 Ruwa

For Ruwa the total required investment between now and 2030 is US$100 million split US$42 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and US$57 million in longer term investments in expansion.

The majority of the expenditure is required in priority 3 projects to expand water and sewerage coverage to new areas. However, unlike many of the other towns considerable areas of these expansions are already in place and therefore the investment is required sooner than in other cases. There is also significant investment required in sanitation to provide a new sewage treatment works in the short term and in order to link the town to the Harare South Trunk Sewer in the long term.

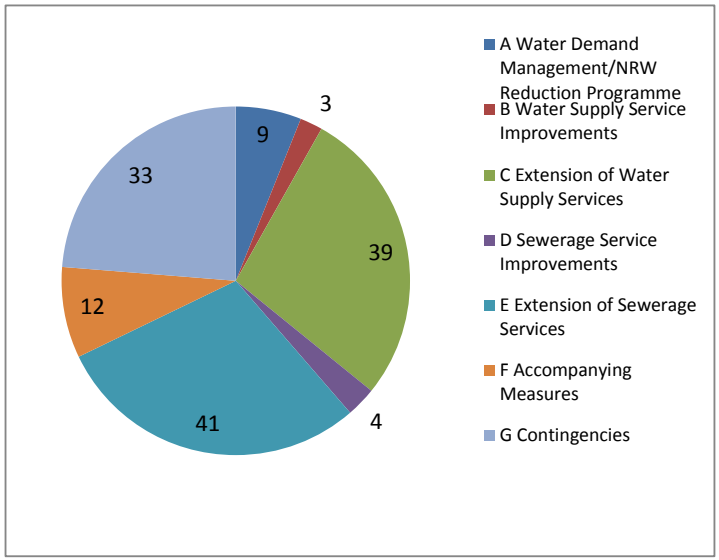
The total programme represents an investment of $3,600 per connection with the repair, rehabilitation and environmental intervention (Priorities 1 and 2) measures costing $3,700 per existing connection whilst expansions will cost approximately US$3,600 per connection added. The high cost of the new WWTW drives up the cost per existing customer of the priority 1 and 2 measures.

The investments are summarised in the tables on the following pages.

Figure 9-9: Overview of Investment Programme - Ruwa

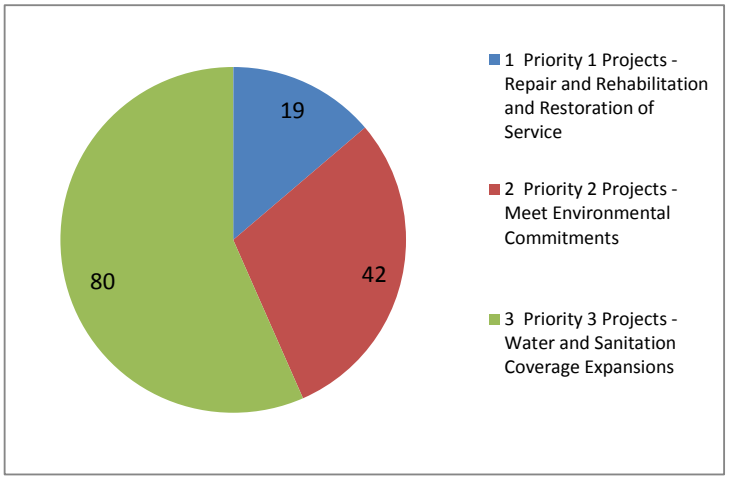
Summary of Ruwa Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	9	3	5
B	Water Supply Service Improvements	3	2	1
C	Extension of Water Supply Services	39	12	27
D	Sewerage Service Improvements	4	2	2
E	Extension of Sewerage Services	41	25	16
F	Accompanying Measures	12	7	5
G	Contingencies	33	16	18
Total		**141**	**68**	**73**



Summary of Ruwa Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Repair and Rehabilitation and Restoration of Service	19	11	8
2	Priority 2 Projects - Meet Environmental Commitments	42	18	23
3	Priority 3 Projects - Water and Sanitation Coverage Expansions	80	38	41
Total		**141**	**68**	**73**
	Reticulation to new development areas	56 40%	27 40%	29 40%



Greater Harare Water and Sanitation Investment Plan

Figure 9-10: Summary of Investment Programme - Harare

Investment Components and Capital Expenditure Programme - RUWA

Item	Category	Ref. No.	Component	Source	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	**Water Demand Management/NRW Reduction Programme**					-	-	-	1,666,600	1,666,600	-	-	254,912	254,912	254,912	2,154,912	254,912	341,412	341,412	452,157	452,157	452,157	8,547,057
		A.1	Rehabilitation/replacement of water distribution network	field inspections, consultations with council and investigations in other towns	1	-	-	-	378,500	378,500	-	-	-	-	-	-	-	-	-	-	-	-	757,000
		A.2	Replacement/Installation of section valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	44,100	44,100	-	-	-	-	-	-	-	-	-	-	-	-	88,200
		A.3	Installation of bulk meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	51,500	51,500	-	-	-	-	-	-	-	51,500	51,500	-	-	-	206,000
		A.4	Rehabilitating/Installation of pressure reducing valves	field inspections, consultations with council and investigations in other towns	1	-	-	-	35,000	35,000	-	-	-	-	-	-	-	35,000	35,000	-	-	-	140,000
		A.5	Replacement of service connections	field inspections, consultations with council and investigations in other towns	1	-	-	-	162,500	162,500	-	-	-	-	-	-	-	-	-	-	-	-	325,000
		A.6	Replacement of service water meters	field inspections, consultations with council and investigations in other towns	1	-	-	-	950,000	950,000	-	-	254,912	254,912	254,912	2,154,912	254,912	254,912	254,912	452,157	452,157	452,157	6,940,857
		A.7	NRW Reduction programme	field inspections, consultations with council and investigations in other towns	1	-	-	-	45,000	45,000	-	-	-	-	-	-	-	-	-	-	-	-	90,000
B	**Water Supply Service Improvements**					-	-	-	1,216,125	1,216,125	-	-	-	-	-	-	-	253,425	253,425	-	-	-	2,939,100
		B.1	Rehabilitation of RUWA WTW	Condition assessments	1	-	-	-	1,216,125	1,216,125	-	-	-	-	-	-	-	253,425	253,425	-	-	-	2,939,100
C	**Extension of Water Supply Services**					1,140,326	1,140,326	1,140,326	3,226,576	3,226,576	1,140,326	1,140,326	881,142	881,142	881,142	881,142	881,142	9,860,142	9,860,142	881,142	881,142	881,142	38,924,205
		C.1	Proposed RUWA WTW Expansion	Discusions with local authority	2	-	-	-	531,250	531,250	-	-	-	-	-	-	-	-	-	-	-	-	1,062,500
		C.2	Distribution System Expansion	Design guidelines, hydraulic modelling	3	-	-	-	1,315,000	1,315,000	-	-	-	-	-	-	-	979,000	979,000	-	-	-	4,588,000
		C.3	Construction of new Storage Reservoirs	Design guidelines, hydraulic modelling	2	-	-	-	100,000	100,000	-	-	-	-	-	-	-	8,000,000	8,000,000	-	-	-	16,200,000
		C.4	Extension of Distribution System in Expansion areas	Discusions with local authority	3	1,140,326	1,140,326	1,140,326	1,140,326	1,140,326	1,140,326	1,140,326	881,142	881,142	881,142	881,142	881,142	881,142	881,142	881,142	881,142	881,142	16,793,705
		C.5	Other new bulk water management	Hydraulic Modelling	1	-	-	-	140,000	140,000	-	-	-	-	-	-	-	-	-	-	-	-	280,000
D	**Sewerage Service Improvements**					-	-	-	1,141,457	1,141,457	-	-	-	-	-	-	-	830,188	830,188	-	-	-	3,943,289
		D.1	Decommissioning of Wastewater Stabilisation Ponds	Condition assessments	3	-	-	-	565,125	565,125	-	-	-	-	-	-	-	-	-	-	-	-	1,130,250
		D.2	Decommissioning of Sewage Pump Stations	Condition assessments	3	-	-	-	109,400	109,400	-	-	-	-	-	-	-	-	-	-	-	-	218,800
		D.3	Rehabilitation/replacement of existing sewer network		3	-	-	-	466,932	466,932	-	-	-	-	-	-	-	830,188	830,188	-	-	-	2,594,239
E	**Extension of Sewerage Services**					1,501,743	1,501,743	1,501,743	8,724,513	8,724,513	1,501,743	1,501,743	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	3,532,140	3,532,140	1,130,420	1,130,420	1,130,420	41,065,384
		E.1	Ruwa Northern Expansion	Wastewater flow calculations & hydraulic analysis	3	-	-	-	1,255,311	1,255,311	-	-	-	-	-	-	-	356,000	356,000	-	-	-	3,222,623
		E.2	Ruwa Southern and Ward 4 Expansion	Wastewater flow calculations & hydraulic analysis	3	-	-	-	313,765	313,765	-	-	-	-	-	-	-	106,320	106,320	-	-	-	840,170
		E.3	Ruwa Eastern Expansion	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	222,815	222,815	-	-	-	445,630
		E.4	New Ruwa WWTW Ponds and Lift Pump Station	Wastewater flow calculations & hydraulic analysis	2	-	-	-	5,653,693	5,653,693	-	-	-	-	-	-	-	82,500	82,500	-	-	-	11,472,387
		E.5	Ruwa Outfall to Lyndhurst Farm / HSTS	Wastewater flow calculations & hydraulic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	1,634,084	1,634,084	-	-	-	3,268,169
		E.6	Extension of sewer reticulation system in new development areas	Population growth calculations	3	1,501,743	1,501,743	1,501,743	1,501,743	1,501,743	1,501,743	1,501,743	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	1,130,420	21,816,406
F	**Accompanying Measures**					264,207	744,207	384,207	2,877,127	2,025,527	264,207	264,207	226,647	226,647	226,647	416,647	226,647	1,481,731	1,481,731	246,372	246,372	246,372	11,849,504
		F.1	Technical operations management		1	-	-	-	430,000	-	-	-	-	-	-	-	-	-	-	-	-	-	430,000
		F.2	Information Communication Technology Infrastructure		1	-	-	-	176,600	-	-	-	-	-	-	-	-	-	-	-	-	-	176,600
		F.3	Commercial operations management		1	-	-	-	350,000	-	-	-	-	-	-	-	-	-	-	-	-	-	350,000
		F.4	Management, commercial and technical information systems		1	-	-	-	83,000	-	-	-	-	-	-	-	-	-	-	-	-	-	83,000
		F.5	Professional services - Institutional Support		1	-	480,000	120,000	240,000	428,000	-	-	-	-	-	-	-	-	-	-	-	-	1,268,000
		F.6	Professional services - Feasibility, Design and Supervision		0	264,207	264,207	264,207	1,597,527	1,597,527	264,207	264,207	226,647	226,647	226,647	416,647	226,647	1,481,731	1,481,731	246,372	246,372	246,372	9,541,904
				Contingencies		924,724	924,724	924,724	5,591,345	5,591,345	924,724	924,724	793,266	793,266	793,266	1,458,266	793,266	5,186,057	5,186,057	862,302	862,302	862,302	33,396,662
				Total		3,831,001	4,311,001	3,951,001	24,443,743	23,592,143	3,831,001	3,831,001	3,286,388	3,286,388	3,286,388	6,041,388	3,286,388	21,485,095	21,485,095	3,572,393	3,572,393	3,572,393	140,665,201
				Cumm. Total		3,831,001	8,142,003	12,093,004	36,536,747	60,128,889	63,959,891	67,790,892	71,077,280	74,363,667	77,650,055	83,691,443	86,977,831	108,462,926	129,948,021	133,520,415	137,092,808	140,665,201	

Engineering Services	10%	of physical works (A+B+C+D+E)
Contractor's P&G and Physical contingencies	35%	of physical works (A+B+C+D+E)
Inflation	0%	

Prioritised Investment Summary - Ruwa

Priority	Description			Sub Total	Priority	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Repair and Rehabilitation and Restoration of Service**					-	480,000	120,000	5,662,551	4,810,951	-	-	369,623	369,623	369,623	3,124,623	369,623	862,514	862,514	655,628	655,628	655,628	19,368,528
				Works and Goods	1	-	480,000	120,000	4,302,325	3,450,725	-	-	254,912	254,912	254,912	2,154,912	254,912	594,837	594,837	452,157	452,157	452,157	14,073,757
				Engineering Professional Services		-	-	-	302,273	302,273	-	-	25,491	25,491	25,491	215,491	25,491	59,484	59,484	45,216	45,216	45,216	1,176,616
				P&G and Contingency		-	-	-	1,057,954	1,057,954	-	-	89,219	89,219	89,219	754,219	89,219	208,193	208,193	158,255	158,255	158,255	4,118,155
2	**Priority 2 Projects - Meet Environmental Commitments**					-	-	-	9,113,168	9,113,168	-	-	-	-	-	-	-	11,719,625	11,719,625	-	-	-	41,665,586
				Works and Goods	2	-	-	-	6,284,943	6,284,943	-	-	-	-	-	-	-	8,082,500	8,082,500	-	-	-	28,734,887
				Engineering Professional Services		-	-	-	628,494	628,494	-	-	-	-	-	-	-	808,250	808,250	-	-	-	2,873,489
				P&G and Contingency		-	-	-	2,199,730	2,199,730	-	-	-	-	-	-	-	2,828,875	2,828,875	-	-	-	10,057,210
3	**Priority 3 Projects - Water and Sanitation Coverage Expansions**					3,831,001	3,831,001	3,831,001	9,668,023	9,668,023	3,831,001	3,831,001	2,916,765	2,916,765	2,916,765	2,916,765	2,916,765	8,902,956	8,902,956	2,916,765	2,916,765	2,916,765	79,631,088
				Works and Goods	3	2,642,070	2,642,070	2,642,070	6,667,602	6,667,602	2,642,070	2,642,070	2,011,562	2,011,562	2,011,562	2,011,562	2,011,562	6,139,970	6,139,970	2,011,562	2,011,562	2,011,562	54,917,991
				Engineering Professional Services		264,207	264,207	264,207	666,760	666,760	264,207	264,207	201,156	201,156	201,156	201,156	201,156	613,997	613,997	201,156	201,156	201,156	5,491,799
				P&G and Contingency		924,724	924,724	924,724	2,333,661	2,333,661	924,724	924,724	704,047	704,047	704,047	704,047	704,047	2,148,989	2,148,989	704,047	704,047	704,047	19,221,297

9.4.6 Greater Harare

For Greater Harare the total required investment between now and 2030 is US$2,225 million split US$863 million in short term investment measures focused mainly on rehabilitation of existing infrastructure and meeting environmental standards and US$1,363 million in longer term investments in expansion.

In the short term the majority of the expenditure is on repair and rehabilitation to existing water networks. The only significant 'new' works in the short term is the first phase of the Kunzvi Scheme and.

In the long term the Kunzvi scheme and the Harare South Trunk Sewer and associated treatment works dominate the cost estimates.

Of the 'expansion' measures there is an approximately 60:40 split between expansion in tertiary water and sewer networks, traditionally carried out by private developers and primary and secondary infrastructure provided by the utility.

The cost per connection implications for each town and greater Harare as a whole are presented below. Total investment between now and 2030 is $2,900 for Greater Harare and ranges between a high of $3,600 and a low of $1,850 in the individual towns. Towns which have their bulk water and sewage treatment needs met by Harare (Epworth, and Chitungwiza) require significantly lower investment than those that meet more of their own needs. Ruwa and Norton's higher initial costs reflect the need for the towns to make significant investment in sewage treatment and disposal, this cost being distributed in the table amongst the existing connections and not the expansions.

Table 9-4: Summary of Cost Per Connection by Town (US$)

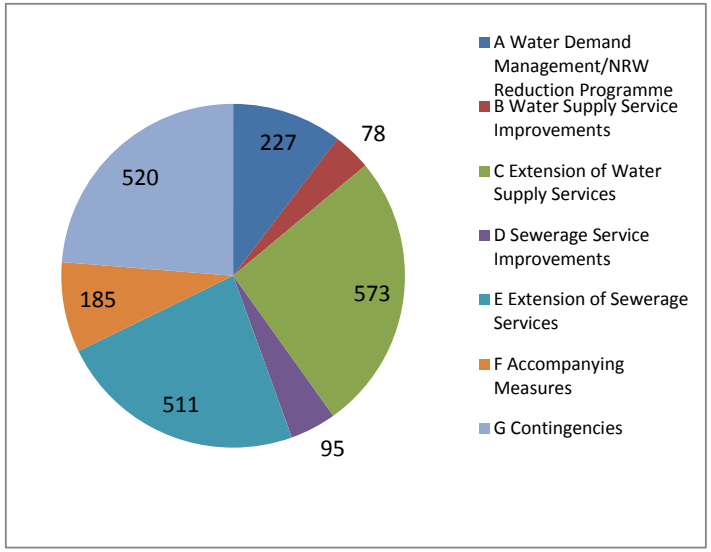
Investment Measures	Greater Harare	Harare	Chitungwiza	Epworth	Norton	Ruwa
Total investment per Connection	2,900	3,000	1,850	2,000	3,600	3,600
Repair and rehabilitation and environmental commitments cost per existing connection	2,400	2,500	1,200	1,000	3,700	3,700
Expansion cost per connection added	3,400	3,400	2,800	3,100	3,600	3,600

The investments are summarised in the tables on the following pages.

Figure 9-11: Overview of Investment Programme - Greater Harare

Summary of Greater Harare Investments by Category

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
A	Water Demand Management/NRW Reduction Programme	227	121	107
B	Water Supply Service Improvements	78	29	48
C	Extension of Water Supply Services	573	181	393
D	Sewerage Service Improvements	95	57	38
E	Extension of Sewerage Services	511	157	354
F	Accompanying Measures	185	91	94
G	Contingencies	520	191	329
Total		**2,190**	**827**	**1,363**
	Reticulation to new development areas	828	205	623
		38%	25%	46%



Summary of Greater Harare Investments by Priority

Item	Description	Total Investment US$ (million)	Investment to 2020 US$ (million)	Investment 2021-2030 US$ (million)
1	Priority 1 Projects - Repair and Rehabilitation and Restoration of Service	580	312	268
2	Priority 2 Projects - Meet Environmental Commitments	327	141	186
3	Priority 3 Projects - Water and Sanitation Coverage Expansions	1,282	373	909
Total		**2,189**	**827**	**1,363**

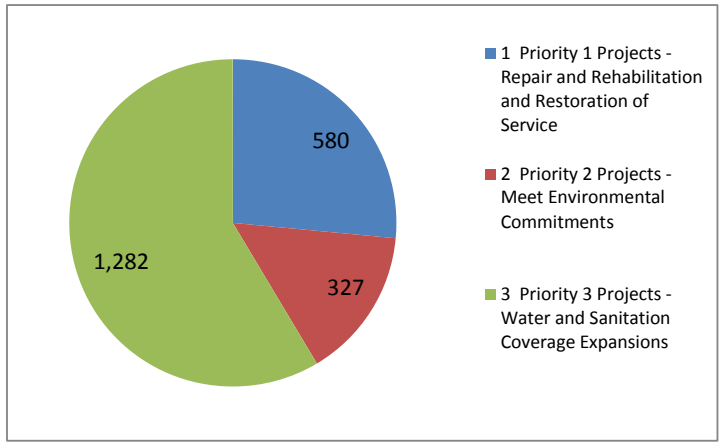


Figure 9-12: Summary of Investment Programme - Greater Harare

Investment Components and Capital Expenditure Programme - GREATER HARARE

Item	Category	Ref. No.	Component	Source	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
A	Water Demand Management/NRW Reduction Programme				-	-	-	36,394,043	36,394,043	23,904,070	23,904,070	15,824,561	817,241	2,400,491	28,035,491	12,880,491	13,503,191	13,503,191	7,154,823	5,571,573	7,154,823	227,442,098
B	Water Supply Service Improvements				-	-	-	14,675,407	14,675,407	-	-	-	-	-	-	-	24,191,576	24,191,576	-	-	-	77,733,966
C	Extension of Water Supply Services				9,849,662	9,849,662	9,849,662	23,824,580	23,824,580	51,696,507	51,696,507	61,147,435	19,300,590	19,300,590	19,300,590	19,300,590	78,470,762	78,470,762	58,657,257	19,300,590	19,300,590	573,140,915
D	Sewerage Service Improvements				-	-	-	22,189,002	22,189,002	6,355,567	6,355,567	6,355,567	-	-	-	-	15,774,756	15,774,756	-	-	-	94,994,218
E	Extension of Sewerage Services				10,298,767	10,298,767	10,298,767	52,842,432	52,842,432	10,298,767	10,298,767	23,689,778	23,689,778	23,689,778	23,689,778	23,689,778	65,571,582	65,571,582	57,073,889	23,689,778	23,689,778	511,224,195
F	Accompanying Measures				2,014,843	8,981,643	6,374,843	27,118,729	20,307,929	13,225,491	13,225,491	10,701,734	4,380,761	4,539,086	7,102,586	5,587,086	19,753,162	19,753,162	12,288,597	4,856,194	5,014,519	185,225,854
				Contingencies	7,051,950	7,051,950	7,051,950	52,583,751	52,583,751	32,289,219	32,289,219	37,456,069	15,332,663	15,886,800	24,859,050	19,554,800	69,136,066	69,136,066	43,010,089	16,996,679	17,550,817	519,820,890
				Total	29,215,221	36,182,021	33,575,221	229,627,944	222,817,144	137,769,620	137,769,620	155,175,144	63,521,033	65,816,745	102,987,495	81,012,745	286,401,094	286,401,094	178,184,654	70,414,814	72,710,526	2,189,582,137
				Cumm. Total	29,215,221	65,397,242	98,972,463	328,600,408	551,417,552	689,187,173	826,956,793	982,131,937	1,045,652,969	1,111,469,714	1,214,457,209	1,295,469,954	1,581,871,048	1,868,272,142	2,046,456,797	2,116,871,611	2,189,582,137	

1

Engineering Services	of physical works (A+B+C+D+E)	2
Contractor's P&G and Physical contingencies	of physical works (A+B+C+D+E)	3
Inflation		4
		5

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Prioritised Investment Summary - GREATER HARARE

Priority	Description			Sub Total	2014 [USD]	2015 [USD]	2016 [USD]	2017 [USD]	2018 [USD]	2019 [USD]	2020 [USD]	2021 [USD]	2022 [USD]	2023 [USD]	2024 [USD]	2025 [USD]	2026 [USD]	2027 [USD]	2028 [USD]	2029 [USD]	2030 [USD]	Total [USD]
1	**Priority 1 Projects - Repair and Rehabilitation and Restoration of Service**				-	6,966,800	4,360,000	106,083,573	99,272,773	47,876,474	47,876,474	32,161,185	1,184,999	3,480,711	40,651,461	18,676,711	71,395,708	71,395,708	10,454,243	8,078,781	10,374,493	580,290,095
				Works and Goods	-	6,966,800	4,360,000	76,914,644	70,103,844	34,259,637	34,259,637	22,180,128	817,241	2,400,491	28,035,491	12,880,491	49,238,419	49,238,419	7,209,823	5,571,573	7,154,823	411,591,459
				Engineering Professional Services	-	-	-	6,481,984	6,481,984	3,025,964	3,025,964	2,218,013	81,724	240,049	2,803,549	1,288,049	4,923,842	4,923,842	720,982	557,157	715,482	37,488,586
				P&G and Contingency	-	-	-	22,686,945	22,686,945	10,590,873	10,590,873	7,763,045	286,034	840,172	9,812,422	4,508,172	17,233,447	17,233,447	2,523,438	1,950,051	2,504,188	131,210,050
2	**Priority 2 Projects - Meet Environmental Commitments**				-	-	-	70,577,230	70,577,230	-	-	2,002,960	2,002,960	2,002,960	2,002,960	2,002,960	60,575,495	60,575,495	50,409,922	2,002,960	2,002,960	326,736,096
				Works and Goods	-	-	-	48,673,952	48,673,952	-	-	1,381,352	1,381,352	1,381,352	1,381,352	1,381,352	41,776,204	41,776,204	34,765,463	1,381,352	1,381,352	225,335,239
				Engineering Professional Services	-	-	-	4,867,395	4,867,395	-	-	138,135	138,135	138,135	138,135	138,135	4,177,620	4,177,620	3,476,546	138,135	138,135	22,533,524
				P&G and Contingency	-	-	-	17,035,883	17,035,883	-	-	483,473	483,473	483,473	483,473	483,473	14,621,671	14,621,671	12,167,912	483,473	483,473	78,867,333
3	**Priority 3 Projects - Water and Sanitation Coverage Expansions**				29,215,221	29,215,221	29,215,221	52,825,920	52,825,920	89,893,147	89,893,147	121,010,998	60,333,073	60,333,073	60,333,073	60,333,073	154,421,004	154,421,004	117,320,490	60,333,073	60,333,073	1,282,255,729
				Works and Goods	20,148,428	20,148,428	20,148,428	36,431,669	36,431,669	61,995,273	61,995,273	83,455,861	41,609,016	41,609,016	41,609,016	41,609,016	106,497,244	106,497,244	80,910,683	41,609,016	41,609,016	884,314,296
				Engineering Professional Services	2,014,843	2,014,843	2,014,843	3,643,167	3,643,167	6,199,527	6,199,527	8,345,586	4,160,902	4,160,902	4,160,902	4,160,902	10,649,724	10,649,724	8,091,068	4,160,902	4,160,902	88,431,430
				P&G and Contingency	7,051,950	7,051,950	7,051,950	12,751,084	12,751,084	21,698,346	21,698,346	29,209,551	14,563,156	14,563,156	14,563,156	14,563,156	37,274,035	37,274,035	28,318,739	14,563,156	14,563,156	309,510,004

CHAPTER 10: IMPLEMENTATION CONCEPT

10 IMPLEMENTATION CONCEPT

10.1 Introduction

This chapter outlines the implementation road map for the investment plan. The road map makes several assumptions regarding modes of implementation, sources of funds and the imminent institutional reforms espoused in the National Water Policy.

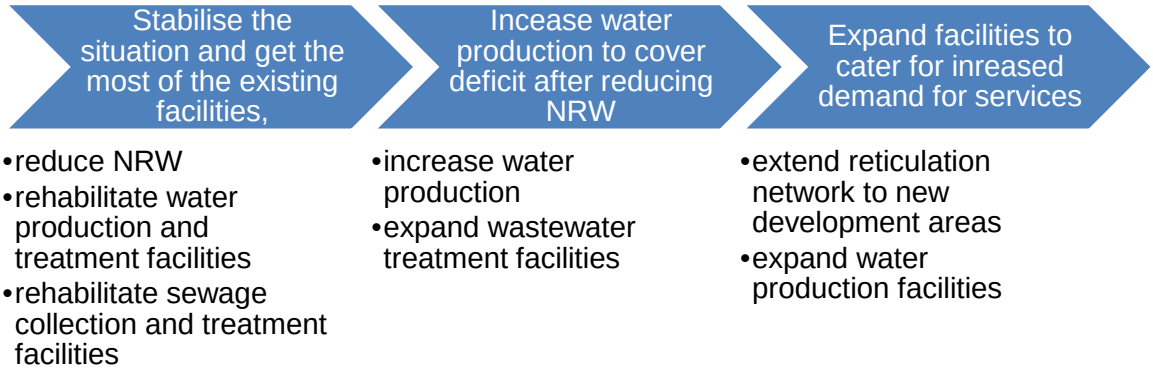
10.2 Key Assumptions

In developing this implementation road map, we have made the following key assumptions:

- Some form of concessionary finance will be available for the implementation of the initial projects in the medium term;
- The institutional arrangements for water and sanitation services in the Greater Harare area will evolve towards an autonomous utility service provider as recommended in the National Water Policy;
- The water utility will be viable enough to attract financing for the investment requirements in the long term (2020 to 2030);
- Electromechanical equipment and devices such as water meters shall be replaced periodically given their relatively short economic life. We assumed that bulk and domestic water meters shall be replaced every Seven (7) years. Pump sets and other electromechanical equipment shall be replaced after Fifteen (15) years;

10.3 Proposed Sequencing of Investment Measures

The sequencing of investment measures should be as illustrated in the figure below.



The first wave of investments should focus on institutional reforms, reduction of NRW and rehabilitation of existing water and sewerage infrastructure. The second wave of investments will focus on increasing water production to bridge the demand gap after reducing NRW to economically feasible levels. The third wave of investments should expand facilities to cater for increased demand due to population and economic growth.

Given the proposed sequencing framework above, the investment measures can be grouped into three main project clusters as follows:

- The medium term investment projects (mainly rehabilitation measures);
- The Kunzvi project Phase I (to increase water production);

- The long term projects (expansion of water production and wastewater treatment facilities).

The following section outlines the timing of the envisaged implementation activities up to 20130.

10.4 Implementation Road Map

The investment plan is expected to be finalised in the second quarter of 2014 after a comprehensive consultative process with all relevant stakeholders. It is assumed that the acceptance of the investment plan report will signify ratification and intent to implement the investment plan. We assume that the internal consultations and initial discussions around financing arrangements will take place in the second quarter of 2014. The second half of 2014 has been set aside for the project appraisal process and finalisation of financing agreements.

Besides the above mentioned activities, it is imperative that the proposed institutional reforms are set in motion to ensure that, by the time investments in infrastructure are completed in 2018, an appropriate institutional arrangement that ring-fences revenue from water supply and sewerage assets, is in place. Going by the pronouncements in the National Water Policy, we believe that there is sufficient political will to transform the water sector and that the necessary reforms will start in time to safeguard the proposed investments.

Actual planning (feasibility study) and design work for the medium term projects is expected to start in the first quarter of 2015 so that the designs and tender documents can be completed by the fourth quarter of 2015. The entire 2016 has been set aside for the process of procuring construction services. The actual implementation of the projects is envisaged to start in the first quarter of 2017. Construction will continue for two years until the end of 2018. Thereafter, the traditional liability period will kick in for another year until the end of 2019. The facilities will be completely handed over to presumably well streamlined “water utility” for operation by end of 2019.

The Kunzvi phase I project is expected to start with a review of the studies and final designs done in 1998. This scheme will involve construction of a new dam, which may be under the jurisdiction of ZINWA. Hence the necessary inter-institutional talks and preparations must start well in advance. Actual construction is expected start in 2019 for three years until 2022.

It is assumed that the new water utility will have adequate human resource and financial capacity to continue with the implementation of the periodic investment measures such as replacement of aging water meters. This assumption hinges on a further assumption that the water tariffs will have been revised to reflect the true cost of service provision and that the institutional reforms will have been completed. Extension of the water and sewerage reticulation system to new development areas will be financed and implemented by private developers.

The long term projects are slated for implementation in the years 2026 and 20207. The studies, planning and design should start two years earlier to provide adequate time for the sometimes lengthy process of procuring contractors. It should also be noted that the construction of the Kunzvi phase II is envisaged to be part of the long term projects.

The critical path of activities is shown in Figure 10-1, while the detailed implementation schedule is presented in Figure 10-2.

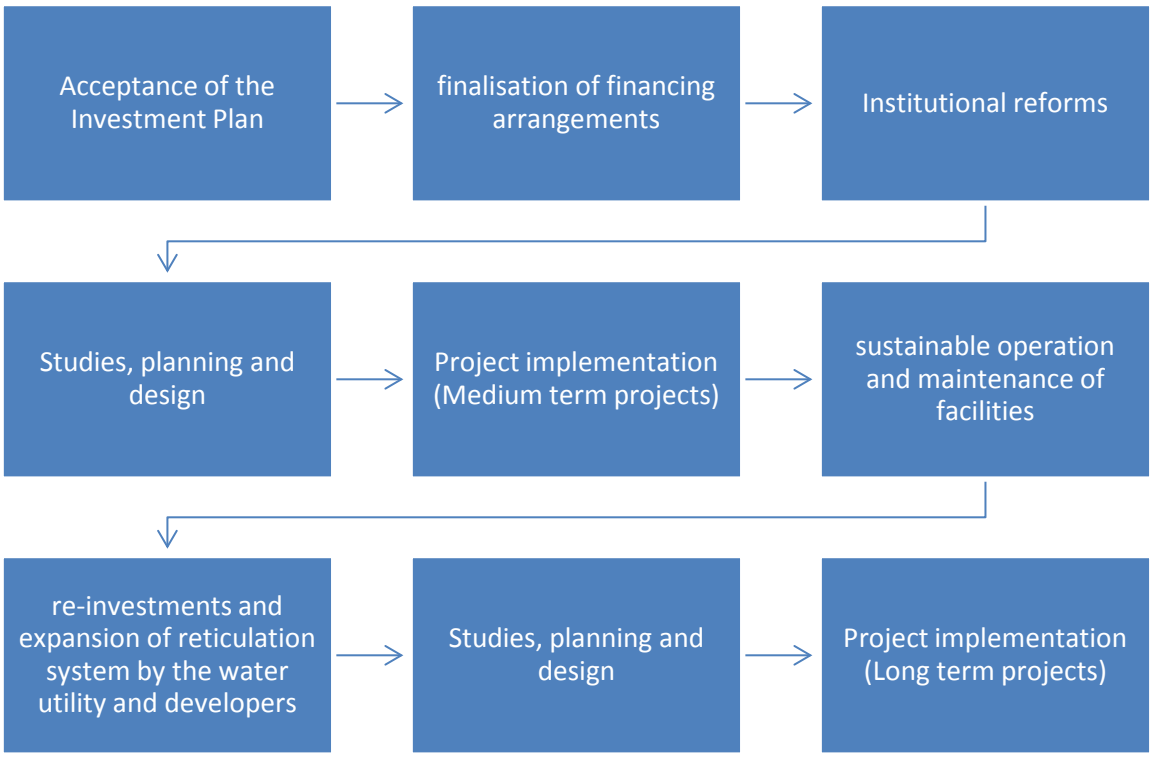


Figure 10-1: Critical Path Activities

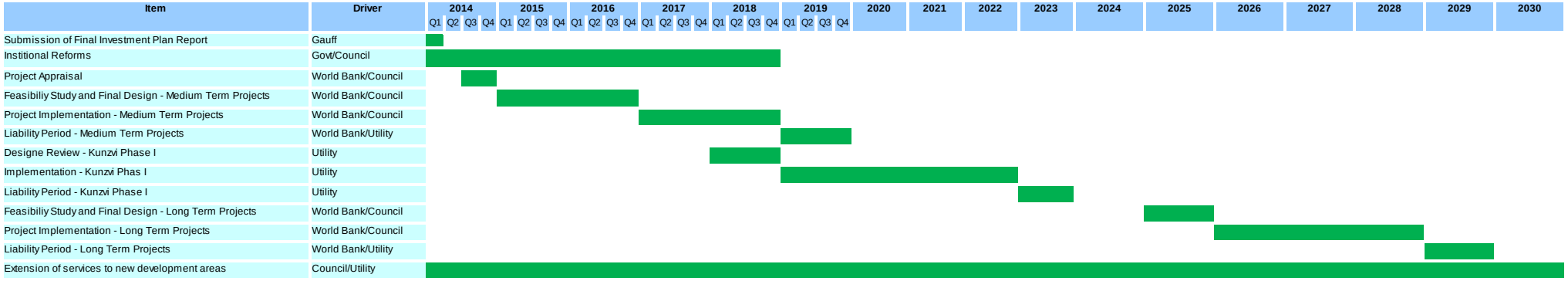


Figure 10-2: Investment Plan Implementation Schedule

10.5 Critical Success Factors for Implementation

The critical success factors for the implementation of the investment plan are presented in the table below.

Table 10-1: Critical Success Factors

Critical success factor	Main key player	Recommended action to influence factor
Institutional reforms to ring-fence water supply and sanitation services are implemented	Government of the Republic of Zimbabwe	Detailed operational development study and implementation plan to ensure that structures are in place: • 2018 WSS Utility
There is willingness and consensus among donors and other financiers to finance the medium term project	Donors, Consultant	Consultant prepares a bankable investment plan with good justification for implementation. Good project appraisal with strong justification by the World Bank
Utility develops capacity for efficient management of water supply and sanitation services	WB/Zim-Fund/Council	Implementation of the recommended training of trainers
Tariff study carried out and recommendations implemented to ensure cost covering tariff.	Government of the Republic of Zimbabwe/Council	Council should actively lobby government to seriously consider setting sustainable tariffs for water and sewerage services.
The Councils (eventually, utility) must own the investment plan and actively source funds (internally or externally) to finance implementation	Council/Water Utility	Council should actively lobby government to speed up institutional reforms

CHAPTER 11: FINANCIAL ANALYSIS

11 FINANCIAL ANALYSIS

11.1 Objective and Output of the Financial Analysis

The main objective of the financial analysis contained in this chapter is to provide a measure of the entity's financial sustainability. The output of the financial analysis is a utility based financial model, providing forecasts of income statements, annual and cumulative cash flows and (simplified) balance sheet over the project evaluation period that include the effects of an investment plan scenario. The financial analysis provides a means of judging the entity's financial viability under the various investment plan scenarios considered.

11.2 Approach and Methodology

In line with the objectives and outputs outlined in the previous section, the general approach of the financial analysis is to firstly identify and quantify all relevant cost/expenditures and revenues over the project horizon, i.e. to 2030, and capture these vide a commonly used spreadsheet application (Excel). The second step of the analysis allocates the relevant annual data to a simplified income statement, which is subsequently used as the first line item for a consolidated annual cash flow statement followed by a simplified balance sheet linked to the investment asset source sheet and aforementioned financial analyses. A schematic overview of the general approach is shown in figure 11.1.

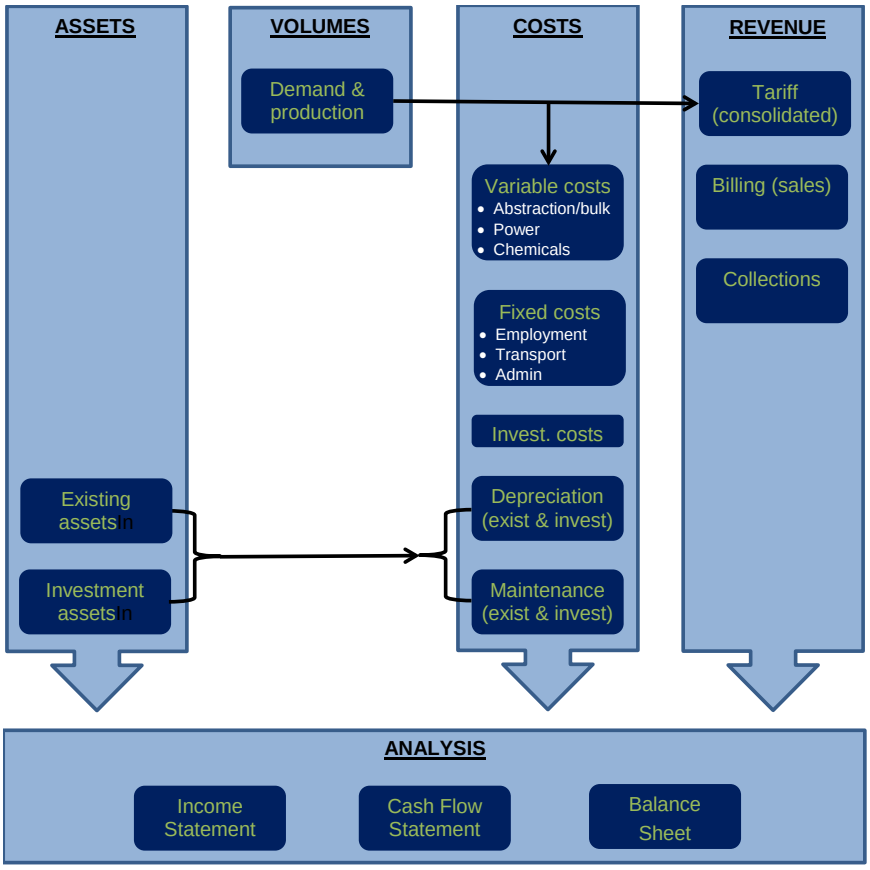


Figure 11-1: Outline Approach Schematic of the Financial Model

These financial statements are specific to water and sanitation activities performed by the entity and form the main analysis tool to determine its financial viability. As such, the analysis effectively isolates and theoretically ring-fences the flow of funds paid and

received for water and sewerage from the council' other financial obligations (related to roads, health, education, etc.).

In fulfilment of the first step, the costs and revenues identified and quantified in the financial model are listed in the following:

Costs

Operating Costs broken down into:

- Fixed Costs comprising:
    - Personnel costs including allowances, bonuses, statutory payments derived from an elementary breakdown of staffing numbers by grade, salary scales to arrive at the net payroll on top of which allowances, pension and bonuses (including other gratuities) are added as a proportion of salaries. An item referred as allocation to WSS adjusts the gross payroll to take into account the existence of vacancies and recharges for staff deployed not only exclusively for water/sewerage but also in other departments of the council;
    - Transport costs are derived from the number of units, distinguishing between vehicles, motorcycles and heavy vehicles/machinery, average distance travelled annually and average consumption costs (litres/ 100 km);
    - Other administrative costs including insurance, office stationary, utilities and maintenance, professional and legal fees (e.g. audit) based on a percentage of calculated personnel costs,
    - Maintenance and repair of existing assets and planned investment assets based on a percentage of their current value;
- Variable Costs

  The following are calculated on the basis of a unit cost linked to raw water abstraction or volumes of water produced, whichever applicable.
    - Raw water abstraction charges payable to the Zimbabwe National Water Authority (ZINWA) for the abstraction of raw water representing a natural resource;
    - Chemicals for both treatment (aluminium sulphate and lime) and disinfection (chlorine) purposes;
    - Power used primarily for pumping raw and/or clear water and sewage[1];
- Capital and Financial Costs for the various investment loans identified, namely the existing Exim Bank loan (CMEC) and the anticipated loan for the investment plans subject to this report.
    - Repayment of principal loan as a constant amount over the period of the loan reducing the balance annually;
    - Capital charges[2], which for the purpose of this financial analysis is equal to the interest on the reducing balance of the loan, applying an assumed rate of interest.

1 The overall power required to pump sewage in relation to that for water is considered negligible overall.

2 Capital Charge: the cost of capital (opportunity cost of capital) times the amount of invested capital.

- Depreciation on existing assets and investment measures used to adjust the income statement to reflect capital items;

Revenues

- Sales and collections for volumes of water supplied in bulk. This is applicable to Harare Water under the current organisational setup, which would become obsolete once the satellite towns to which bulk water is supplied become part of the entity.
- Income (sales) and cash collections for water sold to the entities direct customers with water and sewer connections, referred to as retail sales and collections. For purposes of this project the value of sales and collections for the provision of services in relation to sewerage is combined with water sales through the application of a combined and single water and sewerage tariff.

While the relationship between the production of water and water sales is determined by the billing efficiency (inverse of Non-Revenue Water) and the tariff, the relationship and ultimately the value of the cash collections is determined by the collection efficiency. Although this determines the significant portion of the receivables collected, the model also includes the collection of a small portion of old debt (after 3 years) to quantify the efforts and effects of anticipated debt collection to improve overall collections.

Having identified and quantified the aforementioned cost and revenue streams these are used to forecast three financial analyses over the project's evaluation period. Firstly, an income statement to ascertain the gross margin and accounting profit of the water and sewerage specific enterprise; secondly, an annual cash flow statement to assess the financial sustainability and determine the cash liquidity both in terms of net annual cash surpluses/(deficits) and cumulative cash position; and thirdly a simplified balance sheet to estimate the entities position of assets and liability. The outline methodology applied to arrive at these three financial reports is presented in the following set of tables.

Table 11-1: Methodology Adopted for Annual Income Statement

Line Item	Notes
Revenue[1)] from: • sales of water • sales of sewerage services • other billing	1) The billing is based on the volume of water sold to residential and non-residential use, based on average unit costs (combining fixed and unit charges)
Cost streams • Operation – fixed costs • Operation – variable costs • Maintenance[2)] • Capital charges[3)]	2) Based on assumed percentage of asset values – see next section for assumptions. 3) Use assumed interest on loan
Surplus/(Deficit)	Income – costs
Adjusted Income statement • Total income • Adjusted Expenditure[4)]	4) Add straight line depreciation based on 2013 value of asset and economic life Provision for bad debt equal to the value of uncollected cash, i.e. the difference between billing and actual cash collection for each respective year.
Adjusted Surplus/(Deficit)	This profit/(loss) item is carried forward to the cash flow statement

Table 11-2: Methodology Adopted for Annual Cash Flow Statement

Line Item	Notes
Cash flow from operating activities • Surplus/(Deficit) from Income statement • Adjust for non-cash items[1)]	1) Remove (subtract) depreciation and provision for bad debt/write-off
Adjust for change in working capital • (Increase)/decrease in debtors[2)] • Increase/(Decrease) in creditors[3)]	2) Based on the difference between sales and collection. 3) See assumptions below equating costs with expenses
Cash flow from investment items • Repayment of principal[4)]	4) Value of assets
Cash and cash equivalents	Sum of all cash flow and adjustment items above

Table 11-3: Methodology Adopted for a Simplified Annual Balance Sheet

Line Item	Notes
Assets • Fixed Assets[1)] • Current assets[2)]	1) Value of existing assets as at base year and estimated current value of future investments (as per investment plan). 2) Short term cash (accumulated reserves/(deficit), debtors and creditors.
Equity and liabilities • Liabilities[3)] • Increase/(Decrease) in creditors[3)]	3) Balance on long term loans. 4) Difference of total assets and (less) long balance of long term loans

The rationale behind this analysis approach is to assess the financial sustainability in terms of the entity responsible for the provision of water and sewerage services, net of any other current financial transactions related to other activities provided under the current council set up.

The above analysis is carried out for each of the entities considered in this project, namely, Harare, Epworth, Norton, Ruwa, Chitungwiza and finally Greater Harare, whereby the first five entities are in the form as found currently and the latter representing a clustered form of all previously mentioned organisations. For each of these entities three scenarios are considered separately (spate model file for each):

- Scenario 1: for investment priority 1 + 2 + 3;
- Scenario 2: for investment priority 1 + 2; and
- Scenario 3: for investment priority 3 only.

As mentioned above, the financial model makes use of the commonly used spreadsheet application, MS Excel, encompassing all input and output tables as summarised below:

Table 11-4: Summary of Financial Model Input and Output Tables

Table Name	Input	Output
Human Resource	• Number of staff • Salary scales • Annual increase (if any) • % allowance (of salary) • % pension (of salary) • % bonus (of salary)	• Net payroll • Gross Payroll • Cost of casuals • Annual cost of employment

Table Name	Input	Output
	• Number of casuals • Average wage rate of casuals • Allocation to WSS[3]	
Existing Assets	• Construction cost (2013 value) • Year of construction • Economic life • Asset category (civil,, pipework, M&E);	• Asset value totals and sub-totals • Depreciation (ideal) • Maintenance cost (ideal) • Depreciated residual costs (DRC)
Investment Assets	• Disbursements • Split of funding options (grant/loan) • Depreciation	• Funding summary
Costs	• Water demand • Production capacity • Production losses (%) • Proportion of bulk water sold/ received • Adjustment of depreciation • Unit bulk water cost • Unit abstraction cost and adjustment to payment rate • Unit power cost (KWh) • Unit chemical costs and dosing • Transport units & fuel price • Proportion of admin/employment costs (%) • Adjustment of maintenance costs • Tariff to use vis a vis unit costs	• Disbursements on capital investments (from investment assets • Repayment of principal • Balance of loan • Interest on loan • Annual bulk water costs • Annual abstraction cost • Annual power costs • Annual chemical costs • Annual transport costs • Annual administration costs • Annual maintenance costs • Cost covering unit bulk and retail tariff (suggested)
Revenue	• Bulk water demand volumes • Proportion of water produced available for bulk sales • Non-Revenue Water • Tariff override (option) • Collection efficiency	• Revenue sales for water and sewerage • Cash collections • Payment of old debt
Financial Analysis		• Income statement including adjusted income statement • Net and cumulative cash flows • Annual balance sheets
Dashboard & Results		• Summary results in table and graph form

While key values/milestones and assumptions are dealt with in the next section, additional detail on calculation methods are provided in Annex 11 to this chapter, which furthermore presents detailed input data and results (outputs) for each entity and scenario considered.

As part of the overall approach the financial model was input and calibrated for Harare at first, aligning the key input parameters with information reported by the entity for recent

3 Having ascertained the cost of employment based on the approved establishment, the model adjusts the result to take into consideration the existence of vacancies and recharge for personnel deployed in more than one department (outside the Water and Sewerage Service sector).

years and where available for the base year[4]. The calibration exercise also included modelling of the outputs in line with reported data and realistic values anticipated by the entity. Once this was achieved, the model including the key parameters were used to model the other entities. The purpose of maintaining the same input parameters is to provide a basis for comparing the financial analysis outputs, not only for the various entities but also for the various scenarios considered.

In line with the foregoing, the methodology adopted to ascertain the effect of clustering was to firstly determine a realistic common basis of key parameters applied to all entities including the clustered option. Thereafter, the different results, particularly in relation to profitability was used to determine the relative preference. This obviously implies that the absolute outcome of the financial model of the entities (apart from Harare) may not necessarily be realistic, but serve to fulfil the main purpose of determining the comparative outcome.

11.3 Basic Parameters and Assumptions

To enable the financial analysis to be carried out, a set of basic parameters and assumptions needed to be defined and applied as outlined in the following table.

Table 11-5: Parameters and Assumptions Applied in the Financial Model

Parameter	Harare	Chitu-ngwiza	Epworth	Norton	Ruwa	**Greater Harare**
Project horizon	2013 to 2030					
Base year	2013 for all values					
Costs versus expenditure	It is assumed that all costs will be paid and hence actual expenses are assumed to be equal to costs					
Creditors	In view of late payments to creditors historically and the result of the entities uncreditworthiness costs are assumed to be equal to expenditures. Subsequently, the value of creditors is assumed to be nil, hence expenditure = costs.					
Debtors	Calculated as the difference between sales and revenue collections for the same respective year.					
Provision for bad debt	Equivalent to debtors for the respective year					
Human Resources						
• Staff grading	1 = lowest grade, 12 = highest grade					
• Scales based on	Chegutu	Chegutu	Chegutu	Chegutu	Chegutu	Chegutu plus 10%
• Allowances	30 % of salaries to account for overtime, etc.					
• Pension	10 % of salaries					
• Bonuses	8 % of salaries					
Capital costs	The capital costs used as the value of investment assets acquired and for calculations of depreciation are inclusive of: • **Preliminaries and general;** • **Consultancy for design and supervision** • **Physical** contingency of 10 %					

4 Apart from management reports (not audited), little commercial and financial data could be obtained for the base year resulting in reliance on data received through the donor for other consultancies carried out on Harare Water.

Parameter	Harare	Chitu-ngwiza	Epworth	Norton	Ruwa	Greater Harare
Unit Costs						
• Abstraction[5]	0.06	N/A	N/A	N/A	0.06	0.06
• Power 2013 (USD/m^3)	0.07	N/A	N/A	N/A	0.12	0.07
• Power 2015 (USD/m^3)	0.08	N/A	N/A	N/A	0.12	0.08
• Chemicals (USD/m^3)	0.05	N/A	N/A	N/A	0.05	0.05
• Fuel 2013 (USD/litre)	1.30	1.30	1.30	1.30	1.30	1.30
• Bulk[6] (Water/Sewerage)	N/A	W only	W+S	W+S	W+S	N/A
Depreciation	Straight line on the value/economic life: • **Civil works 60 years** • **Pipework 50 years (average for all pipes)** • **M**&E 15 years					
GHWSSIP Loan conditions	Investment items to be funded in the GHWSSIP are assumed to be 50 % grant and 50 % loan repaid over 20 years, No grace period. Interest rate = 5.0 % p.a., i.e. effective interest rate of 2.5 % p.a. (including grant element).					
CMEC Loan conditions	USD 130 million at 3.5 % p.a. interest repayable over 5 years starting 2014.					
Inflation[7]	Input costs set to increase at 0 % (real inflation).					
Maintenance Costs	Annual maintenance costs are based on the asset value and category: • 1 % for civil works • 2 % for pipework • 3 % for M&E The resulting ideal level of maintenance is gradually implemented up to 50 % to reflect current financial performance of the entities and their actual expenditure on maintenance.					
NRW reduction	Total non-revenue water is assumed to reduce equally between the set milestones in response to reforms and investment measures from the currently reported 58 % to a level of: By **2020** total NRW of **30 %** • 15 % for technical losses, plus • 15 % for commercial losses. By **2030** total NRW of **20 %** • 15 % for technical losses, plus • 5 % for commercial losses.					
Bulk Tariff	0.40 Revenue	0.40 Cost	0.40 Cost	0.40 Cost	0.40 Cost	N/A
Retail Tariff	Combined tariff starting at current average of USD 1.45, reduce overtime to milestones: By **2020:** USD 1.15 By **2030:** USD 0.90 Retail tariff reduction possible with improved revenue and collection					

5 The abstraction fees payable to ZINWA are in practice not paid as far as can be seen from the financial reports provided. It is assumed that these costs will gradually be paid as the overall level of efficiency in service delivery improves.

6 W – Water, S – Sewerage. See table with annual bulk water calculation results for more detail. Note that Ruwa produces part and receives part bulk water while Harare produces exclusively and the other satellite towns rely fully on bulk water supply.

7 While the rates of inflation are set the same for all inputs making a case to adopt nominal inflation, this was input to obtain an idea of the implied future tariffs.

Parameter	Harare	Chitu-ngwiza	Epworth	Norton	Ruwa	Greater Harare
	efficiencies anticipated.					
Collection efficiency	Based on reforms and improved service delivery: Rapid recovery from around 40 % to 70 % by 2016, then **95 %** by **2020**, and hold this level until 2030.					

Additional details on the calculation methodology and functioning of the model are provided in Appendix 11.

Further to the values and milestones presented in the foregoing, the following elaborates on the critical and key variables that determine the outcome of the model's results most.

11.3.1 Water Demand for Retail and Bulk Supply

The water demand versus supply levels of bulk water supply is obviously a current issue as production levels do not cover gross demand (including NRW) for Harare leading to shortfalls in the desired level of water required by the satellite towns. While water demand levels for Harare and the satellite areas are based on average annual demands, the current and future supply of bulk water is arrived at through an iterative process that seeks to reflect the current position and improve the situation as rapidly as possible without depriving the supply of water through a regressive trend for Harare. Despite a forecast erratic and partly reducing average demand (due to current high NRW levels) an excessive increase of bulk water supply will cause greater supply deficits in Harare which are unlikely as Harare, as in the past, has prioritised the supply of water to its residence before satisfying the demand for bulk water supply to the satellite areas. Thus, the volume of water supplied in bulk as a proportion of calculated demand for the same increases from an estimate of 50 % at present (2013), increasing gradually at a rate of 5 % annually until 100 % by 2023. Although this may appear to be considered to be slow, it should be borne in mind that there is likely to be a treatment deficit until 2017. The figure below illustrates the position described above.

This clearly shows that the gross demand (including NRW) is higher than the production capacity in the first five years and that there is likely to be a shortfall in the supply of water for either and/or bulk supply, which is addressed by the allocation/proportion of bulk water supplied.

Apart from affecting the demand satisfaction, this key decision/allocation affects the proportion of water sold at the bulk rate and the other proportion sold at the higher retail rate, though subjected to currently high water losses.

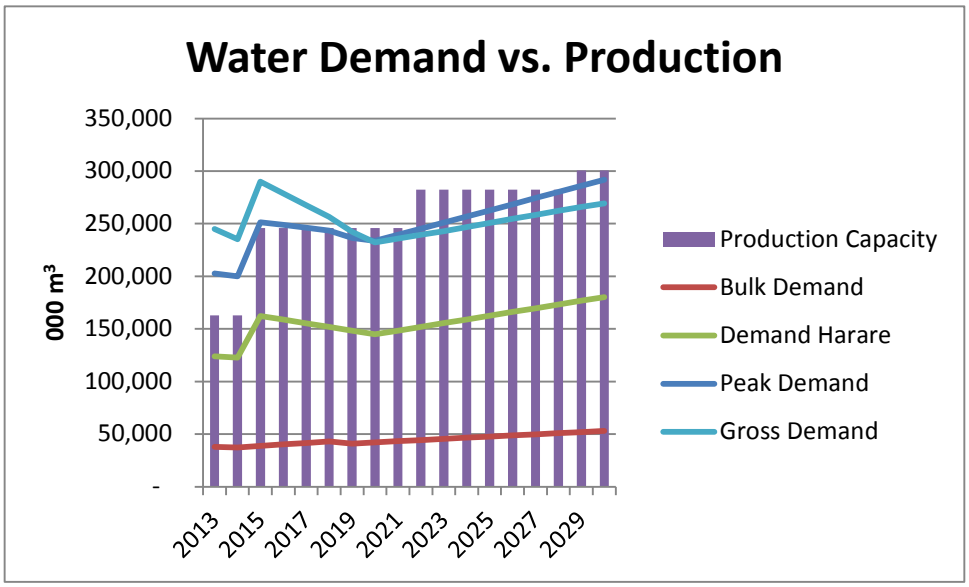


Figure 11-2: Water Demands and Production Capacities

11.3.2 Non-Revenue Water

As outlined in Table 11-5 above the current NRW for Harare is around 60 %, while NRW attributable to physical losses as used in the water demand forecasts is assumed to be 40 %. The financial model takes into account both physical and commercial losses and hence the starting point is 60 % for 2013 with gradual improvements to the agreed milestones of 30 % by 2020 and 20 % by 2030. The NRW forecasts for the periods between the base year and aforementioned milestones is calculated on the basis of a linear interpolation.

11.3.3 Bulk Tariff

Harare Water assumes a major role with regard to the supply of potable water for most residents in Harare and the satellite towns of Chitungwiza, Epworth, Norton and to a lesser extent Ruwa. Except for Chitungwiza, that operates its own sewerage treatment works, the other areas rely on Harare Water for the treatment of sewerage too. As most satellite areas do not have an alternative, this dependence on Harare can be regarded as a one-sided relationship in which Harare, being in charge of water production and sewerage treatment not only determines the level of service(s) provided but also sets the bulk tariff. On the other hand, Harare relies on the prompt payment of the satellite areas to settle costs incurred in the production of water and sewerage treatment services to be settled. This redefines the relationship in a more balanced way and supports the need to determine an affordable and cost covering bulk tariff.

The financial model calculates the average unit bulk water cost taking into consideration:

- Abstraction fees payable to ZINWA;
- 5 % production losses;
- Unit power costs based on the calculated average pumping volumes and dynamic head as well as pump efficiency and of course the cost of power (per KWh);
- Unit chemical costs calculated on the basis of expected dosing levels for flocculation, pH correction and disinfection for surface water treatment;
- 40 % of financial costs;

- 40 % of fixed costs and
- 40 % of maintenance costs.

Other than production losses, no other efficiency losses (NRW or collection) were included in the calculation for bulk water production.

As presented for each year in Appendix 11, the average bulk water tariff for the project period is USD 0.31, ranging from USD 0.25 in 2014to 0.34 by 2030. Based on the current billing and upward trend of bulk water costs as derived from the unit cost calculations and in addition recognising the occurrence of malfunctioning bulk meters and/or losses from the transmission mains, a constant bulk rate of USD 0.40 is applied in the model throughout, which is equal to the current rate charged. This rate is applied as both a cost (for the satellite areas and a unit of revenue (for Harare). Since the main concern for the satellite towns lie in the provision of bulk water rather than the tariff, which offers a potential to realise a gross margin after applying current retail charges there was insufficient reason to reduce the bulk rate.

11.3.4 Retail Tariff

The current charges for water and sewerage are made up of a combination of unit (variable) and fixed charges. Whereas water tariffs are generally charged by the unit of water sold (unless not metered or estimated), the sewerage service charges are based on the type of dwelling, size and/or number of sewerage facilities (toilets, etc.) and essentially represents a fixed charge. Although it is recommended that the tariff levels and structure is reviewed as part of a detailed tariff study to be carried out as one part of the reforms this project uses a combined simple average effective tariff derived from the total revenue received divided by the volume of water sold.

The combined tariff in the base year was assumed to be USD 1.45 based on the revenues and volumes billed reported in the current and recent years. While these are regarded as excessively high in relation to average tariffs in the region, the tariff levels are reduced as assumed improvements in the reduction of water losses are realised, in part as a result of the meter replacements and other NRW reduction activities (pipe rehabilitation) included as part of the medium term measures included in this investment plan.

The assumed combined tariff for retail water sales is expected to reduce from USD 1.45/m^3 in 2013 to 1.15/m^3 by 2020 and further to 0.90/m^3 by 2030. The overall combined tariff, (including water billed in bulk) is USD 1.20/m^3 which is expected to drop to 0.96/m^3 by 2020 and again down to USD 0.76/m^3 by 2030.

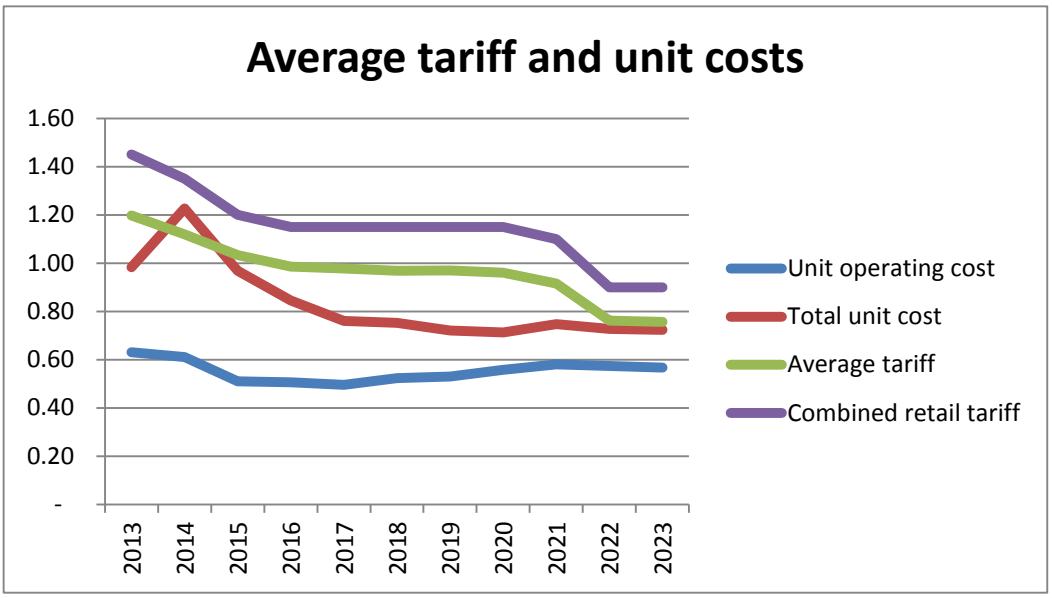


Figure 11-3: Average Tariff and Unit Costs

11.3.5 Collection Efficiency

The collection efficiencies calculated for the base year for the various entities was generally low:

- Harare: 41 %
- Epworth: 64 %
- Norton: 67 %
- Ruwa: 60 %
- Chitungwiza: 60 %.

With the anticipated reforms and associated drive to improve operational efficiencies the milestone for 2020 was set at 95 % which is expected to remain unchanged until 2030. For Harare, with the lowest current collection efficiency, this improvement rate may appear ambitious. However judging reports for previous years (2010: 73 %, 2011: 59 %, 2012: 56 %) the result for the base year appears to be an outlier and therefore it should be possible for Harare Water to achieve much improved collection efficiencies in 2014 (assumed to be 50 %) through to 2017 to increase by 10 % annually.

11.3.6 Maintenance Costs

As explained in Appendix 11 and outlined in Table 11-5 above, the calculation of maintenance costs is based on the value of existing and future investment values> However, due to the significant numbers and sizes of existing facilities and hence high value as well as the anticipated investment costs, the forecast ideal maintenance costs are high. From reports and experience as well as confirmations during field visits, the actual expenditure on maintenance and repair is considerably lower than it should be. Thus, the model adopts a gradual increase from 10 % of the calculated ideal maintenance cost to a maximum of 50 % (by 2021). This represents a gradual increase of maintenance costs from USD 2.3 million in 2013 to USD 13.8 million in 2021. By 2030 the forecast maintenance costs for Harare are estimated to be USD 19.4 million for the year.

11.3.7 Particular Adjustments for Greater Harare

To best model the situation of a clustered entity, the key parameters were based on Harare and adjusted to reflect the weigted average position. Thus, the NRW was adjusted to 55 % in 2013 and the collection efficiency to 45 % for the base year. By 2020 these efficiency levels are assumed to reach the same milestones as assumed for Harare on its own. Furhtermore, the clustering is deemed to benefit from economies of scale and thus the proportion o other administrative costs was adjusted downward from 20 % to 15 %.

11.4 Current Financial Situation

The following sections briefly summarise the financial position based on the latest available data reported by the respective councils and local boards for 2012. While this information provides an indication of the financial performance, it is not complete or in some cases reliable. Nonetheless, it provides a guide to calibrate the base year of the financial model for the individual entities.

11.4.1 Harare Water

As a starting point for the financial assessment of water and sewerage activities relating to Harare (i.e. Harare Water) as well as a foundation for the calibration of the financial model the income statement was obtained for the latest available financial year from Harare Water, 2012 as presented in the following table.

Table 11-6: Income Statement for Harare Water – 2012 (from Harare Water reports)

LINE ITEM	2012 (USD)
INCOME	
Total Income from water & sewerage sales	**64,573,983**
EXPENDITURE	
Chemicals	18,623,767
Power	19,345,564
Maintenance and Repair	10,214,335
Salaries	38,061,926
Other Expenditure	19,674,111
Total Expenditure	**105,919,703**
Surplus / Deficit	**(41,345,720)**

The financial model was calibrated to reflect a similar financial result for 2013, which was further supported with additional information received recently for part of the base year.

11.4.2 Chitungwiza Municipality

The most recent available financial information from Chitungwiza was for 2012. This was summarised in the form of a consolidated income statement as shown in the following table and used to assimilate the base year of the financial model to reflect much the same position.

Table 11-7: Income Statement for Chitungwiza - 2012

LINE ITEM	2012 (USD)
INCOME	
Collections from water sales	3,516,635
Collections from sewerage sales	1,266,102
Total Revenue	**4,782,737**
Bulk Water Charge	3,548,520
Maintenance and Repair	61,607
Salaries	1,837,739
Other Expenditure	17,233
Total Expenditure	**5,465,099**
Surplus / Deficit	**(682,362)**

Table 11.7 above indicates a deficit for 2012, which is reflected as the overall financial result for 2013 and 2014 in the financial model as no significant improvements are anticipated in the immediate years.

11.4.3 Epworth Local Board

An overall indication of the 2012 financial position (most recently available) reported by the local board of Epworth is provided in the following Table. A similar position was applied as the basis for the financial model for 2013.

Table 11-8: Income Statement for Epworth - 2012

LINE ITEM	2012 (USD)
INCOME	
Total Revenue	**40,174**
Expenditure	
Bulk Water Charge	9,600
Power	
Maintenance and Repair	3,592
Salaries	24,876
Other Expenditure	
Total Expenditure	**38,068**
Surplus / Deficit	**2,106**

The small, but nonetheless positive financial result shown in Table 11-8 above is attributed to the low expenditure on bulk water, based on the low levels of water received on the one hand and the fixed charges levied to its customers on the other. Furthermore, the noticeably low levels of expenditure reported for staff contributes towards achieving a surplus reported. The financial model adopts a technically more sustainable situation, with increasing volumes of water received and higher staffing levels with associated higher levels of remuneration. As a result the calculated income statement for 2013 is assumed to record a deficit.

11.4.4 Norton Town Council

A simple income statement for 2012 as extracted from financial data provided by Norton is shown in Table 11.8 below.

Table 11-9: Income Statement for Norton - 2012

LINE ITEM	2012 (USD)
INCOME	
Total Revenue	**1,220,532**
Expenditure	
Bulk Water Charge	597,660
Power	
Maintenance and Repair	50,832
Salaries	365,381
Other Expenditure	31,764
Total Expenditure	**1,045,637**
Surplus / Deficit	**174,895**

While the financial model adopts a similar position for 2013, it is assumed that the surplus has reduced with the adoption of a technically slightly more viable situation of increased water volumes and staffing.

11.4.5 Ruwa Local Board

For the financial year 2012 Ruwa reported a deficit on its water and sewerage operations as summarised in Table 11-10 below.

Table 11-10: Income Statement for Ruwa - 2012

LINE ITEM	2012 (USD)
INCOME	
Total Revenue	**565,224**
Expenditure	
Bulk Water Charge	203,844
Power	214,200
Maintenance and Repair	5,784
Salaries	256,380
Other Expenditure	23,412
Total Expenditure	**703,620**
Surplus / Deficit	**(138,396)**

The major expenditure items are staff, power and bulk water costs, which are not covered by current incomes from water and sewerage services.

11.5 Overall Assessment of the Current Financial Situation

Despite two entities (Epworth and Norton) reporting a surplus on their water and sewerage activities for 2012, the overall result for all five entities is less positive. This is mainly attributed to the councils and local boards inability to maintain their facilities, leave alone provide for replacement and recapitalisation as evidenced in the noticeably low levels reported for maintenance in the financial overviews provided in the foregoing. Whereas this may explain high levels of NRW it is important to recognise other challenges and shortcomings observed in one or more of the entities:

- The operation of a merged and consolidated financial system for all operations carried out by the councils and local boards, whereby billing and receipting of water and sewerage is combined with land rents and other services. It is therefore obvious that expenditure for all council and local board operations are provided

from single source and prioritised on grounds not necessarily related to technical requirements or revenues from water and sewerage. This phenomenon has been seen in other parts of the country and is believed to be responsible for the lack of re-investments and maintenance;

- Due to generally dilapidated facilities production levels and service delivery is low/poor, detrimentally affecting collection efficiencies;
- Unpredictable and low revenue collections affect payments increasing creditor balances (if goods and services sold on credit) and delaying salaries which in turn have negative effects on the reliability of suppliers and working morale of the council's and local boards staff;

Essentially, a situation prevails whereby a downward spiral is created in which service delivery is reduced affecting lower revenues which in turn reduce the already low level re-investment and maintenance of the facilities resulting in lower service delivery. It is clear that a turnaround in both the technical and financial performance is unlikely to be achieved without investments into the basic facilities responsible for the supply of potable water and sewerage collection and treatment services that form part of the entities mandate.

11.6 Funding Source

Having recognised the need to invest into the rehabilitation and expansion of water and sewerage facilities the financial model absorbs the following financing scenario that is either already implemented or anticipated based on discussions with the potential donors (World Bank and ZimFund/AfDB). As presented in the following table for scenario 1 in which all three priorities are implemented 50 % of the required funding would be provided as a grant while the other 50 % would be a loan repayable in 20 years at an interest rate of 5 % p.a. This funding is applied to the main investments excluding meter replacements and pipeline extensions, which are assumed to be financed directly by the utility (Harare Water) and passed onto private developers opening up new areas with housing for which water and sewerage services are essential.

Table 11-11: Breakdown of Investments by Funding Source

A: GHWSSIP										
FUNDING SOURCE	**FINANCE**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Grant	50%	-	-	2,000	2,000	63,207	54,539	46,679	46,679	44,679
Loan	50%	-	-	2,000	2,000	63,207	54,539	46,679	46,679	44,679
Own resources (consumer meters)	N/A	-	-	-	-	-	15,196	15,196	15,196	2,678
External private investments	N/A	-	21,726	21,726	21,726	21,726	21,726	21,726	21,726	48,235
TOTAL INVESTMENT	100%	**-**	**21,726**	**25,726**	**25,726**	**148,140**	**146,000**	**130,280**	**130,280**	**140,272**
B: Other Investments										
OTHER INVESTMENTS		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
CMEC Loan			129,600							
UWSSRP			14,200							
TOTAL OTHER INVESTMENTS		-	143,800	-	-	-	-	-	-	-

A: GHWSSIP										
FUNDING SOURCE	**FINANCE**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Grant	50%	-	-	-	-	79,706	79,706	52,697	-	-
Loan	50%	-	-	-	-	79,706	79,706	52,697	-	-
Own resources (consumer meters)	N/A	383	2,678	17,874	17,874	17,874	17,874	8,133	5,837	8,133
External private investments	N/A	48,235	48,235	48,235	48,235	48,235	48,235	48,235	48,235	48,235
TOTAL INVESTMENT	100%	**48,618**	**50,914**	**66,110**	**66,110**	**225,521**	**225,521**	**161,762**	**54,073**	**56,368**
B: Other Investments										
OTHER INVESTMENTS		**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
CMEC Loan										
UWSSRP										
TOTAL OTHER INVESTMENTS		-	-	-	-	-	-	-	-	-

An existing loan provided by Exim Bank amounting to USD 129.6 million repayable in 5 years (commencing 2014) at a rate of interest of 3.5 % has also been included into the capital and financial costs of the model.

11.7 Areas of Investment Impact

Apart from the detailed presentations of the investment plans with their associated technical impacts detailed in the previous chapters, the planned capital investments should aim to maximise their positive impact on the following key areas in order to turn around and support a financially sustainable entity:

- Increase water supply to cover the demand for water and sewerage services, thereby increasing the revenue base;
- Reduce NRW in line with the milestones; 30 % or lower by 2020 and 20 % or lower by 2030 to reduce the marginal cost of water;
- Increase cash collection efficiencies to 95 % or better by 2020 and maintain this minimum thereby improving the cash flow and liquidity enhancing the financial viability;
- Ensure that maintenance and repair is carried out including meter replacements to enhance the longevity of the existing and newly invested assets;
- Revise and implement a cost covering tariff and review its structure to reduce the fixed elements;

Apart from these main variables that underpin the level of financial sustainability the following associated improvements are also expected to be implemented as part of the overall organisational and operational reforms required:

- Improve on data collection and record keeping of both technical and financial nature including e.g. bulk meters to enable water balances and the like to assess critical performance indicators and enable management decisions;
- Introduce routine recapitalisation in the form of meter replacements to reduce high NRW levels;
- Conduct a full consumer survey to establish the consumer details including consumer category;
- Ensure timely and accurate billing;
- Develop and implement a strict disconnection policy that will improve collection efficiencies;
- Settle financial obligations on time (possible with an improved cash flow position) to improve staff motivation and productivity as well as shorten delivery times of consumables (e.g. chemicals) and materials (e.g. spare parts) thereby ensuring the quality of water and reducing/avoiding the downtime of facilities required in the production of water and/or the collection or treatment of sewerage.
- Ring fence both receivables and payables related to water and sewerage;
- Assess current staff capacities and provide relevant training and/or staff replacements.
- Apply multi-skilling and other measure of improving staff productivity allowing the unit personnel costs (per 1000 connections) to reduce and conversely to enhance the collection rate per staff.

These associated activities and measures should be an integral part of achieving the key goals. They are indirectly assumed forming an intangible part of the financial model.

11.8 Financial Projections and Evaluation Results

11.8.1 Income Statement

An overview of the main line items of the individual income statements forecast and produced for each entity is presented in the following table. This table shows mixed results for the different entities.

HARARE

Apart from 2014 the income statement for Harare is generally positive, with surplus annual gross margins of up USD 54.1 million in 2015, which positively influence a similarly surplus adjusted income statement that shows a peak in 2019 of around USD 32.2 million. The deficit forecast for 2014 is attributed to a combination of lower retail tariffs, high NRW levels and low collection efficiency. The consistently improving levels of revenue and cash efficiencies (i.e. billing and collection efficiency) as well as the generally increasing demand for water provides sufficient income to offset the opposite effects of falling tariffs and increasing costs. This implies that the income generating aspects are anticipated to grow faster than the factors pushing costs upward. The fluctuations in the income statement after around 2017 are mainly due to the effects of the various investment costs,

The overall trend and composition of the income statement for Harare is illustrated in Figure 11-4 above for the period up to 2023.

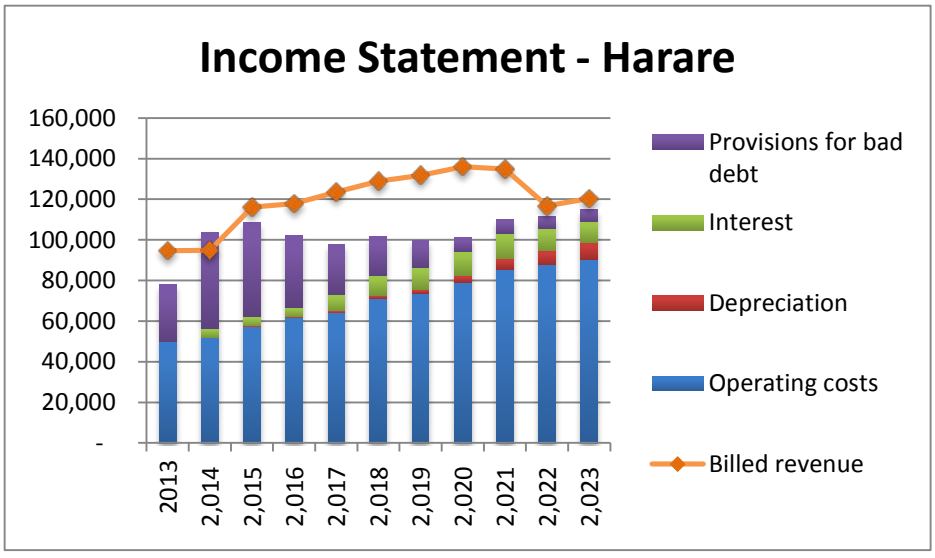


Figure 11-4: Income Statement for Harare Scenario 1

Table 11-12: Income Statement Summary for Scenario 1

ENTITY/ITEM	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
HARARE																		
Income	94,722	94,845	116,044	117,839	123,586	128,820	131,799	135,989	134,810	116,721	120,308	124,508	128,773	133,102	137,495	141,952	146,472	151,057
Expenditure	49,875	56,349	61,848	66,532	71,958	80,784	84,436	90,766	97,973	98,700	100,423	102,362	104,359	107,050	112,376	115,537	115,614	115,515
Surplus/(Deficit)	**44,847**	**38,496**	**54,196**	**51,307**	**51,628**	**48,036**	**47,364**	**45,223**	**36,838**	**18,021**	**19,884**	**22,146**	**24,414**	**26,052**	**25,119**	**26,415**	**30,858**	**35,542**
Provision for Bad Debt	27,916	47,423	46,418	35,352	24,717	19,323	13,180	6,799	6,741	5,836	6,015	6,225	6,439	6,655	6,875	7,098	7,324	7,553
Depreciation	0	169	388	438	998	1,541	1,939	3,507	5,372	6,933	8,641	9,355	9,609	11,148	12,694	13,281	13,525	13,899
Adj. Surplus/(Deficit)	**16,931**	**(9,095)**	**7,390**	**15,517**	**25,913**	**27,172**	**32,244**	**34,916**	**24,726**	**5,252**	**5,228**	**6,566**	**8,367**	**8,250**	**5,550**	**6,037**	**10,009**	**14,090**
CHITUNGWIZA																		
Income	3,027	3,704	4,176	4,940	5,969	7,090	12,077	16,013	15,934	13,551	14,074	14,607	15,148	15,699	16,259	16,828	17,407	17,994
Expenditure	3,968	4,370	5,766	6,625	8,029	10,094	12,603	14,320	14,873	15,046	15,218	15,525	15,698	16,119	16,530	16,089	16,247	16,405
Surplus/(Deficit)	**(941)**	**(666)**	**(1,590)**	**(1,686)**	**(2,059)**	**(3,004)**	**(526)**	**1,693**	**1,061**	**(1,495)**	**(1,144)**	**(918)**	**(549)**	**(420)**	**(271)**	**739**	**1,159**	**1,589**
Provision for Bad Debt	378	926	1,044	1,235	1,194	1,064	1,208	801	797	678	704	730	757	785	813	841	870	900
Depreciation	0	4	14	18	130	236	240	366	517	677	841	1,214	1,065	1,003	1,111	1,164	1,201	1,238
Adj. Surplus/(Deficit)	**(1,319)**	**(1,596)**	**(2,648)**	**(2,939)**	**(3,383)**	**(4,304)**	**(1,974)**	**526**	**(253)**	**(2,850)**	**(2,689)**	**(2,863)**	**(2,371)**	**(2,208)**	**(2,195)**	**(1,266)**	**(912)**	**(548)**
EPWORTH																		
Income	819	1,138	1,436	1,881	2,494	3,225	5,941	8,471	8,264	6,895	7,029	7,164	7,301	7,438	7,577	7,716	7,857	7,998
Expenditure	932	1,141	1,657	1,997	2,526	3,050	4,370	5,436	5,502	5,533	5,563	5,632	5,663	5,819	5,970	5,996	6,019	6,043
Surplus/(Deficit)	**(113)**	**(3)**	**(221)**	**(116)**	**(32)**	**175**	**1,571**	**3,035**	**2,762**	**1,362**	**1,466**	**1,532**	**1,638**	**1,619**	**1,607**	**1,720**	**1,837**	**1,956**
Provision for Bad Debt	164	626	718	753	748	645	594	424	413	345	351	358	365	372	379	386	393	400
Depreciation	0	0	2	3	32	54	55	84	127	177	233	350	302	297	342	372	393	414
Adj. Surplus/(Deficit)	**(277)**	**(629)**	**(941)**	**(871)**	**(811)**	**(525)**	**922**	**2,528**	**2,222**	**841**	**881**	**824**	**971**	**951**	**886**	**963**	**1,052**	**1,142**
NORTON																		
Income	1,113	1,388	1,593	1,919	2,359	2,851	4,940	6,660	6,642	5,661	5,892	6,127	6,366	6,609	6,856	7,108	7,364	7,623
Expenditure	2,173	2,350	3,112	3,557	4,246	5,202	6,217	6,936	7,098	7,168	7,237	7,333	7,403	7,897	8,372	8,372	8,406	8,437
Surplus/(Deficit)	**(1,060)**	**(963)**	**(1,519)**	**(1,639)**	**(1,886)**	**(2,351)**	**(1,277)**	**(277)**	**(456)**	**(1,507)**	**(1,345)**	**(1,206)**	**(1,037)**	**(1,288)**	**(1,516)**	**(1,264)**	**(1,042)**	**(814)**
Provision for Bad Debt	184	416	478	480	472	428	494	333	332	283	295	306	318	330	343	355	368	381
Depreciation	0	2	7	11	57	94	98	152	215	281	352	432	384	431	517	538	552	566
Adj. Surplus/(Deficit)	**(1,244)**	**(1,381)**	**(2,004)**	**(2,129)**	**(2,415)**	**(2,872)**	**(1,869)**	**(761)**	**(1,003)**	**(2,071)**	**(1,992)**	**(1,945)**	**(1,740)**	**(2,050)**	**(2,376)**	**(2,158)**	**(1,962)**	**(1,761)**
RUWA																		
Income	1,232	2,396	2,546	2,910	3,458	4,093	6,623	7,953	7,942	6,777	7,061	7,351	7,646	7,946	8,251	8,561	8,877	9,198
Expenditure	1,563	1,862	2,381	2,753	3,577	4,793	5,278	5,797	5,988	6,256	6,385	6,543	6,671	7,301	7,867	7,913	7,945	7,992
Surplus/(Deficit)	**(330)**	**534**	**165**	**157**	**(119)**	**(700)**	**1,346**	**2,155**	**1,953**	**521**	**677**	**808**	**974**	**645**	**384**	**648**	**932**	**1,206**
Provision for Bad Debt	363	1,198	1,018	873	692	614	662	398	397	339	353	368	382	397	413	428	444	460
Depreciation	0	4	17	25	84	135	143	227	322	418	521	611	556	602	698	724	742	760
Adj. Surplus/(Deficit)	**(693)**	**(668)**	**(870)**	**(741)**	**(894)**	**(1,449)**	**540**	**1,530**	**1,234**	**(236)**	**(197)**	**(171)**	**36**	**(354)**	**(726)**	**(504)**	**(254)**	**(14)**
GREATER HARARE																		
Income	106,220	106,744	127,587	129,294	136,143	142,819	149,322	155,651	154,637	131,311	136,185	141,142	146,183	151,307	156,516	161,807	167,182	172,641
Expenditure	53,140	57,936	70,451	73,960	83,792	93,729	98,172	104,908	112,865	113,726	115,582	117,882	120,011	124,133	130,845	133,472	133,656	133,677
Surplus/(Deficit)	**53,080**	**48,808**	**57,137**	**55,334**	**52,351**	**49,090**	**51,150**	**50,743**	**41,772**	**17,585**	**20,603**	**23,261**	**26,172**	**27,174**	**25,670**	**28,336**	**33,526**	**38,964**
Provision for Bad Debt	29,211	53,372	51,035	38,788	27,229	21,423	14,932	7,783	7,732	6,566	6,809	7,057	7,309	7,565	7,826	8,090	8,359	8,632
Depreciation	0	177	212	245	648	1,029	2,473	2,888	3,273	3,391	3,526	3,984	3,968	4,490	5,117	5,356	5,468	5,622
Adj. Surplus/(Deficit)	**23,870**	**(4,742)**	**5,890**	**16,300**	**24,474**	**26,638**	**33,745**	**40,073**	**30,767**	**7,628**	**10,268**	**12,219**	**14,895**	**15,119**	**12,727**	**14,889**	**19,700**	**24,710**

CHITUNGWIZA

Desptie some Interim surplus results for Chitungwiza, the income statement is overwhelmingly negative. Despite this, a noticeable improvement is forecast from around 2018 when the effects of the planned investments are felt. After this point, notably in 2020 both the basic and adjusted income statements turn positive with a surplus of USD 1.7 million and USD 0.5 millionj respectively. Although the subsequent years are forecast with an adjusted income statement deficit, this is significantly improved in comparison ot the period before the project. While the income statement could be truned positive from the point of the project implementation, this would imply an increase in the tariff, which is not justifiable and not implemented in the model as the projected tariff is kept the same for all entities to provide a level ground for comparison.

EPWORTH

Throughout the evaluation period Epworth is forecast to return deficit income statements despite the application of the same high tariffs used for the other areas. Nonetheless, an improved position is perceived after the implementation of the investments, namely in 2020 and again around the end of the project horizon in 2029

NORTON

Again, this area displays the same trends and similar absolute retunns as sescribed for Chitungwiza implying that the relatively high tariffs are inadequate to cover the bulk plus administrative costs. The entity appears to fall just short of adequate volumes of water that would allow some economies of scale to be realised.

RUWA

Further to the underlying patterns observed for the other areas, Ruwa ia anticipated to break into a positive gross margin from 2019 onward. However the adjusted income statement is forecast to only briefly recover in a window of three years from 2019 to 2021 caused by the effects of the first major investment phase. A second brief recovery of the adjusted income statement is forecast for 2025 only reflecting the impact of he next investment phase.

While Ruwa appears to perform better than Chitungwiza, Epworth and Norton, it is inadequately self-sustainable in the short and medium term from an income statement point of view. As with the aforementioned satellite towns Ruwa would require a subsidy if it were to continue operating independently (with some additional supply of water from Harare).

GREATER HARARE

The main difference of the financial model for the clustered entity is that it replaces the bulk sales otherwise sold to the satellite towns with retail sales made directly to its customers in all areas. Although this involves a greater volume sold at a higher (retail) tariff, it is subject to the weighted average water losses estimated at 55 %. Nonetheless, the total calculated income is higher than for Harare Water alone. On the other hand the combined costs are also higher. As these more or less balance out, the gross margin is not significantly different to that anticipated for Harare Water. While the gross margin is forecast to be surplus throughout the entire evaluation period, the adjusted income statement is expected to start with a surplus in the base year and dip into a one-year deficit in 2014 in much the same way as displayed by the other areas, reflecting the still poor efficiency performance and at the same time implementing a tariff reduction combined with additional costs. This

short deficit turns and remains positive from 2014 onwards with improved efficiencies offsetting the payables.

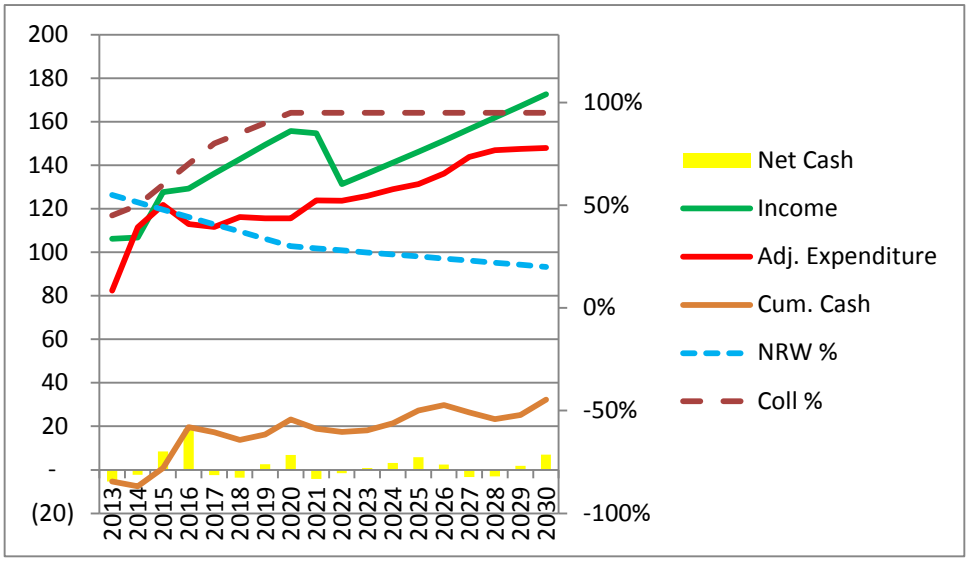


Figure 11-5: Key Financial Results for Greater Harare - Scenario 1

11.8.2 Cash Flow Statement

The bottom line of the cash flow statements are summarised for all entities in the table overleaf, whowing both the annual net cash flow (at the end of each respective year) and the accumulated cash flows.

HARARE

After 2014 the forecast net cash flow projections are expected to be in surplus, growing consistently until 2017 when the Exim Bank loan sets in thereby reducing the net cash flow to a deficit position by 2018. Despite the repayment of the Exim Bank loan upto 2022 a brief recovery of the net cash flow is realised between 2019 and 2020 (both years included). From 2023 the net cash flow is forecast to be positive upto 2026 when the anticipated repayment of the loan for the project under this investment plan commences. By the end of the project horizon the net cash flow is projected to improve into a surplus position.

Thus, the otherwise consistently growing cashflow is interrupted and reduced, in part to a negative net cash flow mainly due to the financial implications of the variouis investments.

The cumulative cash flow is positive overall from 2016 onward. Hoever, the forecast bank balance reduces during the years when the aforementioned effects of the various investments set in. In this respect reduced accumulative cash flows are expected in the years 2021 to 2023 and again in 2027 to 2028. The first dip is illustrated in the figure below that shows the cash flow positon upto and including 2023.

The initial deficit anticipated in the early ears from 2013 to 2015 are attributable to the generally low efficiency levels, i.e. NRW and collection efficiency which are anticipated to improve, rhough gradually over time.

CHITUNGWIZA

The net cash flow for Chitungwiza is positive in only one year (2014) over the project horizon. The initial cash flow in the base year is also negative, mainly due to poor efficiency levels which improve and turn the net cash flow into a positive position in 2014. From 2015 the repayment of the first phase of the loan for the project under this investment plan

reverts the net cash flow back into a deficit which is not recovered over the project period as additional financial costs burden the entities financial position. Similarly the cumulative cash flow for Chitungwiza is in deficit, growing consistently in a more or less linear fashion.

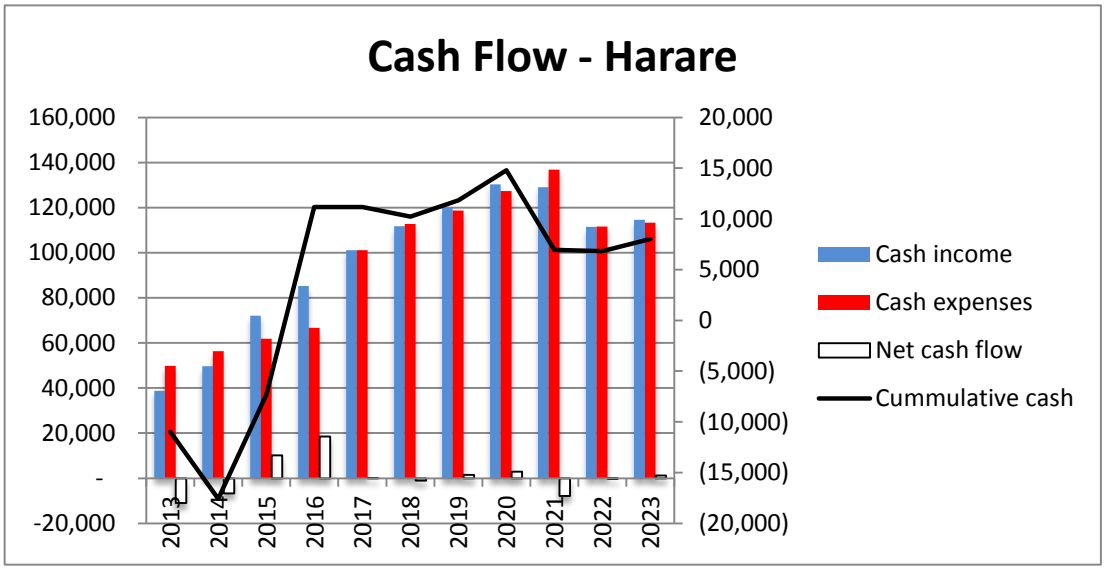


Figure 11-6: Cash Flow Statement for Harare - Scenario 1

Table 11-13: Cash Flow Summary for Scenario 1

ENTITY/ITEM	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
HARARE																		
Net cash flow	(10,985)	(6,611)	10,233	18,547	2	(973)	1,610	2,984	(7,846)	(145)	1,220	3,269	5,278	2,724	(2,404)	(3,955)	273	4,739
Accumulated cash flow	(10,985)	(17,596)	(7,363)	11,183	11,185	10,212	11,822	14,806	6,961	6,815	8,035	11,304	16,582	19,305	16,901	12,946	13,219	17,957
CHITUNGWIZA																		
Net cash flow	(1,697)	723	(117)	(2,921)	(3,985)	(5,512)	(3,168)	(544)	(1,179)	(3,609)	(3,304)	(3,106)	(2,770)	(2,874)	(2,960)	(1,977)	(1,584)	(1,182)
Accumulated cash flow	(1,697)	(975)	(1,092)	(4,013)	(7,998)	(13,509)	(16,678)	(17,222)	(18,402)	(22,010)	(25,315)	(28,420)	(31,190)	(34,064)	(37,024)	(39,000)	(40,584)	(41,767)
EPWORTH																		
Net cash flow	(440)	1,674	1,601	(867)	(961)	(797)	652	2,286	2,018	684	773	832	928	801	680	784	895	1,007
Accumulated cash flow	(440)	1,234	2,835	1,968	1,007	210	862	3,149	5,167	5,851	6,624	7,457	8,384	9,185	9,865	10,649	11,544	12,551
NORTON																		
Net cash flow	(1,428)	924	544	(2,115)	(2,766)	(3,569)	(2,561)	(1,400)	(1,581)	(2,579)	(2,438)	(2,310)	(2,155)	(2,804)	(3,429)	(3,190)	(2,980)	(2,764)
Accumulated cash flow	(1,428)	(504)	40	(2,075)	(4,841)	(8,409)	(10,970)	(12,371)	(13,951)	(16,530)	(18,968)	(21,278)	(23,433)	(26,237)	(29,666)	(32,856)	(35,835)	(38,599)
RUWA																		
Net cash flow	(1,057)	1,639	1,687	(695)	(1,281)	(2,287)	(297)	768	563	(809)	(681)	(564)	(415)	(1,214)	(1,944)	(1,695)	(1,427)	(1,168)
Accumulated cash flow	(1,057)	582	2,269	1,575	294	(1,993)	(2,290)	(1,522)	(960)	(1,769)	(2,449)	(3,014)	(3,429)	(4,642)	(6,587)	(8,282)	(9,708)	(10,876)
GREATER HARARE																		
Net cash flow	(5,341)	(2,278)	8,510	18,749	(2,376)	(3,529)	2,542	6,840	(4,158)	(1,583)	833	3,241	5,842	2,491	(3,369)	(3,065)	1,870	7,047
Accumulated cash flow	(5,341)	(7,619)	891	19,641	17,264	13,735	16,277	23,117	18,958	17,375	18,208	21,449	27,291	29,782	26,413	23,347	25,217	32,264

EPWORTH

The net and cumulative cash flow expected for 2013 is negative, reflecting the situation of low sales due to inadequate and unreliable bulk water supplies from which equally inadequate revenues can be obtained to cover the mainly fixed operating costs. Despite this, Epworth reported a nominal surplus for 2012 achieved in the same situation, whihch is explained through receipt of fixed charges and high recharges to other departments. In any case, the potential of attaining a cash flow surplus from the operation of water and sewerage facilities in Epworth is also reflected in the financial model for the period from 2014 to 2015 (inclusive), which is achieved by an assumed increase in the volumes of bulk water supplied to to the entity. However the net cash flow turns negative in 2016 upto and including 2018. Howver the previously accumulated cash flow is forecast to be adequate to bridge this period and thus the cumulative cash flow remains positive to the end of the project horizon, growing consistently as net cash remain surplus after 2018.

NORTON

Modelled projections of cash flows for Norton follow the same pattern and similar magnitude as outlined for Chitungwiza above. The underlying reasons are the same and overall the entity is unable to generate adequate surpluses despite the relatively high tariffs (same as those applied across all entities).

RUWA

Despite a financial recovery from 2014 to 2017 -based on increased volumes of bulk water supplies coupled with improved revenue and cash efficiencies- at least in terms of the cumulative cash flow, the negative cash flow from 2016 to 2018 and again from 2022 to the end of the project horizon attributed to the financial implications of the various investments result in a constantly negative cumulative cash flow from 2018 onward.

Thus, overall, Ruwa is not expected to greatly improve its financial position and if operated as a separate entity is likely to return similar financial results as reported for 2012 by the logal board and as forecast in the model.

GREATER HARARE

In line with the results for the income statement of Greater Harare, the Cash Flow is similarly in deficit in the early yaers of the evaluation period (for 2013 and 2014 only) and thereafter generally turns and remains positive. Although the net cash flow briefly returns to a deficit from 2014 and 2018 at the onset of the repayments fo the planned investments, the accumulated cash flow is sufficiently positive to buffer this brief period of deficit.

With this result the cluster's liquidity would be adequate to take on the individual losses forecast for the satellite towns.

11.8.3 Annual Balance Sheet

A simplified balance sheet to reflect the position for each year within the evaluation period was generated by the financial model as summarised for all entities in the table overleaf.

In view of the planned investments the total assets have grown significantly over the project horizon. For Harare and Greater Harare this increase is 113 % and 131 % respectively. For the satellite towns this growth is:

- Chitungwiza: 137 %;
- Epworth: over 1000 % (ten-fold);
- Norton: 407 %

- Ruwa: 394 %%

This ties in with the results of negative net current assets implying that the existing and furthermore the future cash position is not tenable to support such heavy investments in the satellite towns.

Table 11-14: Balance Sheet Summary for Scenario 1

ENTITY/ITEM	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
HARARE																		
Fixed Assets	772,845	763,334	757,323	750,811	861,114	963,846	1,046,872	1,126,578	1,212,959	1,206,813	1,201,904	1,209,811	1,216,873	1,378,216	1,542,722	1,641,515	1,631,803	1,623,141
Current Assets	8,216	1,586	15,997	34,713	35,773	35,466	37,399	40,543	31,333	26,285	28,006	31,893	37,796	41,710	40,039	36,935	38,129	43,834
Total Assets	781,062	764,921	773,320	785,524	896,887	999,312	1,084,271	1,167,121	1,244,292	1,233,097	1,229,910	1,241,705	1,254,670	1,419,926	1,582,761	1,678,450	1,669,932	1,666,974
Equity	781,062	635,321	641,820	652,224	729,660	809,554	882,175	955,021	1,026,422	1,028,217	1,038,019	1,062,802	1,088,757	1,191,282	1,295,370	1,361,958	1,377,034	1,397,671
Long term liability	0	129,600	131,500	133,300	167,227	189,758	202,096	212,100	217,870	204,881	191,891	178,902	165,913	228,644	287,390	316,492	292,898	269,303
Total Liability	781,062	764,921	773,320	785,524	896,887	999,312	1,084,271	1,167,121	1,244,292	1,233,097	1,229,910	1,241,705	1,254,670	1,419,926	1,582,761	1,678,450	1,669,932	1,666,974
Debt/Equity ratio	0%	20%	20%	20%	23%	23%	23%	22%	21%	20%	18%	17%	15%	19%	22%	23%	21%	19%
CHITUNGWIZA																		
Fixed Assets	76,813	74,934	74,512	72,922	99,813	124,779	120,967	117,116	117,181	117,121	116,967	128,560	127,661	135,282	142,543	141,921	142,374	142,705
Current Assets	(1,370)	(545)	(656)	(3,486)	(7,325)	(12,690)	(15,042)	(14,901)	(16,205)	(20,451)	(23,665)	(26,701)	(29,377)	(32,161)	(35,029)	(36,806)	(38,288)	(39,365)
Total Assets	75,443	74,389	73,856	69,436	92,489	112,089	105,925	102,215	100,976	96,671	93,302	101,859	98,284	103,120	107,514	105,115	104,087	103,339
Equity	75,443	74,389	73,131	68,749	77,779	84,507	79,840	77,626	77,884	75,075	73,203	83,257	81,179	83,563	85,711	85,225	86,109	87,274
Long term liability	0	0	725	687	14,709	27,582	26,085	24,589	23,092	21,595	20,099	18,602	17,105	19,558	21,802	19,890	17,978	16,065
Total Liability	75,443	74,389	73,856	69,436	92,489	112,089	105,925	102,215	100,976	96,671	93,302	101,859	98,284	103,120	107,514	105,115	104,087	103,339
Debt/Equity ratio	0%	0%	1%	1%	19%	33%	33%	32%	30%	29%	27%	22%	21%	23%	25%	23%	21%	18%
EPWORTH																		
Fixed Assets	6,333	6,885	7,069	7,124	14,772	20,334	19,865	19,388	22,003	24,546	27,020	32,801	35,043	41,376	47,560	49,955	52,200	54,374
Current Assets	(342)	1,379	3,008	2,206	1,343	670	1,778	4,517	6,469	6,803	7,601	8,453	9,407	10,230	10,932	11,743	12,664	13,698
Total Assets	5,990	8,264	10,077	9,330	16,115	21,004	21,644	23,905	28,472	31,350	34,621	41,254	44,450	51,606	58,492	61,697	64,864	68,072
Equity	5,990	8,036	9,804	9,072	12,128	14,369	15,371	17,995	22,925	26,165	29,799	36,794	40,353	45,937	51,353	55,087	58,822	62,598
Long term liability	0	228	273	258	3,986	6,635	6,272	5,910	5,547	5,185	4,822	4,459	4,097	5,669	7,138	6,610	6,042	5,474
Total Liability	5,990	8,264	10,077	9,330	16,115	21,004	21,644	23,905	28,472	31,350	34,621	41,254	44,450	51,606	58,492	61,697	64,864	68,072
Debt/Equity ratio	0%	3%	3%	3%	33%	46%	41%	33%	24%	20%	16%	12%	10%	12%	14%	12%	10%	9%
NORTON																		
Fixed Assets	10,974	12,591	13,812	14,877	32,018	47,685	47,882	48,043	48,873	49,653	50,385	53,381	54,005	69,906	85,521	85,874	86,247	86,573
Current Assets	(1,317)	(352)	196	(1,878)	(4,580)	(8,081)	(10,296)	(11,392)	(13,011)	(15,854)	(18,252)	(20,527)	(22,640)	(25,408)	(28,800)	(31,940)	(34,875)	(37,592)
Total Assets	9,658	12,240	14,008	12,999	27,438	39,604	37,587	36,651	35,861	33,799	32,133	32,854	31,365	44,498	56,721	53,934	51,373	48,981
Equity	9,658	12,012	13,735	12,741	19,342	24,606	23,402	23,281	23,305	22,057	21,205	22,740	22,065	28,682	34,774	33,573	32,598	31,792
Long term liability	0	228	273	258	8,096	14,999	14,184	13,370	12,556	11,742	10,928	10,114	9,300	15,816	21,947	20,361	18,775	17,189
Total Liability	9,658	12,240	14,008	12,999	27,438	39,604	37,587	36,651	35,861	33,799	32,133	32,854	31,365	44,498	56,721	53,934	51,373	48,981
Debt/Equity ratio	0%	0%	2%	2%	42%	61%	61%	57%	54%	53%	52%	44%	42%	55%	63%	61%	58%	54%
RUWA																		
Fixed Assets	24,549	28,035	31,080	33,922	56,785	78,284	79,939	81,513	82,447	83,319	84,127	87,394	88,091	106,842	125,271	125,700	126,073	126,453
Current Assets	(891)	991	2,678	2,033	838	(1,358)	(1,112)	(107)	412	(741)	(1,381)	(1,907)	(2,279)	(3,455)	(5,354)	(6,995)	(8,364)	(9,476)
Total Assets	23,658	29,027	33,758	35,955	57,623	76,925	78,827	81,406	82,859	82,578	82,746	85,487	85,813	103,387	119,918	118,705	117,709	116,977
Equity	23,658	28,799	33,485	35,697	47,589	58,035	60,961	64,564	67,042	67,785	68,978	72,743	74,093	84,047	93,412	94,134	95,072	96,275
Long term liability	0	228	273	258	10,034	18,890	17,866	16,842	15,817	14,793	13,769	12,744	11,720	19,340	26,505	24,571	22,637	20,702
Total Liability	23,658	29,027	33,758	35,955	57,623	76,925	78,827	81,406	82,859	82,578	82,746	85,487	85,813	103,387	119,918	118,705	117,709	116,977
Debt/Equity ratio	0%	1%	1%	1%	21%	33%	29%	26%	24%	22%	20%	18%	16%	23%	28%	26%	24%	22%
GREATER HARARE																		
Fixed Assets	891,515	885,781	883,796	879,656	1,064,500	1,234,927	1,315,526	1,392,638	1,483,462	1,481,452	1,480,403	1,511,947	1,521,674	1,731,621	1,943,615	2,044,964	2,038,695	2,033,244
Current Assets	16,757	14,571	26,978	45,888	44,724	42,179	45,778	53,235	47,621	39,801	41,432	45,417	52,053	55,883	53,408	51,487	54,473	62,684
Total Assets	908,272	900,352	910,774	925,544	1,109,224	1,277,106	1,361,304	1,445,873	1,531,083	1,521,253	1,521,835	1,557,365	1,573,727	1,787,505	1,997,023	2,096,451	2,093,167	2,095,928
Equity	908,272	770,061	777,686	790,682	904,010	1,016,123	1,089,257	1,164,629	1,244,430	1,247,949	1,261,881	1,310,760	1,340,472	1,468,993	1,597,364	1,667,732	1,688,124	1,714,561
Long term liability	0	130,291	133,088	134,862	205,214	260,983	272,047	281,244	286,653	273,304	259,954	246,605	233,255	318,511	399,659	428,719	405,043	381,367
Total Liability	908,272	900,352	910,774	925,544	1,109,224	1,277,106	1,361,304	1,445,873	1,531,083	1,521,253	1,521,835	1,557,365	1,573,727	1,787,505	1,997,023	2,096,451	2,093,167	2,095,928
Debt/Equity ratio	0%	17%	17%	17%	23%	26%	25%	24%	23%	22%	21%	19%	17%	22%	25%	26%	24%	22%

11.9 Financial Projections and Evaluation for Other Scenarios

In addition to the base and ideal investment option as expressed under scenario 1 (investment priority 1 + 2 + 3) -for which results are presented in the foregoing- two additional, lower investment scenarios- were investigated for Harare and Greater Harare to cater for improved service delivery in these areas with lower investment requirements. For these scenarios the requirements of the satellite towns was included under the financial model for Greater Harare.

To provide a comparative basis betweent he various scenarios, all input data except for the actual investment costs remained unchanged. The summary results for all three options are presented in the following tables.

The Income statements for scenarios 2 and 3 in respect of both the gross margin and the adjusted accounting profit are positive throughout, though higher for scenario 3 than x. Similarly the surplus is higher for scenario 2 than sceneario 1.

With regard to the cash flow statements shown in the second table the resulting net and cumulative cash flow is the same in the base year and is generally in surplus, crowing consistently over the project period. Again, the comparison between scenario 1, 2 and 3 reveals the same relationship, i.e. the surplus at the endo fhte project evaluationperiod (2030) is highest for scenario 3, next for scenario 2 and then scenario 1. This comparative result is to be expected as investment costs are lower for scenario 2 than 1 and again lower for scenario 3 than 2, while the benefits remain constant.

Thus the overall outcome is that the financial result is acceptable (generally surplus) for scenario 1, but better for both scenarios 2 and 3. Howver, at the same time, the investments are more extensive and technically superior for scenario 3 than 2 and again scenario 2 is technically superior to 1.

Table 11-15: Summary Income Statements for Harare and Greater Harare (Scenario 1, 2, 3)

ENTITY/ITEM	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
HARARE - Scenario 1																		
Income	94,722	94,845	116,044	117,839	123,586	128,820	131,799	135,989	134,810	116,721	120,308	124,508	128,773	133,102	137,495	141,952	146,472	151,057
Expenditure	49,875	56,349	61,848	66,532	71,958	80,784	84,436	90,766	97,973	98,700	100,423	102,362	104,359	107,050	112,376	115,537	115,614	115,515
Surplus/(Deficit)	**44,847**	**38,496**	**54,196**	**51,307**	**51,628**	**48,036**	**47,364**	**45,223**	**36,838**	**18,021**	**19,884**	**22,146**	**24,414**	**26,052**	**25,119**	**26,415**	**30,858**	**35,542**
Provision for Bad Debt	27,916	47,423	46,418	35,352	24,717	19,323	13,180	6,799	6,741	5,836	6,015	6,225	6,439	6,655	6,875	7,098	7,324	7,553
Depreciation	0	169	388	438	998	1,541	1,939	3,507	5,372	6,933	8,641	9,355	9,609	11,148	12,694	13,281	13,525	13,899
Adj. Surplus/(Deficit)	**16,931**	**(9,095)**	**7,390**	**15,517**	**25,913**	**27,172**	**32,244**	**34,916**	**24,726**	**5,252**	**5,228**	**6,566**	**8,367**	**8,250**	**5,550**	**6,037**	**10,009**	**14,090**
HARARE - Scenario 2																		
Income	94,722	94,845	116,044	117,839	123,586	128,820	131,799	135,989	134,810	116,721	120,308	124,508	128,773	133,102	137,495	141,952	146,472	151,057
Expenditure	49,875	56,320	61,774	66,410	70,339	77,645	81,427	87,921	95,064	95,632	97,197	98,982	100,825	100,842	103,615	104,375	104,650	104,749
Surplus/(Deficit)	**44,847**	**38,526**	**54,270**	**51,429**	**53,247**	**51,176**	**50,372**	**48,067**	**39,747**	**21,088**	**23,110**	**25,526**	**27,948**	**32,260**	**33,880**	**37,576**	**41,822**	**46,308**
Provision for Bad Debt	27,916	47,423	46,418	35,352	24,717	19,323	13,180	6,799	6,741	5,836	6,015	6,225	6,439	6,655	6,875	7,098	7,324	7,553
Depreciation	0	144	307	326	690	1,044	1,567	3,134	5,064	6,335	7,622	7,860	7,754	8,582	9,240	9,016	8,657	8,747
Adj. Surplus/(Deficit)	**16,931**	**(9,041)**	**7,545**	**15,751**	**27,839**	**30,809**	**35,626**	**38,134**	**27,942**	**8,917**	**9,473**	**11,441**	**13,755**	**17,023**	**17,765**	**21,463**	**25,841**	**30,008**
HARARE - Scenario 3																		
Income	94,722	94,845	116,044	117,839	123,586	128,820	131,799	135,989	134,810	116,721	120,308	124,508	128,773	133,102	137,495	141,952	146,472	151,057
Expenditure	49,875	56,349	61,848	66,532	70,429	77,802	80,090	85,132	91,126	92,234	94,338	96,657	99,035	98,988	101,733	102,951	103,852	104,576
Surplus/(Deficit)	**44,847**	**38,496**	**54,196**	**51,307**	**53,157**	**51,018**	**51,709**	**50,857**	**43,684**	**24,487**	**25,970**	**27,851**	**29,738**	**34,114**	**35,762**	**39,001**	**42,621**	**46,481**
Provision for Bad Debt	27,916	47,423	46,418	35,352	24,717	19,323	13,180	6,799	6,741	5,836	6,015	6,225	6,439	6,655	6,875	7,098	7,324	7,553
Depreciation	0	169	388	438	998	1,541	1,939	3,507	5,372	6,933	8,641	9,355	9,609	11,148	12,694	13,281	13,525	13,899
Adj. Surplus/(Deficit)	**16,931**	**(9,095)**	**7,390**	**15,517**	**27,442**	**30,154**	**36,590**	**40,550**	**31,572**	**11,718**	**11,314**	**12,271**	**13,691**	**16,312**	**16,193**	**18,623**	**21,772**	**25,029**
GREATER HARARE - Scenario 1																		
Income	106,220	106,744	127,587	129,294	136,143	142,819	149,322	155,651	154,637	131,311	136,185	141,142	146,183	151,307	156,516	161,807	167,182	172,641
Expenditure	53,140	57,936	70,451	73,960	83,792	93,729	98,172	104,908	112,865	113,726	115,582	117,882	120,011	124,133	130,845	133,472	133,656	133,677
Surplus/(Deficit)	**53,080**	**48,808**	**57,137**	**55,334**	**52,351**	**49,090**	**51,150**	**50,743**	**41,772**	**17,585**	**20,603**	**23,261**	**26,172**	**27,174**	**25,670**	**28,336**	**33,526**	**38,964**
Provision for Bad Debt	29,211	53,372	51,035	38,788	27,229	21,423	14,932	7,783	7,732	6,566	6,809	7,057	7,309	7,565	7,826	8,090	8,359	8,632
Depreciation	0	177	212	245	648	1,029	2,473	2,888	3,273	3,391	3,526	3,984	3,968	4,490	5,117	5,356	5,468	5,622
Adj. Surplus/(Deficit)	**23,870**	**(4,742)**	**5,890**	**16,300**	**24,474**	**26,638**	**33,745**	**40,073**	**30,767**	**7,628**	**10,268**	**12,219**	**14,895**	**15,119**	**12,727**	**14,889**	**19,700**	**24,710**
GREATER HARARE - Scenario 2																		
Income	106,220	106,744	127,587	129,294	136,143	142,819	149,322	155,651	154,637	131,311	136,185	141,142	146,183	151,307	156,516	161,807	167,182	172,641
Expenditure	53,140	57,899	70,353	73,783	81,446	89,158	93,677	100,510	108,218	108,837	110,451	112,435	114,326	114,936	118,259	118,405	118,684	118,800
Surplus/(Deficit)	**53,080**	**48,845**	**57,235**	**55,511**	**54,698**	**53,662**	**55,645**	**55,141**	**46,418**	**22,474**	**25,734**	**28,707**	**31,857**	**36,372**	**38,256**	**43,402**	**48,498**	**53,841**
Provision for Bad Debt	29,211	53,372	51,035	38,788	27,229	21,423	14,932	7,783	7,732	6,566	6,809	7,057	7,309	7,565	7,826	8,090	8,359	8,632
Depreciation	0	147	161	170	429	673	1,868	2,391	2,836	2,837	2,840	2,991	2,874	3,126	3,395	3,327	3,213	3,247
Adj. Surplus/(Deficit)	**23,870**	**(4,673)**	**6,039**	**16,552**	**27,040**	**31,566**	**38,845**	**44,968**	**35,851**	**13,071**	**16,084**	**18,659**	**21,674**	**25,680**	**27,035**	**31,984**	**36,927**	**41,962**
GREATER HARARE - Scenario 3																		
Income	106,220	106,744	127,587	129,294	136,143	142,819	149,322	155,651	154,637	131,311	136,185	141,142	146,183	151,307	156,516	161,807	167,182	172,641
Expenditure	53,140	57,899	70,353	73,783	80,570	87,391	89,958	94,771	100,152	101,013	102,870	105,097	107,231	106,542	108,613	108,647	109,272	109,734
Surplus/(Deficit)	**53,080**	**48,845**	**57,235**	**55,511**	**55,573**	**55,428**	**59,364**	**60,880**	**54,485**	**30,298**	**33,314**	**36,045**	**38,952**	**44,765**	**47,903**	**53,160**	**57,911**	**62,907**
Provision for Bad Debt	29,211	53,372	51,035	38,788	27,229	21,423	14,932	7,783	7,732	6,566	6,809	7,057	7,309	7,565	7,826	8,090	8,359	8,632
Depreciation	0	147	161	170	377	568	1,367	1,597	1,750	1,751	1,755	1,906	1,834	1,946	2,128	2,097	2,080	2,114
Adj. Surplus/(Deficit)	**23,870**	**(4,673)**	**6,039**	**16,552**	**27,968**	**33,438**	**43,066**	**51,501**	**45,003**	**21,981**	**24,751**	**27,083**	**29,809**	**35,253**	**37,948**	**42,973**	**47,471**	**52,161**

Table 11-16: Summary Cash Flow for Harare and Greater Harare (Scenario 1, 2, 3)

ENTITY/ITEM	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
HARARE - Scenario 1																		
Net cash flow	(10,985)	(6,611)	10,233	18,547	2	(973)	1,610	2,984	(7,846)	(145)	1,220	3,269	5,278	2,724	(2,404)	(3,955)	273	4,739
Accumulated cash flow	(10,985)	(17,596)	(7,363)	11,183	11,185	10,212	11,822	14,806	6,961	6,815	8,035	11,304	16,582	19,305	16,901	12,946	13,219	17,957
HARARE - Scenario 2																		
Net cash flow	(10,985)	(6,582)	10,307	18,669	2,890	4,705	7,157	8,368	(2,398)	5,461	6,984	9,188	11,351	13,857	13,671	16,842	20,873	25,140
Accumulated cash flow	(10,985)	(17,567)	(7,260)	11,409	14,299	19,004	26,161	34,529	32,131	37,592	44,577	53,764	65,115	78,973	92,643	109,485	130,358	155,499
HARARE - Scenario 3																		
Net cash flow	(10,985)	(6,611)	10,233	18,547	3,060	5,067	10,531	14,710	6,610	13,929	14,914	16,583	18,211	21,513	22,084	25,111	28,515	32,157
Accumulated cash flow	(10,985)	(17,596)	(7,363)	11,183	14,244	19,310	29,841	44,551	51,161	65,090	80,004	96,587	114,799	136,311	158,396	183,506	212,022	244,179
GREATER HARARE - Scenario 1																		
Net cash flow	(5,341)	(2,278)	8,510	18,749	(2,376)	(3,529)	2,542	6,840	(4,158)	(1,583)	833	3,241	5,842	2,491	(3,369)	(3,065)	1,870	7,047
Accumulated cash flow	(5,341)	(7,619)	891	19,641	17,264	13,735	16,277	23,117	18,958	17,375	18,208	21,449	27,291	29,782	26,413	23,347	25,217	32,264
GREATER HARARE - Scenario 2																		
Net cash flow	(5,341)	(5,341)	(1,083)	9,886	20,537	2,803	5,315	11,004	14,915	4,021	6,676	9,156	11,878	14,688	17,336	17,351	21,999	26,846
Accumulated cash flow	(5,341)	(5,341)	(6,424)	3,462	23,998	26,802	32,117	43,121	58,036	62,057	68,733	77,888	89,766	104,454	121,790	139,142	161,141	187,987
GREATER HARARE - Scenario 3																		
Net cash flow	(5,341)	(5,341)	(1,083)	9,886	20,537	4,287	8,299	17,153	24,298	16,944	19,357	21,594	24,073	26,640	31,495	33,670	38,681	43,181
Accumulated cash flow	(5,341)	(5,341)	(6,424)	3,462	23,998	28,285	36,584	53,738	78,036	94,981	114,338	135,931	160,004	186,644	218,139	251,809	290,490	333,671

11.10 Viability Assessment for Greater Harare Metropolitan Utility

Summarising the various findings presented above it can be stated that the base model for Harare using current and reducing tariff levels is positive with regard to the income statement, sustainable in terms of the cash flow and shown to have an affordable rate of investment according to the balance sheet.

However, this cannot be stated for the satellite towns that return a substantially inferior financial position taking into consideration all three financial statements forecast for these areas. It can further be stated (in general terms) that the satellite areas neither have the liquidity at present nor are they likely to have this in future to cover costs and as such, not be able to honour the obligations of a loan required to implement the much needed investments.

Clustering Harare Water together with the satellite areas does however present an opportunity of achieving a financially sustainable result and at the same time be in a position to refund the loan required to implement the much needed capital investments in all areas.

While the existing loan from Exim Bank has provided for the funding of capital investments in Harare worth USD 130 million, the terms and conditions of a 5-year repayment period at an interest rate of 3.5 % p.a. poses a heavy burden on the entity. Nonetheless, the financial model shows that by and large it is possible to still afford an additional loan or loans required to implement the medium to long-term investment plan as proposed herein and service the existing loan obligations, however with the result that there are occasional periods during which the forecast financial performance may require assistance from the shareholders of the entity.

The two alternative investment plan scenarios offered in this investment plan do provide scope for reducing the financial burden on the entity. However, these do not offer the same degree of satisfactory long-term technical solutions. Since the first option can be afforded, it would be advisable to consider re-negotiating the existing loan towards more favourable conditions in order to comfortably take on the full investments recommended and detailed under the investment scenario 1.

As indicated above, the full investment for all areas, i.e. including all satellite towns, is best achieved under a single entity that clusters all areas into one more capable organisation.

In view of the above, it is therefore recommended to cluster the areas and prioritise the investment plan as detailed under scenario 1.

CHAPTER 12: ENVIRONMENTAL MANAGEMENT FRAMEWORK

12 ENVIRONMENTAL MANAGEMENT FRAMEWORK

12.1 Introduction

The overall thrust of the investment plan is to improve and optimize the future delivery of water and sewerage treatment services within Greater Harare, such that in future the residents of Greater Harare have adequate access to safe and clean water and an efficient system for the disposal of waste water. In doing so it is important that this objective is achieved within the context of safeguarding the wider environment, such that the overall result is a healthy population coupled with a healthy environment. To achieve this requires that environmental and social concerns are identified and incorporated into all stages of the management cycle, from planning through to implementation and operation.

The purpose of this section is to outline a general framework to provide for the incorporation of environmental and social concerns within subsequent implementation of the investment plan and operation of the resulting infrastructure. In this respect it is relevant to note that the investment plan builds on and, in many instances, extends existing infrastructure, such that it comprises a mix of rehabilitation, improvement and extension of existing water and sewerage treatment systems plus, in some cases, the construction of new infrastructure.

The section starts by outlining the relevant national policies and legislation pertinent to the management of water resources and the environment in Zimbabwe, and identifying the key management institutions and outlining their general roles (Section 12.2). Thereafter, consideration is given to the formal procedure for conducting environmental impact assessments in Zimbabwe, and how this will be incorporated as part of the investment process (Section 12.3), as well as to supporting international assessment procedures (Section 12.4). This is followed by a summary of the major project works proposed for Greater Harare, and general guidance as to how environmental and social concerns will be incorporated and addressed within the investment cycle (Section 12.5).

12.2 Zimbabwe Policies, Legislation and Institutions

12.2.1 Constitution of Zimbabwe

The newly adopted “Constitution of Zimbabwe”, as part of the declaration of rights (Chapter 4), specifically recognizes the rights of all persons to safe, clean and potable water (Section 77) and to an environment that is not harmful to their health or well-being, and to have the environment protected for the benefit of present and future generations (Section 73) (Table 12-1).

12.2.2 Key Ministries

There are three ministries that share key responsibilities towards the successful delivery of adequate water and sanitation services within a context of maintaining a healthy environment, namely the:

- Ministry of Local Government, Public Works and National Housing,
- Ministry of Environment, Water and Climate, and
- Ministry of Health and Child Care.

The general responsibility of each is outlined in Table12-2, together with relevant policies, strategies and legislation in Table 12-3. There are other Ministries that play a strong supporting role, such as the Ministry of Finance which is responsible for raising the necessary funds for infrastructure development.

Table 12-1: Extracts from the Constitution of Zimbabwe

Section	Statement
Section 73: Environmental rights	(1) Every person has the right— (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures that— (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting economic and social development. (2) The State must take reasonable legislative and other measures, within the limits of the resources available to it, to achieve the progressive realisation of the rights set out in this section.
Section 77: Right to food and water	Every person has the right to— (a) safe, clean and potable water; and (b) sufficient food; and the State must take reasonable legislative and other measures, within the limits of the resources available to it, to achieve the progressive realisation of this right.

Table 12-2: Core Ministries Involved in the Provision of Water and Sanitation Services

Ministry	Responsibilities
Ministry of Local Government, Public Works and National Housing	Establishing and supervising the functions of urban authorities. The urban councils are responsible for delivery of water and waste water treatment services to residents.
Ministry of Health and Child Care	Promoting the health and quality of life for all people of Zimbabwe
Ministry of Environment, Water and Climate	Development and management of water resources and management and protection of the environment

The Ministry of Local Government, Public Works and National Housing is responsible for supervising local authorities and regional development including both the rural and urban areas. These functions are governed by three pieces of legislation: the Urban Councils Act, the Rural District Councils Act and the Provincial Councils and Administration Act. The Urban Councils Act (Chapter 29:15) provides for the administration of the country's towns and cities. Urban Councils are ranked, according to their size and levels of development, into cities, municipalities, towns and local boards. The Act affords the Minister of Local Government, Public Works and National Housing wide ranging supervisory powers over urban authorities. The provision for input by civil society, in contrast, is relatively weak and poorly developed.

Under the Urban Councils Act, urban councils are mandated to provide water and waste water treatment services to residents, as well as to take responsibility for environmental protection. In doing so, the Act does not preclude the possibility of delegating responsibility to a designated service provider (public, private or mixed). The manner in which water and

sanitation services are organised varies from one council to the next, for example as part of the Department of Engineering, or Department of Works, etc.

The Ministry of Health and Child Care is responsible for promoting the health and quality of life for all people in Zimbabwe. As part of its Preventative Services, the Ministry includes a Department of Environmental Health which administers the Public Health Act (Chapter 19 of 1924) and related regulations. The Public Health Act (Chapter 15:09) clearly states that it is the duty of a local authority to furnish water supplies in line with health requirements. It also requires other agencies providing water in an area, such as ZINWA, to comply with this requirement. The Public Health Act also requires the local authority to maintain existing water supplies in good working order.

Table 12-3: Key Policies, Strategies, Plans, Legislation and Regulations

Responsible Ministry	Policies, legislation, strategies and plans
Ministry of Local Government, Public Works and National Housing	Urban Councils Act (Chapter 29:15), 1997
Ministry of Health and Child Care	Public Health Act of 1924
	Public Health (Effluent) Regulations, 1972
	The National Health Strategy for Zimbabwe 2009-2013
Ministry of Environment, Water and Climate	Zimbabwe National Water Authority Act (Chapter 20:25), 1998
	Water Act (Chapter 20:24), 2002
	National Water Policy 2013
	Environmental Management Act (Chapter 20:27), 2002
	Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007
	Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations, 2007
	National Environmental Policy (2009)
Standards Association of Zimbabwe	Zimbabwe Standard No. 560:1997 (Water for Domestic Supplies)

Specific functions of the Department of Environmental Health include conducting water quality inspections and samples on drinking water sources. Under the Public Health (Effluent) Regulations, 1972, the Department also plays a role in terms of water pollution control, specifically in terms of monitoring the microbiological content of effluents. The Department delivers these services through officers at the national, provincial, district and ward levels.

Responsibility for management of water and environmental resources is primarily vested in the newly constructed Ministry of Environment, Water and Climate, which combines the previously separate Ministry of Environment and Natural Resources Management, and Ministry of Water Resources and Development. The key policies and acts for management

of the environment and water are the National Environmental Policy (2009) and the Environmental Management Act (2002, updated 2007), together with the Water Act (2002) and the recently updated National Water Policy (2013).

12.2.3 Management of Water Resources

The recent National Water Policy defines the vision for urban water supply and sanitation services as follows:

'All urban water users should enjoy adequate, continuous, readily accessible, safe, hygienic, sustainable and affordable domestic water and sanitation services provided by accountable, efficient, coordinated, funded and capacitated institutions'

The policy document demands for adequate and affordable services to all residents and underlines the importance of efficient and conservative management principles when producing and supplying drinking water. These principles have been centrally incorporated into the process of development of the investment plan, as outlined in Chapter 6, which summarises the key strategies applied during the planning process in order to optimize the delivery of efficient, sustainable and affordable water and waste water treatment services.

12.2.4 Environmental Management

The National Environmental Policy and Strategy was gazetted in June 2009. Its vision closely follows that of the National Development Objective of the government 'to alleviate poverty and improve the quality of life of the people of Zimbabwe'. In line with this vision, the goal of the National Environmental Policy is:

"*To avoid irreversible environmental damage, maintain essential environmental processes, and preserve the broad spectrum of biological diversity so as to sustain the long-term ability of natural resources to meet the basic needs of people, enhance food security, reduce poverty, and improve the standard of living of Zimbabweans through long-term economic growth and the creation of employment."*

The Environmental Management Act (Chapter 20:27), 2002 (amended 2006) is the primary legislation dealing with environmental management in Zimbabwe. The intention of the Environmental Management Act was to consolidate previously disparate environmental legislation into a single act, and in so doing to provide an overall and integrated approach to environmental management. It aims to provide for sustainable management of natural resources and protection of the environment and prevention of pollution and environmental degradation.

One of the requirements under the Environmental Management Act is for the Minister to prepare a National Environmental Plan and for each local authority to prepare a local Environmental Action Plan for the area under its jurisdiction. This requirement has yet to be complied with in any of the project areas.

The Act provides for the establishment of an Environmental Management Agency (EMA) and lays out the responsibilities of EMA in terms of overseeing environmental management in the country. One of the functions of EMA is to develop and enforce environmental quality standards for various parameters including minimum quality standards for water for different uses, and for the discharge of effluent into the environment. As yet, EMA has not produced standards for drinking water quality. This has previously been done by the Standards Association of Zimbabwe, whereby Zimbabwe Standard No. 560:1997 (Water for Domestic Supplies) lays down the minimum physical, chemical and bacteriological

requirements for purity as delivered to the consumer, of water for domestic supplies regardless of source. Reference is also commonly made to the World Health Organization guidelines for drinking water quality.

EMA has produced regulations concerning the discharge of effluent to the environment, known as the Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007. According to the regulations no person shall dispose of effluent into a public stream or into any other surface water or ground water, whether directly or through drainage or seepage, except under a licence. The regulations provide criteria for a wide range of physical, chemical and bacteriological parameters, according to which effluent can be categorized into four categories:

- Blue – safe;
- Green – low hazard;
- Yellow – medium hazard;
- Red – high hazard.

Any person wishing to dispose of effluent is required to apply for and receive a permit for the appropriate class of licence. Such a licence is valid for one year and needs to be updated annually.

Another of the key functions of the EMA is to manage the environmental impact assessment (EIA) process, which provides for the incorporation of environmental assessment and management in all economic and development activities, as outlined in the following section.

EMA carries out its duties through a network of national, provincial and district offices and officers.

12.3 Zimbabwe Procedures for Environmental Impact Assessments

The Environmental Management Act identifies those projects for which an EIA is required, as listed in the First Schedule of the Act (Table 12-4). According to the Act:

- A person who proposes to embark on any of the projects listed in the First Schedule is required to submit an EIA report to the Director-General;
- The developer can only embark on the project if she/he has obtained a certificate from the Director-General;
- It is an offence for any person to knowingly implement a project without a certificate showing that an EIA has been carried out.

The process for environmental review and conducting an EIA are outlined in the Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations of 2007. Before carrying out an EIA for a prescribed activity, the developer must first submit a prospectus to EMA. The prospectus should provide the following information:

- A description of the proposed project;
- A description of the anticipated environmental and social impacts; and
- Terms of reference for the proposed environmental impact assessment.

Table 12-4: Sectors for which an EIA is Mandatory (Source: EMA, First Schedule, 2007)

Sector	Notes
Dams and man-made lakes	It is an offence to embark on any of these listed projects unless one is in possession of a licence from the Minister. In order to apply for a licence one must first prepare an EIA report for submission and approval to the Environmental Management Agency. The procedure for preparation, submission, review and approval of EIAs is regulated under the Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations of 2007. The Ministry has prepared sector guidelines to assist in the preparation of EIAs for each of these listed sectors. The fee for submission of an EIA is 1.5% of the estimated investment.
Drainage and irrigation	
Housing developments	
Industry	
Infrastructure	
Mining and quarrying	
Petroleum production, storage and distribution	
Power generation and transmission	
Tourist resorts and recreational developments	
Waste treatment and disposal (including municipal sewage: waste treatment plants, outfalls into aquatic systems and effluent water irrigation schemes)	
Water supply (including water withdrawals from rivers or reservoirs and major pipelines)	

In response to the prospectus, the Director General may require the developer to submit additional information or, if satisfied that the proposed EIA is capable of evaluating the project's impact on the environment, approve the prospectus and ask the developer to proceed with the EIA.

Once the EIA has been completed this must be submitted to EMA for review. Once again, the Director General may either approve the EIA or else, request for additional information. If the project is approved, the Director-General will issue a certificate, which serves as authorization for the project to be implemented.

To assist the EIA process, the former Ministry of Environment and Tourism in 1997 published Environmental Impact Assessment Guidelines. The purpose of these guidelines is to facilitate the implementation of EIAs within specific sectors, including the water and waste management sectors. For each sector the guidelines provide examples of major activities that are likely to be undertaken for projects in that sector; the types of environmental impacts that are likely to result; possible measures for managing such impacts; sample terms of reference for EIA studies; and useful sources of information for use in an EIA study.

Public participation

Public participation is a requirement of the EIA process, and the policy states that the public should participate in the preparation and review of EIA reports. Such consultations typically focus on determining the probable impacts and the mitigation measures that will be acceptable to the community involved.

12.4 International Policies and Procedures

Implementation of the investment plan is likely to depend to a greater or lesser extent on securing foreign investment, for example through the African Development Bank or World Bank. In this case there will be an additional need to comply with environmental and social assessment policies and procedures of the relevant investment agency. For example, the AfDB, in accordance with their environmental and social assessment procedures (2003), classified the existing Urgent Water Supply and Sanitation Rehabilitation Project, as a Category 2 project, this being a project likely to induce site-specific environmental and/or social impacts but that can be minimised by the application of mitigation measures. For Category 2 projects it is necessary to prepare an Environmental and Social Management Plan.

12.5 Framework for Environmental and Social Management

12.5.1 Summary of Works

The following works are proposed for Greater Harare for the medium and long-term for water supply (Table 12-5) and for treatment of waste water (Table 12-6). An indication of the level of environmental assessment likely to be required for each component (ESMP or EIA) is also provided.

For each town and for both water supply and waste water treatment works, it will be possible to address the environmental management for some of the proposed works through an ESMP whilst other works will require a more detailed EIA. Water supply works that will require a full EIA include:

- Construction of the Kunzvi Water Supply Scheme (Harare),
- Construction of new reservoirs (all component towns),
- Construction of new treated water transmission mains (Chitungwiza), and
- Extension of the distribution system to new service areas (all component towns).

Other works that can probably be addressed though an ESMP include:

- Rehabilitation of existing water treatment plants (Harare, Ruwa),
- Upgrading of existing treated water transmission mains (Chitungwiza, Norton, Ruwa),
- Rehabilitation of existing storage reservoirs (Chitungwiza, Epworth, Norton, Ruwa), and
- Rehabilitation and upgrading of existing water distribution network (all component towns).

For the waste water treatment works, the following works will require an EIA:

- Construction of new outfall sewers (Harare, Chitungwiza, Norton, Ruwa),
- Construction of new waste water treatment plants (Harare, Norton), and
- Extension of the sewer reticulation system to new service areas (all component towns).

Other works that can probably be addressed though an ESMP include:

- Rehabilitation of existing sewer reticulation networks and sewers (Harare, Chitungwiza, Norton, Ruwa),
- Rehabilitation of sewer pump stations (Chitungwiza), and

- Rehabilitation of existing waste water treatment plants (Harare, Chitungwiza, Norton).

Table 12-5: Summary of Water Supply Works

Centre	No	Description	
Harare	1	Construction of Kunzwi Water Supply Scheme (Intake, raw water main, water treatment plant [150,000 m3/d nominal capacity], two booster stations, 39 km clear water transmission pipeline to Donnybrook Terminal Reservoirs, 50 km of transmission lines in the distribution network)	EIA
	2	Rehabilitation of water treatment plants (Morton Jaffray and Prince Edward)	ESMP
	3	Construction of new reservoir along Shamva road in the Sally Mugabe area	EIA
	4	Implementation of NRW reduction programme (network investigations, pipe replacements, valve replacements, replacement of all service connections, installation of water meters on all service connections (about 192,000), installation of bulk meters to restore old DMAs)	ESMP
	5	Extension of water distribution network to new service areas	EIA
Chitungwiza	1	Upgrading of existing water transmission mains (12.4 km)	ESMP
	2	Installation of new treated water transmission mains (36 km)	EIA
	3	Rehabilitation of existing storage reservoirs	ESMP
	4	Construction of new storage reservoirs (Makoni Reservoir and reservoir to supply Nyatsime development)	EIA
	5	Implementation of NRW reduction programme (network investigations, pipe replacements, valve replacements, replacement of all service connections, installation of water meters on all service connections)	ESMP
	6	Extension of distribution network to new service areas	EIA
Epworth	1	Installation of new treated water transmission main from Ruwa to the Epworth storage tanks	EIA
	2	Rehabilitation of existing storage reservoirs	ESMP
	3	Phased construction of new storage reservoirs	EIA
	4	Upgrading and rehabilitation of water distribution system, including installation of water kiosks	ESMP
	5	Extension of distribution system to new service areas	EIA
Norton	1	Upgrading of existing treated water main transmission system	ESMP
	2	Rehabilitation of existing storage reservoirs	ESMP
	3	Phased construction of new storage reservoirs	EIA
	4	Upgrading and rehabilitation of water distribution system, including installation of water kiosks	ESMP
	5	Extension of water distribution system to new service areas	EIA

Centre	No	Description	
Ruwa	1	Completion of raw water transmission main from Nora Dam to Ruwa	ESMP
	2	Upgrading of the Ruwa Water Treatment Plant	ESMP
	3	Rehabilitation of existing storage reservoirs	ESMP
	4	Phased construction of new storage reservoirs	EIA
	5	Upgrading and rehabilitation of water distribution system, including installation of water kiosks	ESMP
	6	Extension of distribution system to new service areas	EIA

Table 12-6: Summary of Waste Water Treatment Works

Centre	No	Description	
Harare	1	Replacement of collapsed and under-capacity sewers	ESMP
	2	Construction of new outfall sewer (the Harare South Outfall Sewer from Ruwa and Donnybrook down to near the confluence of Manyame and Nyatsime rivers)	EIA
	3	Rehabilitation of all wastewater treatment plants (Firle, Crowborough, Marlborough and Hatcliffe). The Donnybrook ponds will be abandoned after construction of the Harare South Outfall sewer and associated treatment facility	ESMP
	4	Construction of new waste water treatment works (the Harare South WWTW)	EIA
	5	Extension of the sewer reticulation system to new service areas	EIA
Chitungwiza	1	Rehabilitation and upgrading of sewer reticulation network	ESMP
	2	Rehabilitation of Tilco Pump Station	ESMP
	3	Installation of new outfall sewers (22 km)	EIA
	4	Rehabilitation of Zengeza waste water treatment works - BNR plant	ESMP
	5	Rehabilitation of Zengeza waste water treatment works – modified conventional works (biological filters and ponds)	ESMP
	6	Extension of sewer reticulation system to new service areas	EIA
Epworth	1	Extension of sewer reticulation system	EIA
Norton	1	Rehabilitation of sewer reticulation network	ESMP
	2	Construction of new outfall sewer – the Western Areas Trunk Sewer(s)	EIA
	3	Rehabilitation of existing waste water treatment works	ESMP
	4	Construction of new Western Waste Water Treatment Works	EIA
	5	Extension of sewer reticulation system to new service areas	EIA

Centre	No	Description	
Ruwa	1	Construction of new trunk sewer to connect Ruwa to the new Harare South Outfall Sewer	EIA
	2	Construction of a new set of ponds	EIA
	3	Rehabilitation of sewer reticulation network	ESMP
	4	Extension of sewer reticulation system to new service areas	EIA

12.5.2 Planning

In terms of the overall project cycle from planning to implementation to operation, the present investment plan effectively covers the planning stage, at least in broad terms. In preparing the investment plan consideration of environmental and social concerns has been incorporated into all of the proposed investment components (Table 12-7).

For many aspects, the scope of possible options has been constrained by the need to incorporate and build on existing water and sanitation infrastructure, for example in terms of potential locations for treatment plants and the types of technologies to be used.

The major exception, in terms of water supply, is the construction of the Kunzvi Water Supply System. Detailed feasibility studies for the Kunzvi system have previously been carried out, although these will need to be updated.

In terms of sanitation one of the key planning considerations is how to optimally extend sewer services to the southern portions of the city, where much of the future expansion is envisaged to occur, and to treat the resulting waste water. These issues have been examined and analysed in a series of three discussion papers. These include consideration of factors such as: impacts to catchment water flows and water supply from the Manyame catchment, the location and quality of effluent releases, different types of treatment technology (pond systems with or without irrigation, BNR systems), efficiency of nutrient removal, one centralized versus numerous dispersed treatment plants, cost factors, (capital and operational and maintenance costs), predicted energy costs, affordability, land requirements, carbon budgeting and staffing requirements (numbers and skills). Based on these considerations it is proposed to construct a new trunk sewer around the south of the city, and then to pump and transfer the sewerage into the Mupfure catchment for treatment in ponds followed by disposal through land irrigation.

12.5.3 Construction and Operation

In addition to the construction of the Kunzvi water supply system, the Harare South outfall sewer, pump station and waste water treatment works, the construction of new water transmission mains, water storage reservoirs, main sewers and the construction of a new waste water treatment facility in Norton, can be anticipated to require detailed EIA studies.

As regards the production of EIAs concerning the extension of water supply and sewers to new service areas, it is possible that these could be picked up by prospective developers rather than being incorporated as part of the existing investment plan.

The remainder of the proposed construction measures primarily focus on the rehabilitation of existing infrastructure, such that it should be possible to adequately address potential environmental and social concerns through preparation of an Environmental and Social Management Plan. Such plans should identify potential environmental and social impacts

that might arise during the construction and operational phases, and provide detailed measures to mitigate the potential detrimental impacts of these. The ESMPs should be prepared in such a way that it also meets the requirements of any international financing agencies that may be supporting the investment process.

Table 12-7: Incorporation of Environmental and Social Concerns

Component	Relation to environmental and social concerns
Characteristics of the project area	Enables the identification of potentially sensitive areas and potential environmental issues of concern
Demographic profile	Enables estimates of future levels of demand for water and sanitation services and the spatial pattern of demand
Water source	Assesses the adequacy of existing water sources to meet future demands in terms of quantity of water and quality of water
Water supply service improvements and extension	To enable delivery of adequate services to all residents in terms of quantity/reliability and quality of water Design for flexible service levels and water that is affordable to consumers
Water demand management	To promote conservative and efficient use of water and energy, reduction of wastage and improved financial performance
Sanitation service improvements and extension	To enable improved collection and treatment of sewage and to promote public health To improve quality of effluent released to the environment and to reduce leakages from sewers
Revenue improvement programme	Modern and improved billing and infrastructural management systems are essential requirements for long term sustainability of services
Operations improvement programme	Improved tools, equipment and systems for operations and maintenance procedures, leading to improved sustainability of services
Management and technical information systems	Improved accounting and asset management systems leading to improved sustainability of services
Training and capacity building	Improved skills and performance of staff Improved occupational health and safety
Public awareness and sensitization campaigns	Essential component for incorporating and managing social concerns
Provision for consulting services	Enables access to essential skills to promote coordinated planning and delivery of services

CHAPTER 13: RISK ASSESSMENT

13 RISK ASSESSMENT

This chapter summarises the specific issues that need special consideration when progressing to the next project phases, the detailed studies, designs and implementation of the works. When developing this investment plan, specific assumptions were made regarding technical design criteria and standards, the economic growth and political stability, the institutional arrangements within the councils regarding water and sewerage operations and available financial arrangements. All such assumptions impact in various ways and magnitude on the investment programme, from planning all the way through to implementation and operation. The risks can be grouped into four main categories as follows:

- Principle Design Criteria – assumptions made with regard to principal design criteria;
- Institutional Arrangements and Financing – assumptions made regarding sustainability of the investment measures and availability of funds to implement them;
- Project Implementation – assumptions made regarding the scheduling of the implementation programme;
- Sustainability Issues – assumptions regarding operational improvements

13.1 Risk Assessment of Principle Design Criteria

The principle design criteria determine largely the layout and implementation schedule of the infrastructure components, some of the design criteria are critical and the rating of the risk is medium to high. The responsibility to develop suitable criteria is with the Consultant. Such criteria will be fine-tuned during subsequent planning stages as more refined data becomes available. Additional information such as; flow, pressure, quality, effluent and other operational data collected by the Council during their operations will improve the quality of design criteria. The responsibility to review and approve the proposed criteria is with the World Bank and the Councils.

Table 13-1: Risks and mitigation measures of principle design criteria

Risk	Rating	Risk Mitigation Measure	Responsibility
Population growth assumptions – key planning criteria that influences size of infrastructure and cost	High	Wide consultations with key stakeholder such as councils. Engagement of a qualified demographer to validate the assumptions on demographic projections	Consultant, Councils, World Bank
Water demand forecast	High	Use of water demand forecasting criteria from industry reviewed standards and design guidelines	Consultant, Councils, World Bank
Water loss assumptions	Medium to high	Implementation of network rehabilitation measures, implementation of operational improvement measures	Government , Financiers, Councils,
Availability of water resources – yield and water	High	Updated yield assessments to provide accurate yield figures,	ZINWA, Councils and

Risk	Rating	Risk Mitigation Measure	Responsibility
rights issues		development of new sources in other catchments, transparency and fairness in water rights allocations	Financiers,
Establishment of pressure and supply zones	Medium	Planning and implementation of measureable and controllable zones, bulk meter installations	Consultant, Councils, Financiers
Cost estimates and overrun	Medium	Cost comparison with other projects in the region, inclusion of physical and price escalation contingencies	Consultant, Councils, Financiers
Public health	Low to medium	Planning of adequate and improved water and sanitation infrastructure to promote public health and safety. Implementation of these measures	Consultant, Council, Financiers

13.2 Institutional Arrangements and Financing

The institutional arrangements and the financing risks of the investment measures are mainly with the Government of Zimbabwe and the various other financiers. The implementation of the National Water Policy will be a critical component of the project success. Institutional and organisational changes, the involvement of the private sector and other key policy principles will promote the successful implementation of the investment measures and lead to sustainable operations.

Table 13-2: Risks and mitigation measures of institutional arrangements and financing

Risk	Rating	Risk Mitigation Measure	Responsibility
National Water Policy implementation	Medium to high	Government commitment to the implementation of the policy strategies	Government of Zimbabwe
Creation of semi-autonomous water utility company	Medium to high	Government commitment to the implementation of the policy devolution strategies	Government of Zimbabwe
Restructuring of council organisation	Medium to high	Ring-fencing of funds and responsibilities, change of organisational structure, re-organisation, change of responsibilities, change management	Government of Zimbabwe, Council
Availability of funds on time	Medium	Coordinated effort by all key parties	GoZ, WB, and other financiers
Capacity to manage the funds and expenditure	Medium	Setting up of a well-staffed project implementation unit	World Bank, Councils
Corruption	Medium to high	Rigid application of Government policies and procedures for anti-corruption practices.	Government of Zimbabwe

13.3 Project Implementation

Given that there is no financial commitment yet for the implementation of the project measures under this investment plan, there is a huge risk that the priority investment measure which will set the foundation for improved service delivery and enable the service providers to operate in a sustainable manner, may not be implemented. The implementation is depended on the positive appraisal of the investment measures by the World Bank and other fanciers. Preparatory activities such as detailed studies and design must be financed and begin as quickly as possible. The responsibility to encourage financial support, secure funds and to follow the implementation schedule is with the Government, the World Bank and the Councils.

Table 13-3: Risks and mitigation measures of project implementation

Risk	Rating	Risk Mitigation Measure	Responsibility
Implementation schedule and milestones	Medium to high	Investment appraisal should be done as soon as possible so that the bankable projects are identifies and the financial mobilisation process can start quickly	GoZ, WB, other financiers
Investment funds	Medium to high	Financial commitment from government to demonstrate local contribution and encourage other cooperating partners to finance implementation	GoZ, WB, Donors
Delay in appointing a design and supervision Consultant	Medium	Preparation of ToR and allocation of sufficient time for procurement	GoZ, WB
Environmental and social impact considerations	Medium	Planning of necessary mitigation measures before, during and after implementation of works	Consultant, WB
Delay in appointing a Contractor	Medium	Review of Consultants design and tender documents on time, following clear procurement principles, time management	WB
Construction management and cost control	Medium	Selection of qualified consulting firm, professional cost, works quantity and quality control, control of delays	Consultant, WB

13.4 Sustainability Issues

In order to ensure the sustainability of the investments and the whole undertaking of proving water supply and sanitation services to the urban population, the issues listed in the Table 13-4 are cardinal.

Table 13-4: Risks and mitigation measures of sustainability issues

Risk	Rating	Risk Mitigation Measure	Responsibility
Willingness to pay for services	Medium	Improved services and active collaboration with consumers	Councils, Consumers
Awareness and communication	High	Communication with consumers over utility operations, service and quality improvements	Council/ Utility Provider
Effective and efficient operation and maintenance	High	Selection of adequate staff, retrenchment of unqualified staff, continuous training and motivation of qualified staff	Council/ Utility Provider
Staff performance improvement	High	Staff and team performance targets and control, bonus schemes	Council/ Utility Provider
Billing efficiency and revenue collection	High	Up-to date billing data base, billing data surveys, follow-up defaulting consumers, disconnection policy	Council/ Utility Provider, GoZ
Continuous NRW programme	High	Importance of technical and commercial interactions to reduce NRW, technical and commercial audits	Council/ Utility Provider
Organisational strengthening	Medium to high	Independent structure within Council, support and assistance to maintain independence in terms of revenue allocation and financing	Council/ GoZ
Political interference	Medium to high	Clear governance rules and principles	Government of Zimbabwe