Infrastructure Master Plan 2020
2020/2021 – 2050/2051

Volume 7:
Buffalo System

Infrastructure Development Division, Umgeni Water

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Umgeni Water

Infrastructure Master Plan 2020

2020/2021 – 2050/2051

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PREFACE

This Infrastructure Master Plan 2020 describes:

- Umgeni Water's infrastructure plans for the financial period 2020/2021 – 2050/2051, and
- Infrastructure master plans for other areas outside of Umgeni Water's Operating Area but within KwaZulu-Natal.

It is a comprehensive technical report that provides information on current infrastructure and on future infrastructure development plans. This report replaces the last comprehensive Infrastructure Master Plan that was compiled in 2019 and which only pertained to the Umgeni Water Operational area.

The report is divided into **ten** volumes as per the organogram below.

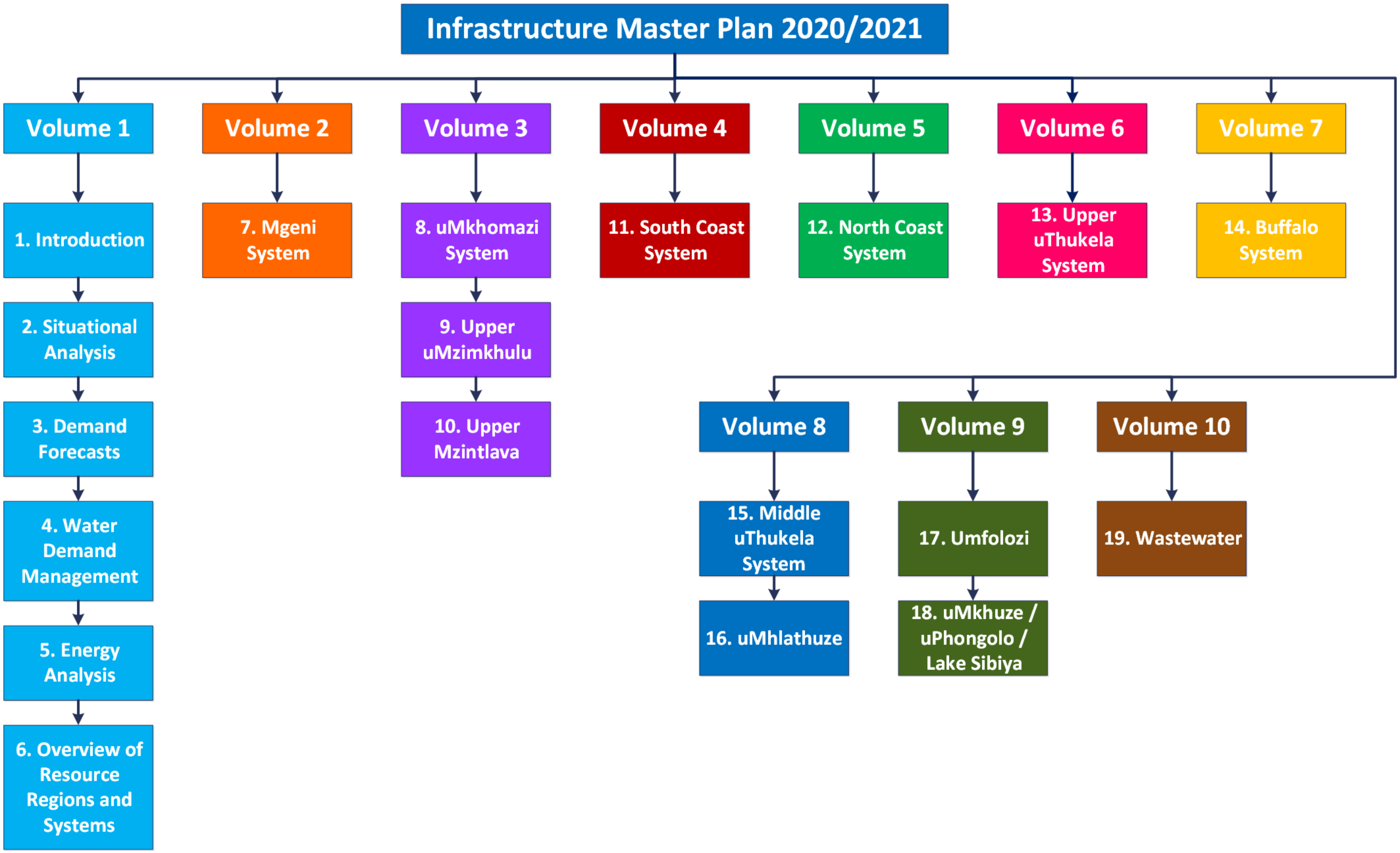
Volume 1 includes the following sections and a description of each is provided below:

- **Section 2** describes the most recent changes and trends within the primary environmental dictates that influence development plans within the province.
- **Section 3** relates only to the Umgeni Water Operational Areas and provides a review of historic water sales against past projections, as well as Umgeni Water's most recent water demand projections, compiled at the end of 2019.
- **Section 4** describes Water Demand Management initiatives that are being undertaken by the utility and the status of Water Demand Management Issues in KwaZulul-Natal.
- **Section 5**, which also relates to Umgeni Water's Operational Area, contains a high level review of the energy consumption used to produce the water volumes analysed in **Section 3**.
- **Section 6** provides an overview of the water resource regions and systems supplied within these regions.

The next eight volumes describe the current water resource situation and water supply infrastructure of the various systems in KwaZulu-Natal, including:

• **Volume 2**	**Section 7**	Mgeni System.
• **Volume 3**	**Section 8**	uMkhomazi System
	Section 9	uMzimkhulu System
	Section 10	Mzintlava System
• **Volume 4**-	**Section 11**	South Coast System
• **Volume 5**	**Section 12**	North Coast System
• **Volume 6**	**Section 13**	Upper uThukela System
• **Volume 7**	**Section 14**	Buffalo System
• **Volume 8**	**Section 15**	Middle uThukela System
	Section 16	Mhlathuze System
• **Volume 9**	**Section 17**	Umfolozi System
	Section 18	uMkhuze / uPhongolo / Lake Sibiya System

Volume 10, Section 19 describes the wastewater works currently operated by Umgeni Water (shown in pale brown in the adjacent figure) and provides plans for development of additional wastewater treatment facilities. The status of wastewater treatment in WSA's that are not supplied by Umgeni Water are also described in this section.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Volume 1
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6. Overview of Resource Regions and Systems
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19. Wastewater

It is important to note that information presented in this report is in a summarised form and it is recommended that the reader refer to the relevant planning reports if more detail is sought. Since the primary focus of this Infrastructure Master Plan is on Umgeni Water's existing bulk infrastructure supply network, the water resource infrastructure development plans are not discussed at length. The Department of Water and Sanitation (DWS), as the responsible authority, has undertaken the regional water resource development investigations within Umgeni Water's area of operation. All of these investigations have been conducted in close collaboration with Umgeni Water and other major stakeholders in order to ensure that integrated planning occurs. Details on these projects can be obtained directly from DWS, Directorate: Options Analysis (East).

The Infrastructure Master Plan is a dynamic and evolving document. Outputs from current planning studies, and comments received on this document will therefore be taken into account in the preparation of the next update.

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AADD	Annual Average Daily Demand
AC	Asbestos Cement
ADWF	Average Dry Weather Flow
API	Antecedent Precipitation Index
AsgiSA	Accelerated and Shared Growth Initiative of South Africa
AVGF	Autonomous Valveless Gravity Filter
BID	Background Information Document
BPT	Break Pressure Tank
BWL	Bottom Water Level
BWSP	Bulk Water Services Provider
BWSS	Bulk Water Supply Scheme
CAPEX	Capital Expenditure
cl	class (of pipe)
CMA	Catchment Management Agency
CoGTA	Department of Co-operative Governance and Traditional Affairs
CWSS	Community Water Supply and Sanitation project
DAEA	Department of Agriculture and Environmental Affairs
DEA	Department of Environmental Affairs
DFA	Development Facilitation Act (65 of 1995)
DM	District Municipality
DMA	District Management Area
DRDLR	Department of Rural Development and Land Reform
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
DWAF	Department of Water Affairs and Forestry
EFR	Estuarine Flow Requirements
EIA	Environmental Impact Assessment
EKZN Wildlife	Ezemvelo KZN Wildlife
EMP	Environmental Management Plan
EWS	eThekwini Water Services
EXCO	Executive Committee
FC	Fibre Cement
FL	Floor level
FSL	Full Supply level
GCM	General Circulation Model
GDP	Gross Domestic Product
GDPR	Gross Domestic Product of Region
GVA	Gross Value Added
HDI	Human Development Index
HL	High Lift (reference to Pump Station)

IDP	Integrated Development Plan
IFR	In-stream Flow Requirements
IMP	Infrastructure Master Plan
IMQS	Infrastructure Management Query Statement
IRP	Integrated Resource Plan
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resources Management
KZN	KwaZulu-Natal
LM	Local Municipality
LUMS	Land Use Management System
MA	Moving Average
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MBR	Membrane Bioreactor
mill	million
MMTS	Mooi-Mgeni Transfer Scheme
MMTS-1	Mooi-Mgeni Transfer Scheme Phase 1
MMTS-2	Mooi-Mgeni Transfer Scheme Phase 2
mPVC	Modified Polyvinyl Chloride
MTEF	Medium-Term Expenditure Framework
MTSF	Medium-Term Strategic Framework
MWP	Mkomazi Water Project
MWP-1	Mkomazi Water Project Phase 1
N/A	Not Applicable
NCP-1	North Coast Pipeline I
NCP-2	North Coast Pipeline II
NCSS	North Coast Supply System
NGS	Natal Group Sandstone
NPV	Net Present Value
NSDP	National Spatial Development Perspective
NWSP	National Water Sector Plan
OPEX	Operating Expenditure
p.a.	Per annum
PES	Present Ecological Status
PEST	Political, Economical, Sociological and Technological
PGDS	Provincial Growth and Development Strategy
PPDC	Provincial Planning and Development Commission (KZN's)
PS	Pump Station
PSEDS	Provincial Spatial Economic Development Strategy
PWSP	Provincial Water Sector Plan
RCC	Roller Compacted Concrete
RDP	Reconstruction and Development Programme
Res	Reservoir

RO	Reverse Osmosis
ROD	Record of Decision
RQO	Resource Quality Objective
SCA	South Coast Augmentation
SCP	South Coast Pipeline
SCP-1	South Coast Pipeline Phase 1
SCP-2a	South Coast Pipeline Phase 2a
SCP-2b	South Coast Pipeline Phase 2b
SDF	Spatial Development Framework
SHR	St Helen's Rock (near Port Shepstone)
STEEPLE	Social/demographic, Technological, Economic, Environmental (Natural), Political, Legal and Ethical
SWRO	Seawater Reverse Osmosis
TEC	Target Ecological Category
TBC	To Be Confirmed
TBM	Tunnel Boring Machine
TLC	Transitional Local Council
TWL	Top Water Level
uPVC	Unplasticised Polyvinyl Chloride
UW	Umgeni Water
WA	Western Aqueduct
WC	Water Conservation
WDM	Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSNIS	Water Services National Information System
WSP	Water Services Provider
WSS	Water Supply Scheme
WTP	Water Treatment Plant
WWW	Wastewater Works

Spellings of toponyms have been obtained from the Department of Arts and Culture (DAC). DAC provides the official spelling of place names and the spellings, together with the relevant gazette numbers, can be accessed at http://www.dac.gov.za/content/toponymic-guidelines-map-and-other-editors.

When using any part of this report as a reference, please cite as follows:
Umgeni Water, 2020. *Umgeni Water Infrastructure Master Plan 2020/2021 – 2050/51, Vol 1 - 10*. Prepared by Planning Services, June 2020.

LIST OF UNITS

Length/Distance:	mm	millimetre
	m	metre
	km	kilometre
Area:	m^2	square metres
	ha	hectare
	km^2	square kilometres
Level/Altitude:	mASL	metres above sea-level
Time:	s	second
	min	minute
	hr	hour
Volume:	ℓ	litre
	m^3	cubic metres
	Mℓ	megalitre
	million m^3	million cubic metres
	mcm	million cubic metres
	kℓ	kilolitre
Water Use/Consumption/Treatment/Yield:	ℓ/c/day	litre per capita per day
	kℓ/day	kilolitre per day
	Mℓ/day	megalitre per day
	million m^3/annum	million cubic metres per annum
	kg/hr	kilograms per hour
Flow velocity/speed:	m/s	metres per second
Flow:	m^3/s	cubic metres per second
	ℓ/hr	litres per hour
	m^3/hr	cubic metres per hour

14. BUFFALO SYSTEM

14.1 Synopsis of the Buffalo System

The uThukela River, the largest river in KwaZulu-Natal (KZN), originates in the Mont-Aux-Sources of the Drakensberg Mountains (the source of the Orange and Vaal Rivers as well) and flows approximately 502 km through the KwaZulu-Natal (KZN) Midlands into the Indian Ocean. The uThukela River has a total catchment area of approximately 29 100 km^2 and it is shown in **Figure 14.2** that the uThukela catchment consists of the following water resource regions:

- Upper uThukela;
- Bushmans;
- Mooi;
- Sundays;
- **Buffalo;**
- Middle uThukela; and
- Lower uThukela.

Umgeni Water currently does not operate infrastructure in the Buffalo and Middle uThukela Water Resource Regions. The Lower uThukela Water Resource Region is discussed in **Section 11 in Volume 4** and the Mooi water resource region in **Section 7 in Volume 2**.

The **Buffalo System** (**Figure 14.1**) consists only of the Buffalo Water Resource Region (a secondary catchment, V3) as depicted in **Figure 14.2** , and the following settlements are supplied from this system:

- Newcastle central business district (CBD), industrial area and suburbs, Madadeni, Osizweni, Emadlangeni, Blaauwbosch, Waterval, Alcockspruit, Northdown, Signal Hill (all fed from the Ngagane WTP). These settlements fall under the Ntshingwayo/Newcastle Bulk Water Supply Scheme (BWSS).
- Dundee, Glencoe, Hattingspruit, Verdruk, Springlake Collieries, Sibongile, Sithembile and Wasbank (all fed from the Biggarsberg WTP). These settlements fall under the Biggarsberg BWSS.
- Nqutu CBD (and suburb), Bambisinani, Ndatshane, Ndindindi, Telezini, Izicole, Maceba, Ngonini, Ngobhoti, Jabavu, Masotsheni, St Augustines (all fed from the Vants Drift WTP), Isandlwana and Qhudeni (fed from their own package WTPs). These settlements fall under the Nqutu BWSS.

The Water Treatment Plants (WTPs) supplying these settlements are shown in **Figure 14.3** and although, as mentioned above**,** Umgeni Water does not operate any of these WTPs**.** The Buffalo River is the largest river in the Buffalo Water Resource Region, originating in the Mpumalanga Province (about 4km northeast of Volkrust at 2047 mASL) and flows approximately 339.13 km through to its confluence with the uThukela River. The total catchment area of the Buffalo River is approximately 9804 km^2, containing three tertiary catchments (V31, V32 and V33).

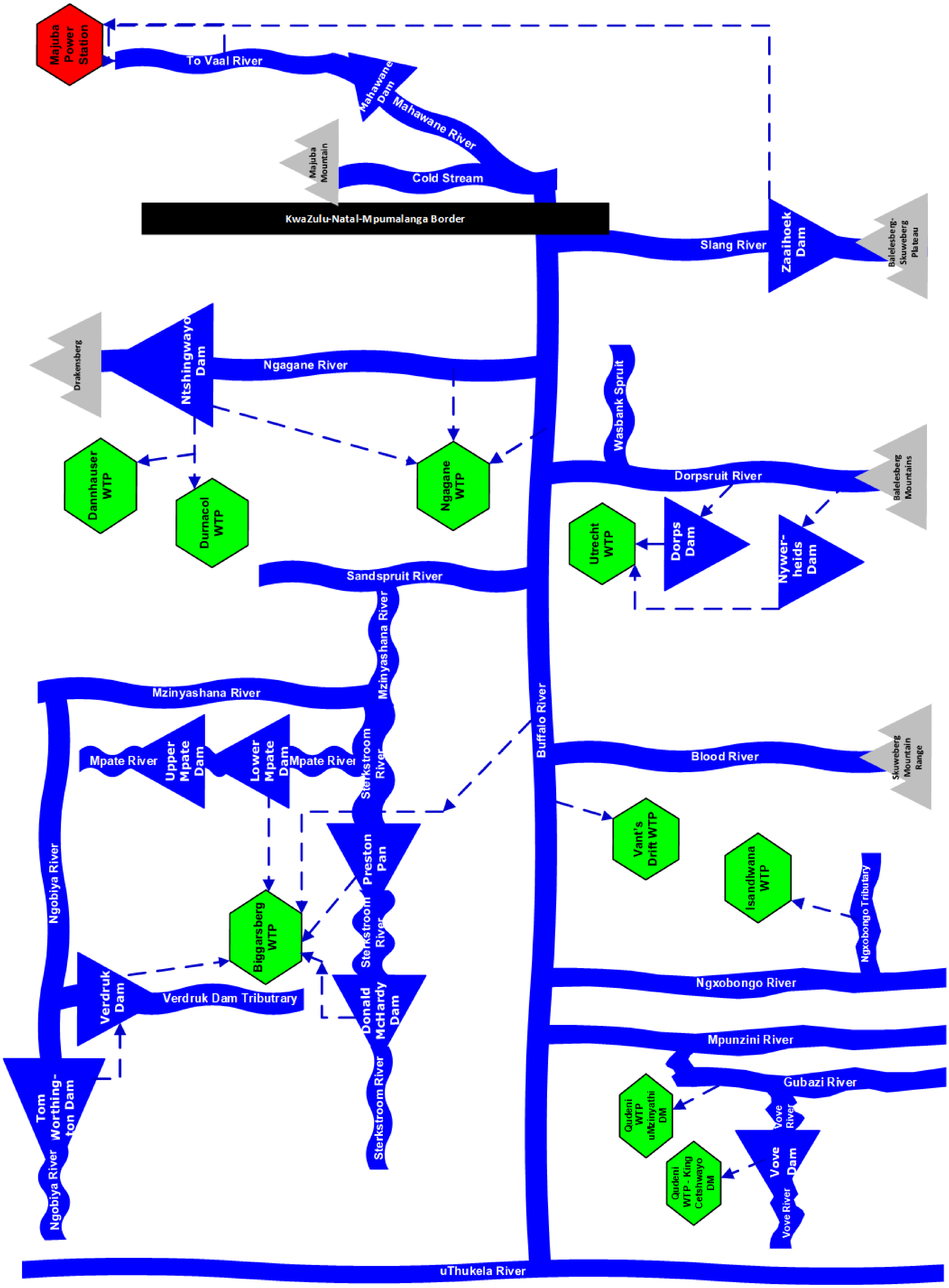

Figure 14.1 Schematic of the Buffalo River System

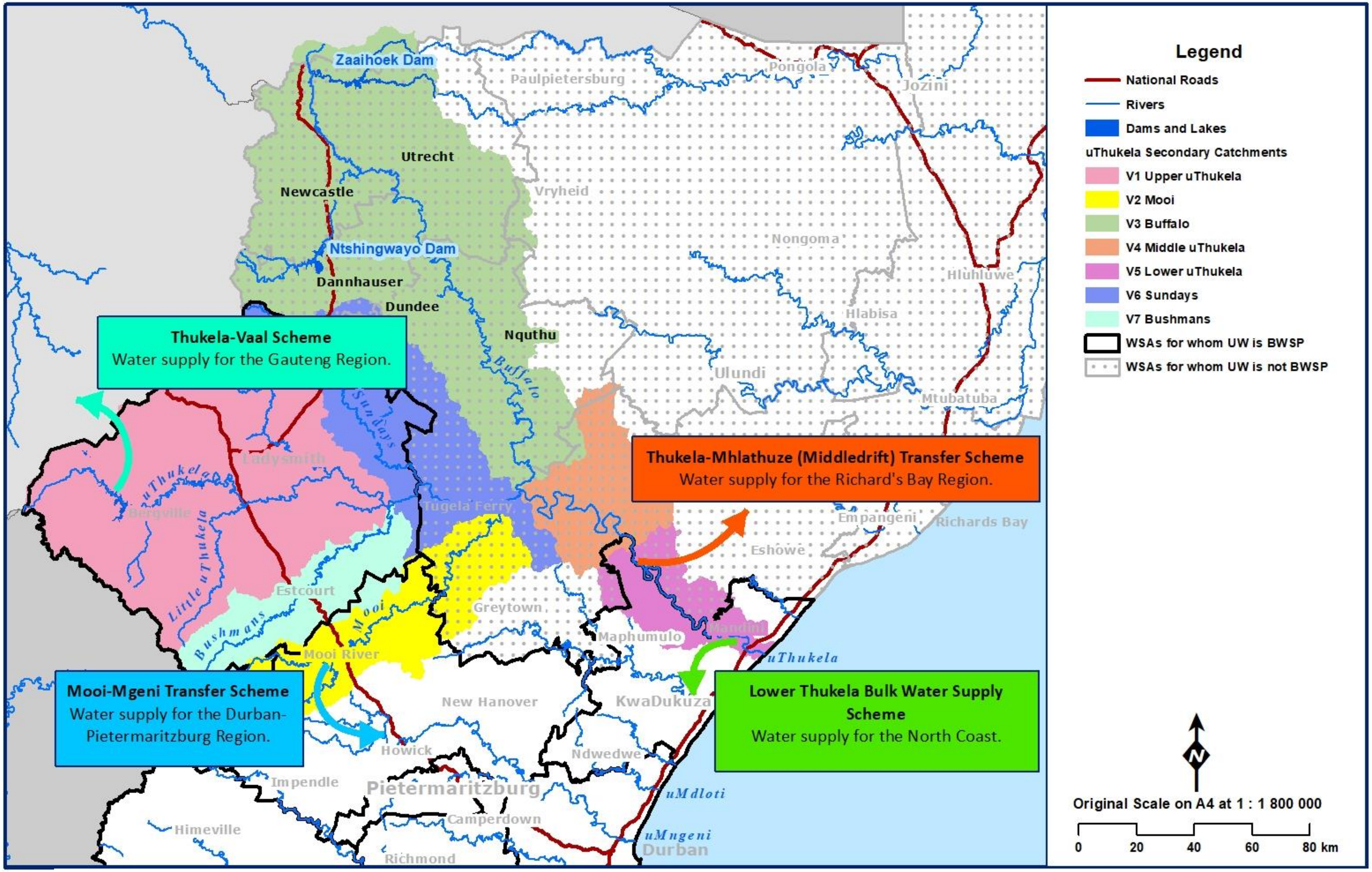

Figure 14.2 General layout of the uThukela River System (KZN DoT 2017, MDB 2016, Umgeni Water 2019, WR2012).

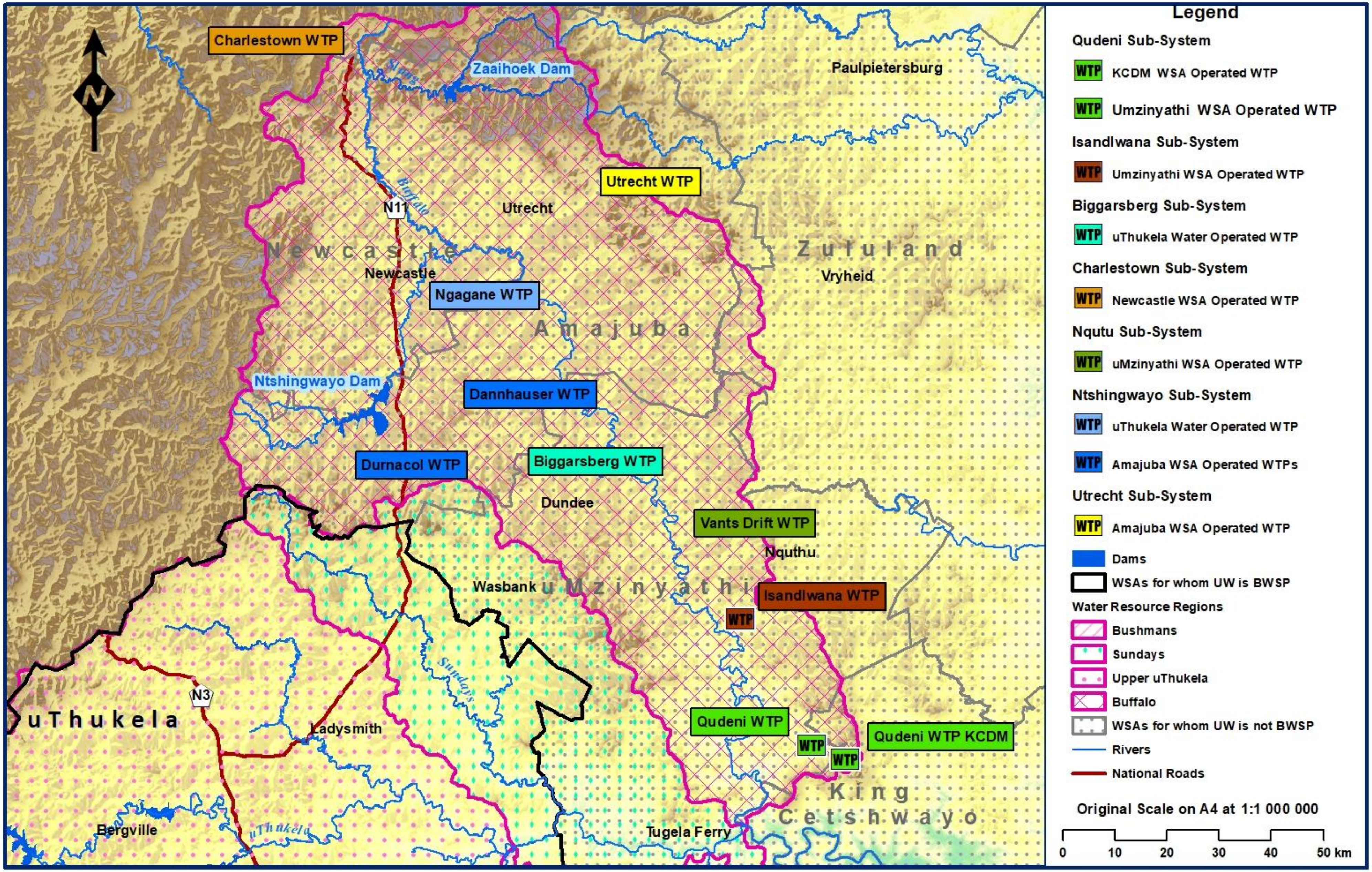

Figure 14.3 General Layout of the Buffalo System (KZN DoT, MDB 2016, Umgeni Water 2019, WR2012)

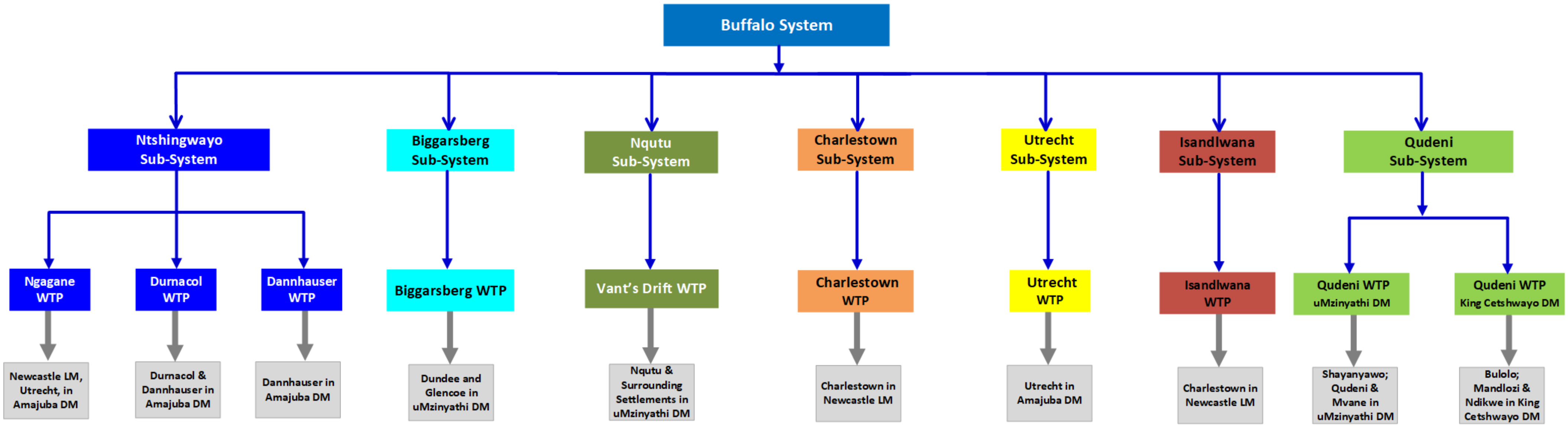

Figure 14.4 General Layout of the Buffalo System (KZN DoT, MDB 2016, Umgeni Water 2019, WR2012)

14.2 Water Resources of the Buffalo System

14.2.1 Description of the Buffalo System Water Resource Regions

(a) Buffalo Region

(i) Overview

The Buffalo River, the largest tributary of the uThukela River (**Section 13.1**) starts at the confluence of the Cold Stream and Mahawane Rivers, approximately 300 m south-east of the KwaZulu-Natal-Mpumalanga boundary as the crow flies (2929BD 1 : 50 000 Topographic Map 2012). The headwaters of the Mahawane, which flows between the settlements of Volksrust and Vukuzahke, are in Mpumalanga. The headwaters of the Cold Stream, which meanders on the western and northern side of Charlestown, are in the Majuba Mountains (approximately 6 km south-west of Charlestown as the crow flies) in KwaZulu-Natal. The Buffalo catchment traverses through Amajuba District Municipality before entering Umzinyathi District Municipality and then confluences with uThukela River in the Msinga Local Municipality.

The Buffalo River meanders in a south-easterly direction with important tributaries including the:

- Slang River, which flows in a westerly direction from its headwaters in the Balelesberg-Skuweberg Plateau (Umgeni Water 2019: 42) through the Zaaihoek Dam (approximately 6.3km south-west of the town of Wakkerstroom in Mpumalanga) to the confluence with the Buffalo River (approximately 3.6 km north-east of Charlestown as the crow flies). The Wakkerstroom (in Mpumalanga) and Thata Rivers join the Slang River at the inlet of the Zaaihoek Dam.
- Ngogo River, which flows in an easterly direction from its headwaters located approximately 1.4 km from the KwaZulu-Natal boundary with the Free State as the crow flies (2729DC 1 : 50 000 Topographic Map 2012), to the confluence with the Buffalo River approximately 2.1 km south east of the settlement of Ngogo as the crow flies (2729BD 1 : 50 000 Topographic Map 2013). The Harte River is a tributary of the Ngogo River.
- Ncandu River on the banks of which the town of Newcastle was originally developed (McCallum 2014: website[1]). The Ncandu River is a tributary of the Ngagane River. The headwaters of the Ncandu River are situated in the Low Drakensberg Escarpment (EKZNW 2009:7) approximately 230 m east of the KwaZulu-Natal-Free State border as the crow flies (2729DC 1 : 50 000 Topographic Map 2013).
- The Ncandu River meanders in a north-easterly direction, transecting the Ncandu Nature Reserve, flowing over the Ncandu Waterfall, and through the town of Newcastle (the Ingumduma River joins the Ncandu River approximately 310 m south-east of the Fort Amiel Museum as the crow flies) and the Amcor Dam (the Amcor Dam wall is located approximately 1.7 km east of the N11 freeway as the crow flies) before joining the Ngagane River upstream of the Madadeni settlement.

[1] https://grahamlesliemccallum.wordpress.com/2014/04/26/newcastle-natal/.

- Ngagane River, which meanders in an easterly direction from its headwaters (approximately 607 m east of the KwaZulu-Natal-Free State border) in the Low Drakensberg Escarpment (after EKZNW 2009: 7) through the Ntshingwayo Dam in the Chelmsford Nature Reserve, between the Eskom-owned non-operational Kilbarchan Colliery[2] and the Ngagane settlement (2729DD 1 : 50 000 Topographic Map 2013) and around Madadeni to join the Buffalo River (2730CA 1 : 50 000 Topographic Map 2011).
- Dorpspruit, which meanders in a southerly direction pass the Balelesberg Mountains from its headwaters (2730CB 1 : 50 0000 Topographic Map 2011), flowing to the north and west of Utrecht (2730CB 1 : 50 0000 Topographic Map 2011), joining the Buffalo River via a wetland (2730CA 1 : 50 0000 Topographic Map 2011).
- Sandspruit, into which the Sterkstroom (on which the Douglas McHardy and Preston Pan Dams are located) flows. Tributaries of the Sterkstroom include the Mpate River on which the Upper and Lower Mpate Dams are located and the Mzinyashana River, into which the Ngobiya River flows. The Tom Worthington Dam is located on the Ngobiya River and the Verdruk Dam is on an unnamed tributary of the Ngoyiba River.
- Blood River, the source of which is approximately 17.8 km east of Utrecht (2730CB 1 : 50 000 Topographic Map 2011) and 9.3 km west of the Skuweberg Mountain Range (2730DA 1 : 50 000 Topographic Map 2011) as the crow flies. The Blood River meanders in a southerly direction, through the Blood River Vlei and the Blood River Dams (2730DC 1 : 50 000 Topographic Map 2011), pass the settlement of KwaMbunda on the eastern bank, joining the Buffalo River at Vant's Drift approximately 3 km west of the settlement of Hlathi-Dlamini (2830BA 1 : 50 000 Topographic Map 2013) and 16.6 km south-west of Nqutu as the crow flies (2830BA 1 : 50 000 Topographic Map 2013).
- Batshe River, which meanders in a southerly direction between the settlements of Ndindindi (its source is located to the west of Ndindindi) and Mafitleng (2830BC 1 : 50 000 Topographic Map 2013) and continuing to flow between the settlements of Nkalwini and Masotsheni before joining the Buffalo River approximately 2.3 km north-east of the Oskarberg Mountain (as the crow flies) near the Battle of Rorke's Drift 1879 landmark (2830BA 1 : 50 000 Topographic Map 2013).
- Mpunzini River, which is the tributary of the buffalo river, has two tributaries, namely the Gubazi River and Vove River. The Vove and Gubazi River join and continue as the Gubazi River flowing into Buffalo River.

The confluence of the Buffalo River with the uThukela River is approximately 2.4 km downstream of the Nguvebu settlement located on the banks of the Nguvebu River, 19.2 km downstream of the Tugela Ferry settlement and approximately 47.5 km west of Nkandla as the crow flies (2830DA and 2830CB 1 : 50 000 Topographic Maps 2012).

The total area of the Buffalo Region is 9 803.8 km^2 (WR2012 Secondary Catchments GIS Dataset) with the predominant land cover categories being agriculture, mining and urban (**Figure 14.5**). Key towns include Newcastle (the administrative seat of Amajuba District Municipality and the fourth largest local municipality in KZN in terms of number of people (**Section 2**)), Dundee (the administrative seat of uMzinyathi District Municipality), Dannhauser, Utrecht and Charlestown. The two other key towns of Nqutu and Glencoe are on the watershed of the Buffalo Region with Nqutu being on the watershed between the Buffalo and Mfolozi Regions and Glencoe between the Buffalo and Sundays Regions (both the Buffalo and Sundays Regions are located in the uThukela primary catchment).

(ii) Surface Water

The Buffalo region general layout is shown in **Figure 14.5**.

[2] http://www.eskom.co.za/OurCompany/SustainableDevelopment/EnvironmentalImpactAssessments/Kilbarchan/Pages/default.aspx.

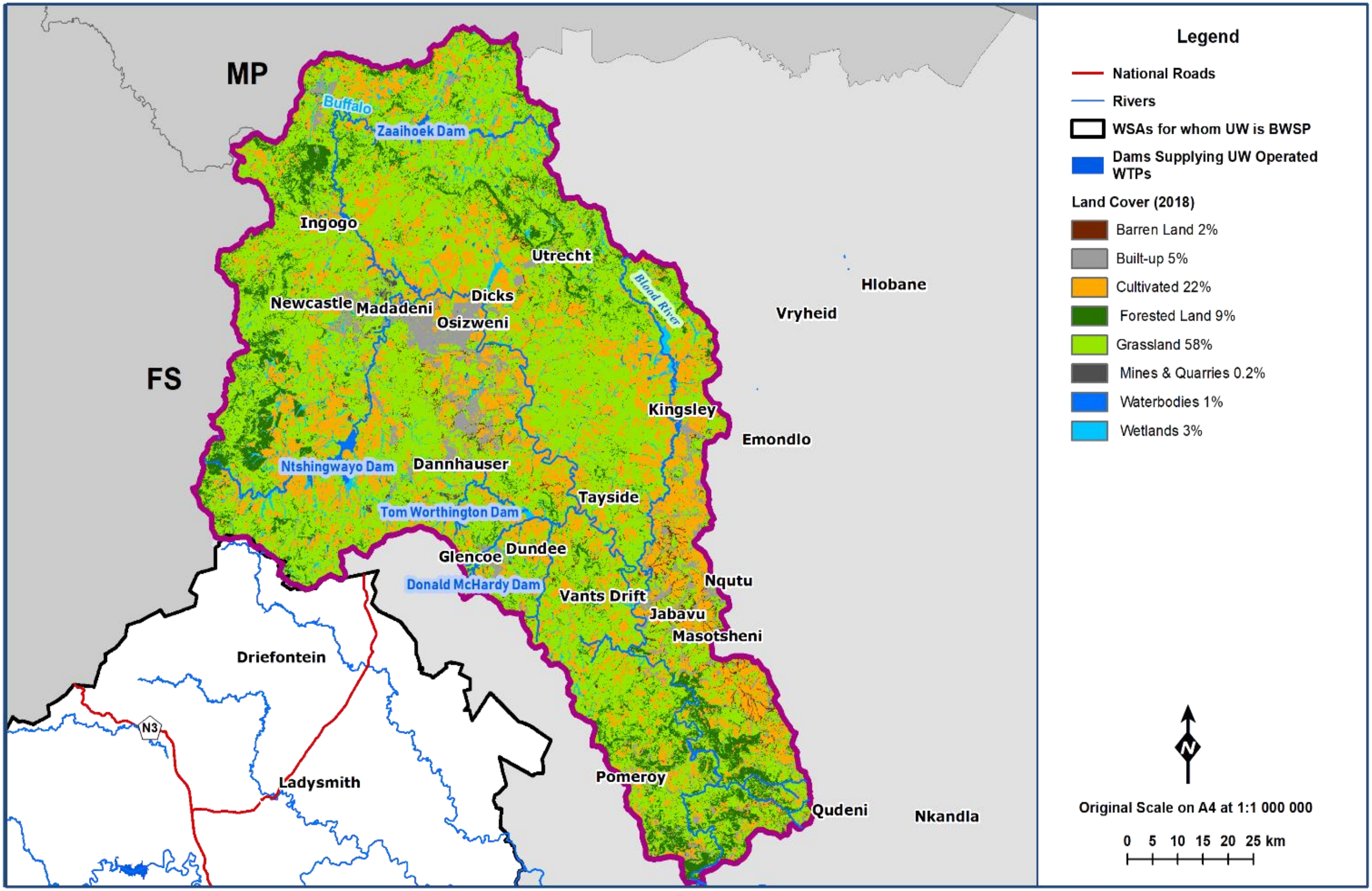

Figure 14.5 Buffalo System general layout (DEA and GTI 2018; KZN DoT 2017; MDB 2016; Umgeni Water 2020.

The hydrological characteristics for this region are summarised in **Table 14.1**. It is shown in **Table 14.1** (and **Section 2 in Volume 1**) that tertiary catchment V31, the catchment in which the Slang, Ncandu and Ngagane Rivers are located, receives the largest volume of runoff in the Buffalo Region. This can be attributed to the high elevation and rainfall area of the Drakensberg Mountains and the Balelesberg-Skuweberg Plateau.

The Blood River, largely located in tertiary catchment V32, forms the border with Zululand District Municipality, before it confluences with the Buffalo River at Vants Drift. The Batshe River, largely located in tertiary catchment V33, joins the Lower Buffalo near the area of Nqutu.

Table 14.1 Buffalo Region Hydrological Characteristics (WR2012: Thukela Quat Info WMA 7 7Jul2015 spreadsheet).

Region	River (Catchment)	Area (km^2)	Annual Average			
			Evaporation (mm)	Rainfall (mm)	Natural Runoff (million m^3/annum)	Natural Runoff (mm)
Buffalo	Ngagane River (V31)	3948	1435	851	469.9	119.0
	Blood River (V32)	4018	1491	778	291.3	72.5
	Batshe (Lower Buffalo) (V33)	1837	1477	747	118.0	64.2
	Total	**9803**				

(iii) Groundwater

Tertiary catchments V31 and V32 of the Buffalo Region are located in the North Western Middleveld Hydrogeological Region (**Section 2 in Volume 1**). In tertiary catchment V33, the Buffalo River meanders through the North Western Middleveld Hydrogeological Region, passing through the North Eastern Middleveld Hydrogeological Region before joining the uThukela River in a small portion of the KwaZulu-Natal Coastal Foreland Hydrogeological Region (**Section 2 in Volume 1**).

The aquifer in the North Western Middleveld Hydrogeological Region is intergranular and fractured with extremely low to medium development potential (DWAF 2008: 16). The underlying geology is mostly arenaceous rock of the Ecca formation (DWAF 2008: 16).

The aquifer types in the North Western Middleveld Hydrogeological Region are:

- Fractured with a low development potential, mainly Diamictites (Dwyka Tillite).
- Intergranular and fractured with a low development potential, mainly Arenaceous and argillaceous rocks.

(DWAF 2008: 14)

The fractured acquifers in the KwaZulu-Natal Coastal Foreland Hydrogeological Region are created by predominantly arenaceous rocks consisting of sandstone and diamictite (DWAF 2008: 18). The Dwyka Tillite forms very productive aquifers in KwaZulu-Natal (King 1997 in DWAF 2008: 18).

• Hydrogeological Units

The draft 2019 Amajuba Environmental Management Framework (EMF) Status Quo report summarised the hydrogeologically relevant lithological units, stratigraphy, aquifer classes and types in **Table 14.2**.

Table 14.2 Buffalo Region hydrogeologically relevant lithological units (Amajuba District Municipality 2019: 108).

Hydrogeologically Relevant Lithological Unit	Stratigraphy	Aquifer Type - Nature	Aquifer Type - Regime
Alluvium	Quaternary sediments	Primary	Intergranular
Lineaments/faults	Tectonic fractures (l/f)	Secondary	Fractured
Dolerite sheets/dykes	Post-Karoo intrusive structures (Jd)	Secondary	Fractured-and-weathered
Shales/mudstones and sandstone	Karoo Supergroup	Secondary	Fractured
Volcanic rocks; granite	Achaean granite (Z-Rg)	Secondary	Fractured-and-weathered

• Geohydrology

The 2004 uThukela ISP identified that most of the region comprises of 'hard rock' secondary porosity aquifers of the 'weathered and fractured' and 'fractured' aquifer classes (DWAF 2004: 21). The ISP continued to explain that "faults, joints and intrusive Karoo dolerite contacts in the regional 'hard rocks' are zones usually of increased groundwater presence" (2004: 21).

The ISP further identified that:

> "Except in one instance where water for the village of Nqutu is abstracted from the primary porosity intergranular sand aquifer in the river bed of the Buffalo River at Vant's Drift by means of a system of lateral screen caisson wells, which actually draw down surface water flowing on the river bed, all groundwater abstraction is by means of 'hard rock' boreholes located in the second porosity 'hard rock' aquifers."
>
> (DWAF 2004: 21)

• Groundwater Potential

The groundwater potential for the Buffalo Region is shown in **Figure 14.6**. The 2004 uThukela ISP stated that "groundwater yields from 'hard-rock' boreholes are generally low and in the range 0.1 to 0.6 ℓ/s, although significantly higher yields (3 ℓ/s) can be obtained in hydrogeologically favourable situations, such as intrusive Karoo dolerite contact zones" (DWAF 2004: 21).

The draft 2019 Amajuba EMF Status Quo report assessed yields of the approximately 800 boreholes located in Amajuba District Municipality recorded in the National Groundwater Database. The results of this assessment are shown in **Table 14.3**.

Table 14.3 Summarised statistic of depth related borehole yield data in the Amajuba District Municipality (Amajuba District Municipality 2019: 110).

Lithological Unit	Mean Yield Data (ℓ/s)	Mean Yield Range	Maximum Yield Data (ℓ/s)	Maximum Yield Range
Quaternary sediments	0.9	Moderate	4.8	High
Dolerite intrusions	2.7	Moderate	58	High
Karoo sediments	1.2	Moderate	19.8	High
Archaean rocks	0.9	Moderate	2.8	Moderate

Where Yield Ranges: High > 3 ℓ/s; Moderate > 0.5 to 3 ℓ/s; Low > 0.1 to 0.5 ℓ/s; Very Low ≤ 0.1 ℓ/s

A summary of the results are:

- "The success rate of boreholes was noted to vary considerably within an area and often within the same lithology.
- The highest borehole yields appear to be associated with fractures occurring along dolerite contact zones.
- Fractured and weathered zones found at depth within sedimentary rocks are often strong aquifers.
- Boreholes drilled into dolerite sills or dykes are not likely to yield water unless a fracture zone is intersected.
- Significant water strikes appear to occur at depths greater than 30 m but less than 60 m,
- Rotary air flush percussion drilling is the generally accepted drilling method required to drill through all hard rock formations with appropriate sleeving in top weathered sections.
- Drilling through unconsolidated sediments require either symmetrix, odex or mud rotary drill methods."

(Amajuba District Municipality 2019: 110)

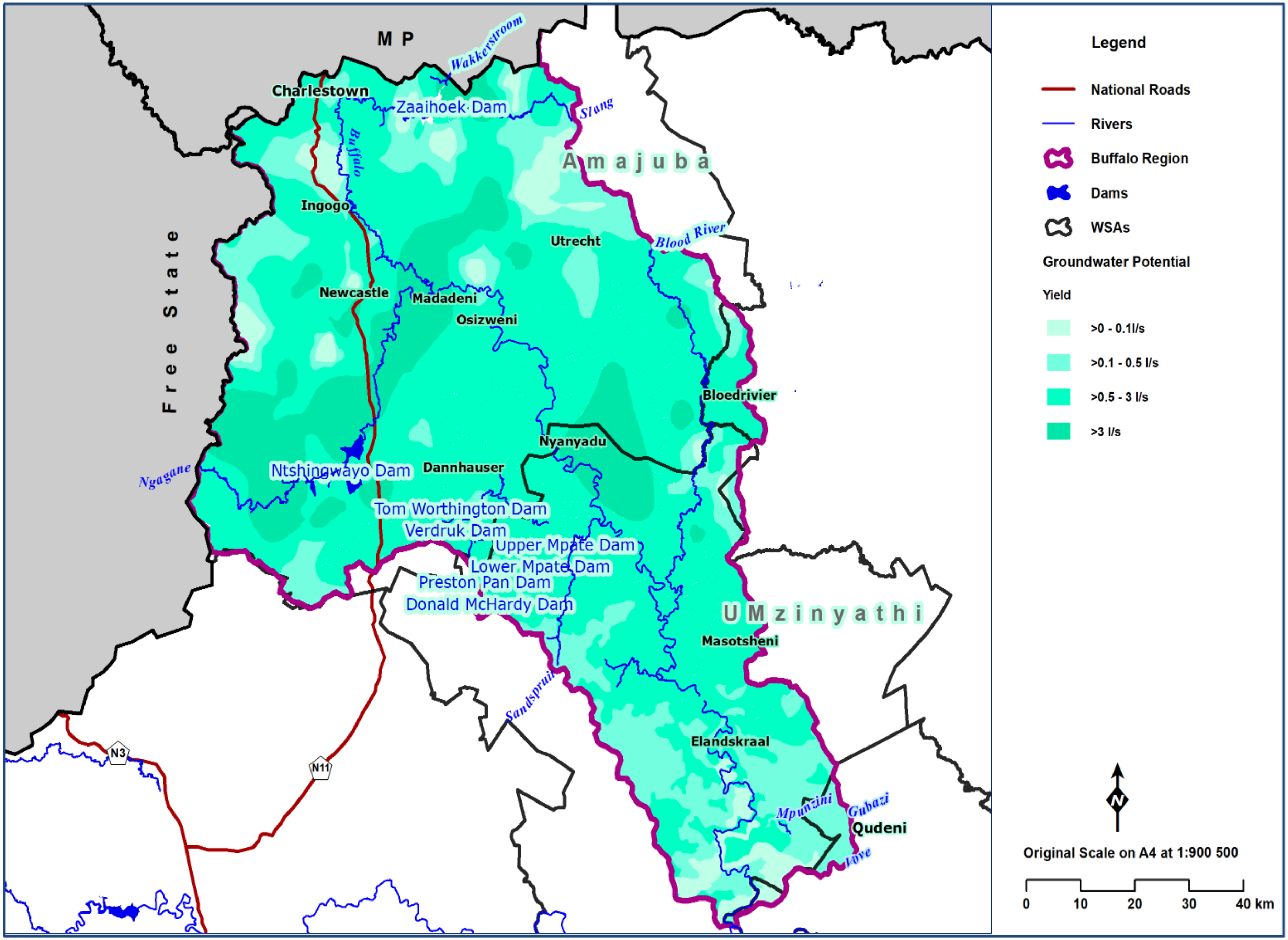

Figure 14.6 Groundwater potential in the Buffalo Region (KZN DoT 2017; MDB 2016; Umgeni Water 2019; WR2012).

(iv) Water Quality

- **Surface Water**

The 2004 the uThukela Internal Strategic Perspective (ISP) identified that, from a water quality perspective, the Buffalo River is "the most severely impacted of all the uThukela River's tributaries" with the "water quality in the Buffalo River from the upper reaches all the way down to its confluence with the uThukela River very poor" (DWAF 2004: 42). The 2004 uThukela ISP and the Draft 2019 Amajuba Environmental Management Framework (EMF) Status Quo report identified that the water quality impacts result from:

- industrial activities such as those from the Newcastle area and the Ngagane River area;
- wastewater discharge (**Section 19 in Volume 10**); and
- impacts associated with mining such as high salinity and low pH's resulting from acid mine drainage from the numerous old coal mines.

(DWAF 2004: 42; Amajuba District Municipality 2019: 52)

Umgeni Water is currently undertaking no water quality monitoring in the Buffalo Region. The Draft 2019 Amajuba EMF Status Quo report identified that:

> "… water quality data is supplied primarily by the Department of Water and Sanitation. These data are associated with specific monitoring points located strategically in the catchment and provide measured information providing insight to impacting activities in upstream catchment areas. The limitation of this approach is the limited number and relatively biased (towards key dams) distribution of monitoring points. This means that large areas … have no data with respect to water quality."

(Amajuba District Municipality 2019: 52)

- **Groundwater**

The 2004 the uThukela ISP stated that "groundwater quality is generally good, with the best quality groundwater found in the higher rainfall portions and the poorest quality in the lower rainfall areas" (DWAF 2004: 21). The ISP further identified that "the Total Dissolved Solid (TDS) content of the groundwater is generally in the range of 90 to 200 mg/ℓ, but it can rise to more than 500 mg/ℓ in the lower rainfall areas" (2004: 21). Groundwater pollution is localised, occurring in areas "where underground coal mining and the dumping of mine discard material has taken place over the last 100 years or more" (DWAF 2004: 21).

14.2.2 Reserve

(a) Buffalo Region

As stated in **Section 13.2.2 (a) in Volume 5** and **Section 15.2.2 (a) in Volume 8**, the uThukela Primary Catchment was not part of the DWS 2016 study to determine the Ecological Reserve and Resource Quality Objectives. DWS commissioned the Reserve and Resource Quality Objective's study for the entire uThukela Primary catchment in 2020. Water for the Ecological Reserve is water that must remain in the river and may not be abstracted and hence, results in a reduction in the yield available for supply.

The DWAF 2004 "Thukela Reserve Determination Study" was an informant to the uThukela ISP, and reported that:

> "…after careful review and consideration of the Reserve Study results, it became clear that assumptions made for the Reserve Study, while valid for Reserve determination, are not valid for the allocation of water in the uThukela catchment today or in the short-term. The reasons for this are as follows:
>
> - The Thukela Reserve water resource analysis assumed that the Reserve will ultimately be met, and in order to achieve this, curtailments were applied within the model to users throughout the catchment. This curtailment results in surplus water becoming available in the lower reaches of the Thukela River.
> - The Thukela Reserve water resource analysis assumed that the Spioenkop, Ntshingwayo and Wagendrift dams will all contribute to the users and the Reserve in the Lower Thukela. This conjunctive use of these three dams results in large theoretical surpluses in the Lower Thukela.
> - The methodology used in the Thukela Reserve analysis, whereby the excess yield is determined at the bottom of each key area, represents the best-case scenario. If the yield is required further upstream in the catchment then excess yield is less. The reason for this is that releases are only made from the large dams to meet the users' shortfalls after they have made use of run-of-river yields. The further downstream a user is situated, the more run-of-river yield becomes available, with the result that less water needs to be released from the dams and hence more surplus is available."

(DWAF 2004: 25 – 26)

The uThukela ISP noted that a "more conservative approach was used" and that the following assumption with reference to the Reserve was used in determining the water resource availability:

> "Any surplus in the Buffalo Key Area will be retained for use in this area and will not be used to support users in the Lower Thukela. The Ecological Reserve will not be implemented immediately in the Little Thukela or Sundays River Key areas because this would require compulsory licensing. In the interim, the Reserve in the main stem of the river will need to be met from the Spioenkop and Wagendrift dams. Given that the Little Thukela and Sundays Key Areas cannot contribute fully to the Reserve; this reduces the yield available from these two dams. The surplus yield available in the other Key Areas, where applicable, has been expressed in two forms: the maximum surplus if abstracted at the outlet of the Key Area, and the minimum if abstracted from the relevant dam (Spioenkop, Wagendrift and Ntshingwayo Dam)."

(DWAF 2004: 26)

The uThukela ISP reported that the Ecological Reserve for the Buffalo Region at 1 : 50 year assurance was 33 million m^3/annum. As stated above, the ISP indicated that "any surplus in the Buffalo Key area will be retained for use in this area and will not be used to support users in the Lower Thukela" (DWAF 2004: 26).

The Amajuba DM & EDTEA 2019 "Environmental Management Framework for the Amajuba District Municipality" reported that DWS's Present Ecological State (PES) information indicates that the Buffalo River is a category B. The Ncandu River is a category D and the Ngagane River is a category C. The results indicate that even though the tributaries are in a poor to fair condition, the main Buffalo River within the municipality is in a good condition, which is largely natural with a few modifications. The Classification of the Thukela WMA study has been commissioned by DWS in 2020 and some of the objectives are to assess development scenarios, including the Reserve, and long term plans in the uThukela catchment. The progress will be reported in the next IMP update.

14.2.3 Existing Water Resource Infrastructure and Yields

(a) Buffalo Region

The significant surface water resource infrastructure in the Buffalo Region comprises of both impoundments and abstractions on the main stem and tributaries of the Buffalo River. These are listed in **Table 14.4**. The yields listed are historical yields, and it would be useful to undertake a detailed water resources study to determine the long-term stochastic yields of the entire resource infrastructure in the Buffalo catchment.

Table 14.4 Yield information for the existing water resource infrastructure in the Buffalo Region (DWS 2019: List of Registered Dams Database).

Impoundment	River	Full Supply Capacity (million m^3)	Yield (million m^3/annum) Historical
Zaaihoek Dam	Slang River	185.000[a]	59[d]
Mahawane Dam	Mahawane River	2.1[b]	Not Available [b]
Ntshingwayo Dam	Ngagane River	211.258[a]	54[d] 100% - 75[g] 80% - 68[g] 60% - 60[g] 40% - 52[g] 20% - 38[g]
Roy Point Abstraction (Ngagane WTP)	Ngagane River	-	10[e]
Schurvepoort Run-of-River Abstraction (Ngagane WTP)	Buffalo River	-	3.65[e]
Dorpspruit Run-of-River	Dorpspruit River	-	0.57[e]
Tom Worthington Dam	Ngobiya River	1.89 [a]	1.9 [b]
Verdruk Dam (Off-Channel Dam)	Tributary to the Ngobiya River (first tributary downstream of the Tom Worthington Dam)	1.29 [a]	
Donald McHardy Dam	Tributary to the Sterkstroom River [c]	2.68 [a]	1.1 [b]
Preston Pan Dam	Sterkstroom River	0.268 [a]	
Upper Mpate Dam	Mpate Stream [a]	0.264 [a]	0.4 [b]
Lower Mpate Dam	Mpate Stream [a]	0.128 [a]	
Tayside Weir Run-of-River Abstraction (Biggarsberg WTP)	Buffalo River	-	2.92[e]
Buffalo Run-of-River Abstraction (Vant's Drift WTP)	Buffalo River	-	3.03[e]
Tributary of the Ngxobongo River	Tributary of the Ngxobongo River (last major tributary prior to confluence of Ngxobongo and Buffalo River)	-	350kl/day production
Gubazi Run-of-River abstraction (Qhudeni uMzinyathi DM)	Gubazi River	-	350kl/day production
Vove Dam	Vove River	- 0.02	0.12[f]

[a] DWS 2019: List of Registered Dams Spreadsheet.
[b] DWS 2012 and 2015 in Umgeni Water 2016: 37.
[c] 2830AA 1 : 50 000 Topographic Map 2013.
[d] DWS 2013: pg 28
[e] DWS 20
[f] KCDM staff
[g] DWS 2013: Short-term stochastic yields (May Decision) at various dam level %'s

The Zaaihoek Dam (**Figure 14.7** and **Table 14.5**) and the Mahawane Dam (**Figure 14.8** and **Table 14.6**) form part of the Zaaihoek Transfer Scheme, the second scheme to transfer water from the uThukela primary catchment to the Vaal catchment (the first scheme is the Thukela-Vaal Scheme described in **Section 13.2.3**).

Figure 14.7 Zaaihoek Dam (DWS 2008: DWS website).

Table 14.5 Zaaihoek dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	622 km^2 [a]
Total Catchment Area:	622 km^2 [a]
Mean Annual Precipitation:	916 mm [b]
Mean Annual Runoff:	97.25 million m^3 [b]
Annual Evaporation:	1 400 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1700 mASL [d]
Full Supply Level:	1729.5 mASL [c]
Spillway Height:	43.5 m [c]
Net Full Supply Capacity:	184.497 million m^3 [c]
Dead Storage:	0.780 [g]
Total Capacity:	185 million m^3 [c]
Surface Area of Dam at Full Supply Level:	12.446 km^2 [c]
Original Measured Dam Capacity	185.277 million m^3 (1984) [d]
Second Measured Dam Capacity	184.8727 million m^3 (October 2001) [d]
Third Measured Dam Capacity	184.4974 million m^3 (February 2018) [d]
Dam Type:	Gravity [c]
Crest Length:	Crest Length: 527 m [c] Spillway Section: 30 m [d] Non-Spillway Section: 497 m [d]
Type of Spillway:	Ogee Spillway [c]
Capacity of Spillway:	2500 [f]
Date of Completion:	1988 [c]
Date of Area Capacity Survey:	2018 [d]
Date of next Area Capacity Survey:	2033 [g]

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] DWS Hydrographic Surveys Dams Database (2018).
[e] Measured on Google Earth.
[f] SANCOLD
[g] DWS Survey Return Period

Figure 14.8 Mahawane Dam (Google Earth 2019: website).

Table 14.6 Mahawane Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	8.7 km^2 [a]
Total Catchment Area:	8.7 km^2 [a]
Mean Annual Precipitation:	856 mm [b]
Mean Annual Runoff:	1.90 million m^3 [b]
Annual Evaporation:	1400 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	N/A
Full Supply Level:	1687 mASL [f]
Spillway Height:	15 m [a]
Net Full Supply Capacity:	1.92 million m3 a
Dead Storage:	Unknown at this stage
Total Capacity:	1.92 million m^3 [a]
Surface Area of Dam at Full Supply Level:	0.23 km^2
Original Measured Dam Capacity	N/A
Second Measured Dam Capacity	N/A
Third Measured Dam Capacity	N/A
Dam Type:	Earth Fill [a]
Crest Length:	Crest Length: 330 m [a]
Type of Spillway:	Side Channel Spillway [a]
Capacity of Spillway:	N/A
Date of Completion:	1979 [a]
Date of Area Capacity Survey:	2007 [a]
Date of next Area Capacity Survey:	2017 (Overdue) [a]

[a] DWS List of Registered Dams Database (April 2019).
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] Used the identify tool on WR2012 dataset on ArcGIS.
[d] Calculated using the identify tool on ArcGIS using WR2012 dataset.
[f] 0.5 contours from DEM

The Vaal catchment is a constituent catchment of the Orange-Senqu River catchment, which is:

> "… regarded as the most developed river system in southern Africa, with approximately 300 built structures which include 30 large dams and several large inter- and intra-basin transfers. This river system provides the water for the most economically active area in southern Africa, supports large-scale irrigation and meets the domestic needs of more than 14 million people."

(ORASECOM 2013: 3)

The Zaaihoek Transfer Scheme contribution to the overall Orange-Senqu River system is described as follows:

> "The Zaaihoek Transfer Scheme consists of a pumping station in the Slang River and the Zaaihoek Dam.
>
> Water for Majuba Power Station, Volkrust and the Vaal catchment is pumped from Zaaihoek Dam in the Buffalo catchment to the Uitkyk Reservoir. The pump station has a maximum capacity of 3 m^3/s but general delivers at about 0.34 m^3/s when required for the Majuba Power Station only. At Uitkyk, there is provision for a diversion to Mahawane Dam to supply Volksrust. From Uitkyk the water can also flow via a gravity main to Majuba Power Station and the water for the Vaal catchment is released into the Perderwaterspruit, upstream of Amersfoort Dam. This transfer has a maximum transfer capacity of 2.79 m^3/s.
>
> The main purpose is to supply cooling water to the Majuba Power Station. However, Majuba (at the time of the report) was running well below capacity, so surplus water is transferred to supplement Volksrust and the Ngagane River Government Water Scheme and other irrigation. Any further surplus water can be transferred from the uThukela primary catchment to the Vaal catchment."

(DWS 2016: 1-1; ORASECOM 2013: 21)

The Zaaihoek Dam is a rollcrete gravity dam and was the "first dam where full-scale implementation of the rollcrete construction method was introduced in South Africa" (DWA 1988: 2). A part of what is referred to as the Slang River Government Water Scheme, construction of the Zaaihoek Dam commenced in 1985 and was completed in 1988 (DWA 1988: 2 and 4). The former DWA describes the Zaaihoek Dam as follows:

> "The Zaaihoek Dam consists of two rollcrete sections which are joined by the outlet block of conventional concrete. On the left flank crack inducers were used to control the position of cracks in the wall.
>
> The dam has a crest length of 527 m and an uncontrolled spillway of 160 m in the river section. The outlet block on the right flank of the dam houses the scour and river outlets that release water for downstream consumers. A separate set of pipes transports water to a pumping station 20m downstream of the dam. The outlet block was used as the river diversion during the construction period.
>
> The upstream face of the dam is vertical. The downstream face is stepped to accommodate the rollcrete construction method. The steps also help to dissipate the energy of the water discharge over the spillway. A smaller apron slab than that necessary for a conventional dam was, therefore, needed at the toe of the dam, to protect the river bed from the scouring action of the water."

(DWA 1988: 2)

The former DWA continued to explain the conveyance of the water to the Majuba Power Station as follows:

> "Water is transported over a distance of 22 km from the downstream pumping station by means of a rising main to a balancing reservoir on the watershed north of Volksrust. A gravity main conveys water from this reservoir over a distance of 30 km to a terminal reservoir at the Majuba Power Station.
>
> The gravity main crosses the Perdewaterspruit which is a tributary of the Vaal River. An outlet structure is provided at the crossing which can release water into the stream. The water then flows down the Schulpspruit, over the spillway of the Amersfoort Dam and from there to the Vaal River, upstream of the Grootdraai Dam."

(DWA 1988: 3)

The rising main from the Zaaihoek Dam passes near the Mahawane Dam (located "3 km outside Volkrust on the N11 Amersfoort/Ermerlo Road"[3]) and there is an off-take from this rising main to supplement the water in the Mahawane Dam (Umgeni Water 2016: 43). Mahawane Dam is located in the Mahawane Country Resort, an Eskom Holdings SOC (Pty) Ltd asset that was established in November 1989 to "provide recreational and accommodation facilities to the community as well as serving business needs" (Mahawane Country Resort unknown date: website). Mahawane Dam cannot supply water for irrigation purposes (Umgeni Water 2016: 39).

Mahawane Dam is one of three dams that provide water to the Greater Volksrust Water Supply Scheme (WSS). The Greater Volksrust WSS consists of the two WTPs:

i) Vukuzakhe WTP, located in the Vukuzakhe settlement east of Volksrust, is supplied by the Mahawane Dam. The WTP, the dam and the settlement are all located in Mpumalanga.
ii) Volksrust WTP, located in Volksrust, is supplied by the Balfour and Schuilhoek Dams, which are located on tributaries of the Vaal River. The WTP, the dams and the town of Volksrust are all located in Mpumalanga. However, in addition to the town of Volksrust, the Volksrust WTP further supplied the town of Charlestown in KZN in 2015.

(Umgeni Water 2016: 43)

The UAP Phase 2 reported that "in winter, the Balfour and Schuilhoek Dams dry up and that supply is augmented from the Mahawane Dam via the Vukuzakhe WTP" (Umgeni Water 2016: 43). It further stated that "the Newcastle WSA had assumed water reticulation operations for Charlestown from 1 July 2013 and that an account to purchase bulk water from the Dr Pixley ka Isaka Seme Local Municipality had been opened" (Umgeni Water 2016: 43). At the time of the report (2016), a "draft agreement had been developed and was yet to be signed after the tariff formula and modelling had been agreed by the two municipalities" (Umgeni Water 2016: 43).

The UAP Phase 3 Draft Diligence Report identified that the Newcastle WSA had "commissioned a package plant in 2018/2019 to treat and supply water to Charlestown" and therefore Charlestown was no longer reliant on the Greater Volksrust WSS that is managed by the neighbouring Mpumalanga Dr Pixley ka Isaka Seme Local Municipality (Umgeni Water 2019: 19). This package plant is supplied by groundwater and discussed below.

The UAP Phase 2 further identified that "domestic water supply to Volksrust, Charlestown and Wakkerstroom may be supplemented from the Zaaihoek Dam" (Umgeni Water 2016: 39).

The Ntshingwayo Dam (**Figure 14.9** and **Table 14.7**) is one of the largest dams in KZN and the largest dam in the Buffalo Region (**Table 14.4**). Located in the Chelmsford Nature Reserve, approximately 24 km south of Newcastle (DWA 1988: 2). The Ntshingwayo Dam was originally called the Chelmsford Dam. EKZNW explains the name change as follows:

[3] http://mahawane.co.za/.

> “The Chelmsford Nature Reserve and the Chelmsford Dam located within the nature reserve took its name from the farm on which it was proclaimed which in turn was name Chelsmford after a small town in England, and incidentally shares the name with Lord Chelmsford, the British general who commanded the British army and led the military invasion against King Cetshwayo and the Zulu Kingdown in 1879.
>
> On 6 August 2000, the Chelmsford Dam was renamed Ntshingwayo Dam after the Zulu military strategist, Inkosi Ntshingwayo kaMahole Khoza, who led the great battle of resistance at Isandlwana on 22 January 1879. Inkosi Ntshingwayo kaMahole Khoza was a senior general in King Cetshwayo’s army and the hereditary chief of the Khoza Tribe in north-western Zululand.
>
> The name change was made in honour of Zulu King Goodwill Zwelithin’s 52nd birthday. The battle of Isandlwana was the battle at which the invading British were defeated in one of the most humiliating events in Britain’s colonial history (South Africa Government Information 2006: website).”

(EKZNW 2013: 8)

Construction of the Ntshingwayo Dam was completed in 1961 (DWA 1988: 4) and was “initially designed to provide an assured supply of water to the town of Newcastle, Eskom’s thermal power station and the irrigation farmers downstream” (DWA 1988: 2). DWA continues to explain that “as Newcastle was favourably situated for industrial development, the dam was also designed to impound sufficient water to meet the requirements of possible future development” (1988: 2).

Figure 14.9 Ntshingwayo Dam (DWS 2008: DWS website).

Table 14.7 Ntshingwayo Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	834 km^2 [a]
Total Catchment Area:	834 km^2 [a]
Mean Annual Precipitation:	885 mm [b]
Mean Annual Runoff:	103.10 million m^3 [b]
Annual Evaporation:	1450 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1222.11 [d]
Full Supply Level:	1245.11 mASL [c]
Spillway Height:	23 m [c]
Net Full Supply Capacity:	194.59 million m^3 [c]
Dead Storage:	3.852 million m^3 [C]
Total Capacity:	211.26 million m^3 [c]
Surface Area of Dam at Full Supply Level:	36.10 km^2 [c]
Original Measured Dam Capacity	78.407 million m^3 (November 1972) [d]
Second Measured Dam Capacity	78.274 million m^3 (October 1979) [d]
Third Measured Dam Capacity	198.438 million m^3 (1982) [d]
Fourth Measured Dam Capacity	198.438 million m^3 (April 1983) [d]
Fifth Measured Dam Capacity	194.586 million m^3 (November 2001) [d]
Dam Type:	Earth fill & Gravity [c]
Crest Length:	Crest length: 1549 [c] Spillway Section: 120 m [e] Non-Spillway Section: 1429 m [e]
Type of Spillway:	Ogee With Radial Gates [c]
Capacity of Spillway:	722 [f]
Date of Completion:	1961 [c]
Date of Area Capacity Survey:	2001 [d]
Date of next Area Capacity Survey:	2016 [g] (Overdue)

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] DWS Hydrographic Surveys Dams Database (2018).
[e] Measured on Google Earth.
[f] SANCOLD
[g] DWS Survey Return Period

The Ntshingwayo Dam is a part of the Ngagane River Government Water Supply Scheme, which DWA elaborates as follows:

> "The establishment of the Iscor steel works at Newcastle and the increasing urbanisation of the Newcastle town itself, led to the Ngagane River Government Water Supply Scheme being approved in 1962. The scheme comprises a purification works, pumping station, pipelines and a terminal reservoir each of which has been upgraded and extended over the years.
>
> The raw water utilised by this scheme is obtained from the Ntshingwayo Dam. Due to increasing demand for raw and potable water, the Nthshingwayo Dam was raised in 1982, increasing the storage capacity of the dam from 84 million m^3 to 199 million m^3. During the severe drought in 1983, an emergency scheme was built whereby water can be gravitated from the weir at Schurwepoort on the Buffalo River directly to the Ngagane Purification Works. This scheme can divert up to 800 000 m^3 of water per month to the works and the resultant additional runoff in the Ngagane River can be impounded in the Ntshingwayo Dam."

(DWA 1988: 2 – 3)

DWA describes the Ntshingwayo Dam as:

> "… a composite dam comprising a central concrete gravity spillway section equipped with crest gates flanked by earth embankments. A secondary embankment is situated in a low neck approximately 2 km from the main wall. Before the raising of the wall, the central spillway measured 18.3 m above the normal river bed level. In 1982 the Ntshingwayo Dam was raised by 4.57 m. The raising of the spillway crest was accomplished by the addition of 1.37 m of concrete and eleven 3.2 m high radial crest gates. In addition, the wall itself was reinforced, as were the earth embankments.
>
> An interesting feature of the dam is the three river/scour outlets that are centrally situated at the base of the spillway section. The placement of the outlets differs from the conventional method (at the time of the report) of placing the outlets on either side of the spillway below the outlet house. Two water supply outlets have been provided in the wall, one of which supplies water to the Durnacol/Dannhauser pipeline while the other serves the Ngagane (Eskom) Power Station and the Ngagane River Government Water Scheme which supplies potable water to the Newcastle, Madadeni and Osizweni areas."

(DWA 1988: 3)

The supply to Newcastle, Madadeni, Osizweni, Durnacol and Dannhauser as identified above and including the communities of Mbanane and Fairbreeze is commonly referred to as the Newcastle Water Supply Scheme (DWS 2016: 6-35). The Ngagane WTP, which supplies the Newcastle Water Supply Scheme, has a design capacity of 150.00 Mℓ/day (DWS 2016: 6-37) and is supplied with raw water from three sources (DWS 2016: 6-38):

i) *The main source of supply is the Ntshingwayo Dam where raw water is abstracted through two gravity pipelines to supply Ngagane WTP (DWS 2016: 6-38).*
    - There are off-takes on the pipeline to supply farmers and the Ngagane quarry (DWS 2016: 6-38).
    - The capacity of each of the raw water pipelines is approximately 92 Mℓ/day. However, because of corrosion problems and the deterioration of the lining of the pipeline, the pipeline capacity is reduced to approximately 70 Mℓ/day (DWS 2016: 6-38).
    - The condition of the pipeline is very poor and is leaking badly (DWS 2016: 6-38).
    - "With an allocation of 33 million m^3/annum (or 90.4 Mℓ/day), the design capacity of the raw water pipelines will not be sufficient to abstract the full allocation from Ntshingwayo given the fact that there are also off-takes on the existing raw water mains (DWS 2016: 6-38).

ii) A second raw water pipeline is from the Ngagane River downstream of the dam (DWS 2016: 6-38).

- This is a 600 mm diameter mild steel-lined pipeline, which also delivers raw water by gravity to the Ngagane WTP (DWS 2016: 6-38).
- The maximum pipeline capacity is 20 Mℓ/day, which when compared to the allocation of 30 Mℓ/day is not sufficient to meet future raw water abstraction requirements from the Ngagane River (DWS 2016: 6-38).

iii) Raw water abstraction from Buffalo River at Schurvepoort (DWS 2016: 6-38).

- The other source of supply is the run-of-river abstraction from the Buffalo River at the Schurvepoort during the wet periods (DWS 2016: 6-38).
- The raw water abstraction infrastructure from the Buffalo River can deliver up to a maximum of 10 Mℓ/day (DWS 2016: 6-38).
- This abstraction works has now become permanent in order to deliver a total abstraction to the Ngagane WTP of 130 Mℓ/day (DWS 2016: 6-38).
- The design capacity of the raw water abstraction works is sufficient to meet the capacity of the existing WTP. This will require refurbishment of the bulk pipeline to the Ngagane WTP (DWS 2016: 6-38).

As identified above, the Ntshingwayo Dam supplies water to the Dannhauser/Durnacol area via the "Dannhauser/Durnacol Raw Water Pipeline". The Durnacol WTP, with a design capacity of 5.00 Mℓ/day (DWS 2016: 6-37), abstracts raw water from the Ntshingwayo Dam (Dannhauser Municipality 2019: 171; DWS 2016: 6-35) via this pipeline.

The Ngagane WTP further supplements the Utrecht Water Supply Scheme (DWS 2016: 6-35) during dry periods (Umgeni Water 2016: 48; Umgeni Water 2019: 25) with potable water. Supplying the town of Utrecht, "the Town within a Game Park" (Emadlangeni Local Municipality 2020: website), located in the "foothills of the Balele Mountains and within the Balele Community Game Park and the Utrecht Community Game Farm" (Emadlangeni Local Municipality 2020: website), the Utrecht WTP has a design capacity of 4 Mℓ/day (DWS 2016: 6-37) but operates at 2 Mℓ/day under normal conditions. It abstracts raw water from the Dorps Dam (DWS 2016: 6-35) and the Nywersheid Dam (Amajuba Technical Services Manager 2020: Personal Communication). The Dorps Dam (**Figure 14.10**) and the Nywersheid Dams (**Figure 14.11**) are off-channel storage dams on the Dorpspruit River and are approximately 1.2 km north-east of Utrecht as the crow flies (2730CB 1 : 50 000 Topographic Map 2011).

Figure 14.10 Dorps Dam in the Balele Game Park (Emadlangeni Municipality Unknown Date: website[4]).

Figure 14.11 Nywersheid Dam (Google Earth 2018: website).

4 http://emadlangeni.gov.za/.

The Biggarsberg WTP with a design capacity of 16.00 Mℓ/day (DWS 2016: 6-37) supplies the Dundee/Glencoe Water Supply Scheme. The Biggarsberg WTP abstracts raw water from four sources of supply, which are in the Buffalo River catchment (DWS 2016: 6-42):

i) *Dams in Ngobiya River*
- The first source of supply for the Biggarsberg WTP is the two dams in the Ngobiya River namely Tom Worthington Dam (**Figure 14.12** and **Table 14.8**) and Verdruk Dam (**Figure** 14.13 and **Table 14.9**) (DWS 2016: 6-42).
- These dams are located in the Amajuba DM but are a source of supply for the Biggarsberg WTP (DWS 2016: 6-42).
- Water is pumped from the raw water pumping stations to a 1.3 Mℓ balancing dam from where it then gravitates to a balancing dam at the WTP (DWS 2016: 6-42).

ii) *Dams in Sterkstroom River*
- The second source of supply is the dams in the Sterkstroom River which include Donald McHardy Dam (**Figure 14.14** and **Table 14.10**) and the Preston Pan (**Figure 14.15** and **Table 14.11**) (DWS 2016: 6-42).
- It is estimated that the total available water from the Sterkstroom River is 3.34 Mℓ/day (1.2 million m^3/annum) (DWS 2016: 6-42).

iii) *Mpate River catchment*
- There are two small dams located near the Biggarsberg WTP, which are also supplying raw water (DWS 2016: 6-42).
- Raw water is gravitated from both the Upper Mpate Dam (**Figure 14.16** and **Table 14.12**) and Lower Mpate Dam (**Figure 14.17** and **Table 14.13**) directly into the WTP (DWS 2016: 6-42). The Upper Mpate and Lower Mpate Dams are located downstream of the Dr Alden Lloyd Nature Conservation Area (2830AA 1 : 50 000 Topographic Map 2013).
- The yield of the dams has been estimated at 0.26 million m^3/annum based on the live storage capacity of the dams (DWS 2016: 6-42).

iv) *Buffalo River abstraction*
- The main source of supply currently for the Biggarsberg WTP is the Buffalo River (DWS 2016: 6-43).
- Raw water is currently abstracted at Tayside where it is pumped approximately 26.85 km to the Biggarsberg WTP (DWS 2016: 6-43).
- The raw water pumping main is a 400 mm diameter steel pipeline (DWS 2016: 6-43).

The dams are supplemented by releases from Ntshingwayo Dam (DWS 2016: 6-35).

Figure 14.12 Tom Worthington Dam (Google StreetView 2010: website).

Table 14.8 Tom Worthington Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	54 km^2 [a]
Total Catchment Area:	54 km^2 [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	12.6 million m^3 [b]
Annual Evaporation:	1 500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1281.5 mASL [g]
Full Supply Level:	1295.5 mASL [g]
Spillway Height:	14 m [c]
Net Full Supply Capacity:	1.89 million m^3 [c]
Dead Storage:	N/A
Total Capacity:	1.89 million m^3 [c]
Surface Area of Dam at Full Supply Level:	0.55 km^2 [c]
Original Measured Dam Capacity	1.89 million m^3 (1956) [d]
Dam Type:	Gravity [c]
Crest Length:	Crest Length: 157 m [c] Spillway Section: 39 m [e] Non-Spillway Section: 118 m [e]
Type of Spillway:	Siphon [c]
Capacity of Spillway:	N/A
Date of Completion:	1955 [c]
Date of Area Capacity Survey:	1956 [d]
Date of next Area Capacity Survey:	2016 [C] (Overdue)

[a] Catchment delineated using 20m DEM and Spatial Analyst.

[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.

[c] DWS List of Registered Dams Database (April 2019).

[d] DWS Hydrographic Surveys Dams Database (2018).

[e] Measured on Google Earth.

[f] Obtained using identify tool on ArcGIS using WR2012 dataset.

[g] 0.5m Contours from DEM

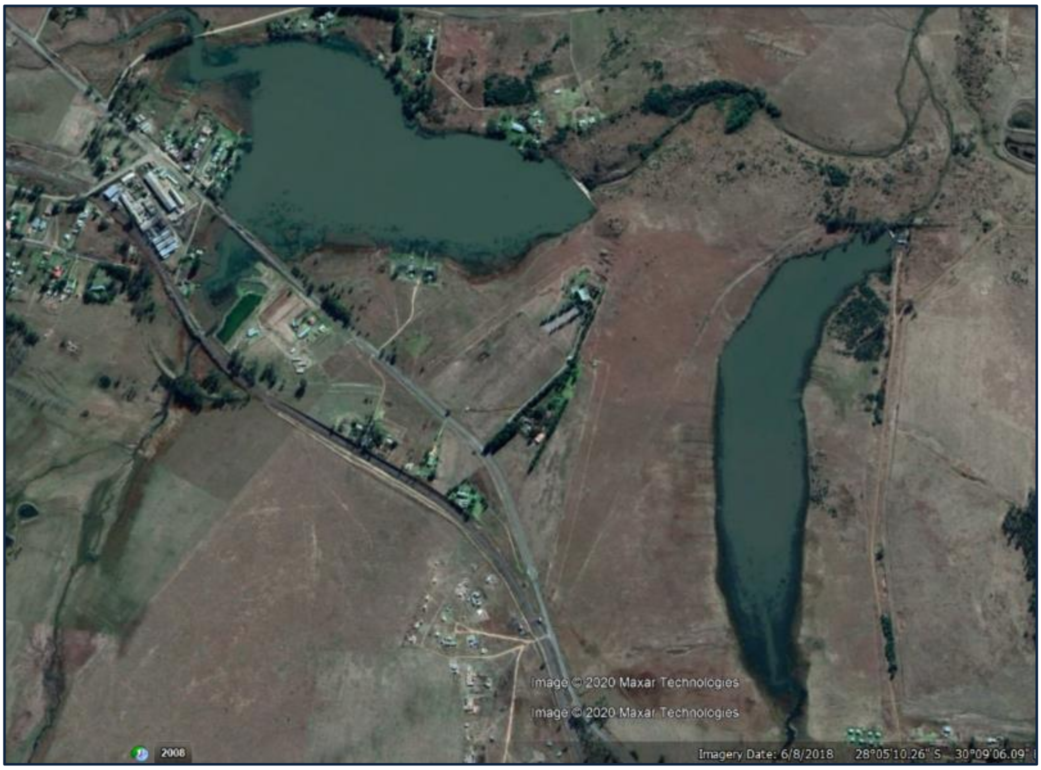

Figure 14.13 Tom Worthington Dam and Verdruk Dam (Google Earth 2018: website).

Table 14.9 Verdruk Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	37 km^2 [a]
Total Catchment Area:	37 km^2 [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	8.6 million m^3 [b]
Annual Evaporation:	1 500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1284 mASL [g]
Full Supply Level:	1295 mASL [g]
Spillway Height:	11 m [c]
Net Full Supply Capacity:	1.29 million m^3 [c]
Dead Storage:	N/A
Total Capacity:	1.29 million m^3 [c]
Surface Area of Dam at Full Supply Level:	0.29 km^2 [c]
Original Measured Dam Capacity	1.29 million m^3 [d]
Dam Type:	Concrete Gravity [c]
Crest Length:	Crest Length: 86 m [c] Spillway Section: 22 m [d] Non-Spillway Section: 64 m [d]
Type of Spillway:	Syphon And Gates [c]
Capacity of Spillway:	10 m^3/s [h]
Date of Completion:	1908 [c]
Date of Area Capacity Survey:	N/A
Date of next Area Capacity Survey:	N/A

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] DWS Hydrographic Surveys Dams Database (2018).
[e] Measured on Google Earth.
[g] 0.5m Contours from DEM
[h] SANCOLD Spreadsheet

Figure 14.14 Donald McHardy Dam (Toni Honiball in the Northern Natal Courier 2019: website).

Table 14.10 Donald McHardy Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	21 km² [a]
Total Catchment Area:	21 km² [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	4.1 million m³ [b]
Annual Evaporation:	1 500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1237.5 mASL [f]
Full Supply Level:	1249.5 mASL [f]
Spillway Height:	12 m [c]
Net Full Supply Capacity:	2.68 million m³ [c]
Dead Storage:	N/A
Total Capacity:	2.68 million m³ [c]
Surface Area of Dam at Full Supply Level:	0.71 km² [c]
Original Measured Dam Capacity	2.68 million m³ [d]
Dam Type:	Earth Fill [c]
Crest Length:	Crest Length: 473 m [d] Spillway Section: 164 m [d] Non-Spillway Section: 309 m [d]
Type of Spillway:	Side Channel [c]
Capacity of Spillway:	N/A
Date of Completion:	1970 [c]
Date of Area Capacity Survey:	N/A
Date of next Area Capacity Survey:	N/A

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] Measured on Google Earth.
[e] Obtained using identify tool on ArcGIS using WR2012 dataset.
[f] 0.5m Contours from DEM

Figure 14.15 Preston Pan (Google Earth 2018: website).

Table 14.11 Preston Pan (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	13 km^2 [a]
Total Catchment Area:	13 km^2 [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	2.5 million m^3 [b]
Annual Evaporation:	1500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1227.7 mASL [e]
Full Supply Level:	1234 mASL [e]
Spillway Height:	6.3 m [c]
Net Full Supply Capacity:	0.268 million m^3 [c]
Dead Storage:	Unknown at this stage
Total Capacity:	0.268 million m^3 [c]
Surface Area of Dam at Full Supply Level:	0.13 km^2 [c]
Original Measured Dam Capacity	0.268 million m^3 [c]
Dam Type:	Earth fill [c]
Crest Length:	Crest length: 230 m [c]
Type of Spillway:	Open Side Channel [c]
Capacity of Spillway:	N/A
Date of Completion:	1970 [c]
Date of Area Capacity Survey:	N/A
Date of next Area Capacity Survey:	N/A

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] Obtained using identify tool on ArcGIS using WR2012 dataset.
[e] 0.5m Contours from DEM

Figure 14.16 Upper Mpate Dam (Google Earth 2018: website).

Table 14.12 Upper Mpate Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	8 km^2 [a]
Total Catchment Area:	8 km^2 [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	1.6 million m^3 [b]
Annual Evaporation:	1 500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1357 mASL [f]
Full Supply Level:	1375 mASL [f]
Spillway Height:	18 m [c]
Net Full Supply Capacity:	0.264 million m^3 [c]
Dead Storage:	N/A
Total Capacity:	0.264 million m^3 [c]
Surface Area of Dam at Full Supply Level:	0.05 km^2 [c]
Original Measured Dam Capacity	N/A
Dam Type:	Earth fill [c]
Crest Length:	Crest Length: 293 m [d] Spillway Section: 30 m [d] Non-Spillway Section: 263 m [d]
Type of Spillway:	Open channel [c]
Capacity of Spillway:	N/A
Date of Completion:	1880 [c]
Date of Area Capacity Survey:	N/A
Date of next Area Capacity Survey:	N/A

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] Measured on Google Earth.
[e] Obtained using identify tool on ArcGIS using.
[f] 0.5m Contours from DEM

Figure 14.17 Lower Mpate Dam (Google Earth 2018: website).

Table 14.13 Lower Mpate Dam (DWS 2018: Hydrographic Surveys Dams Database, DWS 2019: List of Registered Dams Database, WR2012).

Catchment Details	
Incremental Catchment Area:	8.7 km^2 [a]
Total Catchment Area:	8.71 km^2 [a]
Mean Annual Precipitation:	776 mm [b]
Mean Annual Runoff:	1.69 million m^3 [b]
Annual Evaporation:	1 500 mm [b]
Raised Dam Characteristics	
Gauge Plate Zero:	1331 mASL [g]
Full Supply Level:	1344 mASL [g]
Spillway Height:	13 m [c]
Net Full Supply Capacity:	0.128 million m^3 [c]
Dead Storage:	Unknown at this stage
Total Capacity:	0.128 million m^3 [c]
Surface Area of Dam at Full Supply Level:	0.02 km^2 [c]
Original Measured Dam Capacity	0.128 million m^3 [c]
Dam Type:	Earth fill [c]
Crest Length:	Crest Length: 171 m [d] Spillway Section: 10 m [d] Non-Spillway Section: 161 m [d]
Type of Spillway:	Open channel [c]
Capacity of Spillway:	N/A
Date of Completion:	2001 [c]
Date of Area Capacity Survey:	N/A
Date of next Area Capacity Survey:	N/A

[a] Catchment delineated using 20m DEM and Spatial Analyst.
[b] WR2012 Thukela Quaternary Info WMA 2015 spreadsheet.
[c] DWS List of Registered Dams Database (April 2019).
[d] DWS Hydrographic Surveys Dams Database (2018).
[e] Measured on Google Earth.
[f] obtained using the identify tool on ArcGIS using WR2012 dataset.
[g] 0.5m Contours from DEM

The Nqutu Water Supply Scheme comprises raw water abstraction from the Buffalo River downstream of the confluence with the Blood River (2016: 6-45) and from a tributary of the Ngxobongo River for the supply to the Vant's Drift WTP and Isandlwana WTP respectively. The Vant's Drift WTP, which is on the banks of the Buffalo River, has a design capacity of 14.0 Mℓ/day currently producing 9 Mℓ/day and the Isandlwana WTP has a design capacity of 0.350 Mℓ/day (DWS 2016: 6-37). DWS noted that:

- Given the design capacity of the Vant's Drift WTP of 14.0 Mℓ/day (or 5.1 million m^3/annum) and the current operation of the scheme, the existing raw water pumping infrastructure appears to have sufficient capacity to meet the capacity of the existing WTP (DWS 2016: 6-45).
- This may not be sufficient to meet the capacity of and upgraded Vant's Drift WTP (DWS 2016: 6-45).

A summary of the dams in the Buffalo Region is shown in **Table 14.14**.

Table 14.14 Existing dams in the Buffalo Region (DWS 2016: 5-30).

Impoundment	River	Full Supply Capacity (million m^3/annum)	Purpose
Zaaihoek Dam	Slang River	185.00 [a]	Municipal and Industrial [a]
Mahawane Dam	Mahawane River	2.1 [b]	Municipal [c]
Ntshingwayo Dam (formerly Chelmsford Dam)	Ngagane River	211.26 [a]	Municipal and Industrial [a]
Dorps Dam (off-channel dam)	Dorpspruit River	1.1 [b]	Municipal [c]
Amcor Dam	Ncandu River	0.48 [a]	Recreation [a]
Tom Worthington Dam	Ngobiya River	1.89 [a]	Municipal and Industrial [a]
Verdruk Dam (off-channel dam)	Tributary to the Ngobiya River (first tributary downstream of the Tom Worthington Dam)	1.29 [a]	Municipal and Industrial [a]
Dumfirmline Dam	Ngogo River	0.66 [a]	Irrigation [a]
CISA Chrome Chemicals Waste Disposal Site Dam	Ngagane River	0.47 [a]	Industrial Waste [a]
Lentevlei	Ngudumeni River	0.49 [a]	Irrigation [a]
Donald McHardy Dam	Sterkstroom River	2.68 [a]	Municipal and Industrial [a]
Preston Pan Dam	Sterkstroom River	0.268 [a]	Municipal and Industrial [a]
Upper Mpate Dam	Mpate Stream	0.29 [a]	Municipal and Industrial [a]
Lowe Mpate Dam	Mpate Stream	0.13 [a]	Municipal and Industrial [a]
Klipspruit 1 Dam	Blood River	3.37 [a]	Irrigation [a]
Klipspruit 2 Dam	Blood River	5.19 [a]	Irrigation [a]

[a] DWS 2016: 5-30.
[b] DWS 2012 and 2015 in Umgeni Water 2016: 37.
[c] Umgeni Water 2016: 39.

The following areas have been identified as reliant on groundwater in the Buffalo Region:

- DWS identified the *Qudeni Water Supply Scheme* as a groundwater dependent scheme with the community supplied by stand alone boreholes (DWS 2016: 6-35). This scheme is located in the south-eastern area of the Buffalo Region. It has been confirmed with uMzinyathi and KCDM that there are other sources supplying this scheme, namely, Gubazi run-off river and

Vove Dam. There are two WTPs currently active at Qudeni Water Schemes. One is within the uMzinyathi DM (Lat -28.576048; Long 30.779823), and one is within the King Cetshwayo (KC) DM (Lat -28.610946 Long 30.829663) a few kilometres away. Both have capacities of 350kℓ/day but are supplying 200kℓ/day, and are not interconnected. KCDM is supplied off the Vove Dam, and the uMzinyathi DM plant is fed directly off the Gubazi River. These plants do not receive water from boreholes, but there would be a few standalone boreholes in these water supply schemes (The WTPs abstract surface water).

- The UAP Phase 3 Draft Due Diligence Report stated that the "new package plant (as discussed above) for *Charlestown* abstracts water from four production boreholes" (Umgeni Water 2019: 20). It was further identified that the "operations are reliant on the availability of electricity to provide water, in addition the yield from the source itself is diminishing" (Umgeni Water 2019: 20). The package plant has a design capacity of 2 Mℓ/day (Umgeni Water 2019: 20). There are "two storage tanks (2 x 260 kℓ) at the package plant, providing water to the ground reservoir (0.5 Mℓ) which then supplies two elevated tanks (0.38 Mℓ and 0.04 Mℓ) from where water is distributed to residents" (Umgeni Water 2019: 20).

- The *Amajuba Forest Water Supply Scheme* is located on private farmland and water is available from boreholes, springs and water tanks provided by the WSA (Umgeni Water 2019: 20).

- Areas in the *Dannhauser Buffalo Flats Water Supply Scheme* such as "Chester, Cork, Flint, Greencock, Mullingar, Nyanyadu, Spookmill and Zondo in the north-east and Geduld, Hilltop, Kempshoek, Kliprand, Nguqunguqu, Strijbank, Twhatgwha and Verdriet in the southern part of the scheme area are reliant on ground water supplies and water tankers" (Umgeni Water 2019: 23).

- Groundwater is one of the main sources for the *rural areas in the Emadlangeni Municipality* (Umgeni Water 2019: 40). It was identified that "groundwater in the northern portion of the Emadlangeni Municipality is of general good quality, but deteriorates towards the south" (Umgeni Water 2019: 40).

There is also a Vove dam (yield of 0.33 Mℓ/day) in Vove River (tributary of Gubazi River) that supplies Vutshini Regional Water Supply. The capacity of the Vove Dam is very small provided as 0.02 million m^3. The capacity of the dam and its firm yield is approximately 0.02 million m^3/annum and is insufficient to meet the peak capacity of the Qhudeni Water Treatment Works of 0.38 Mℓ/day.
(Department of Water Affairs All Town Study, 2011, Page 22)

The Amajuba DM, UMzinyathi DM & Newcastle LM Regional Bulk Water Supply Scheme. Prefeasibility Study Revised, June 2017, performed a yield analysis on the Ntshingwayo Dam. This report stated the yield of the Dam, without the Ecological Water Reserve (EWR) as 61.8million m^3/annum, and with the EWR, the yield was reduced to 39.6 million m^3/annum (equates to a yield of 108.49 Mℓ/day with the EWR). *(UAP Phase iii,2019, Page43)*

14.2.4 Operating Rules

The Ntshingwayo Dam is operated by DWS as per the following operating rules:

- "Evaluating the hydrology of the Buffalo Region in order to determine water availability;
- Developing and implementing decision support systems to optimise water allocation/supply to the parties;
- Effecting water supply rationing when necessary;

- Developing and applying a water resources accounting system to determine the amounts of water used and/or "banked" by the users and;
- Facilitating communication and discussions between DWS, Eskom and stakeholders on system operation."

(DWS 2016: 5-29)

Water from Ntshingwayo Dam is currently the preferred source of water for supply to Newcastle due to the relative good quality. Water from the Buffalo River is preferred over water from the Ngagane River, since the supply from the Buffalo River is through gravity and hence has a lower operating cost. As such the current operating rule for the Newcastle WSS is to use the water from the Ntshingwayo Dam first, followed by water from the Buffalo River and, as a last resource, water from the Ngagane River.

The resultant drought operating rule or curtailment curve for the Newcastle WSS for the May decision month is shown in **Figure 14.18**. These drought operating rules show the allocation (as a factor and not a percentage) versus the storage in the dams at the beginning of the decision month. As can be seen from the graph, restrictions within the Newcastle WSS for the 2011 demands are required once the Ntshingwayo Dam drops below 20%. As the demand on the system increase restrictions have to be implemented earlier each year as indicated in **Figure 14.18**.

These drought operating rules are not associated to a specific hydrological/financial/calendar year (although it is presented in this way), but rather for a specific water requirement likely to be incurred in that specific hydrological/financial/calendar year. Also of importance is that each operating rule curve is for a specific demand and a specific priority user classification. Should the demands (upstream and imposed on the dam) change, new curtailment curves have to be produced. In addition, the drought operating rules were developed with Ntshingwayo Dam operated on 95% of its full supply capacity in line with the flood operating rule generated for this dam as part of the Ntshingwayo Dam Flood Operation (DWS 2013).

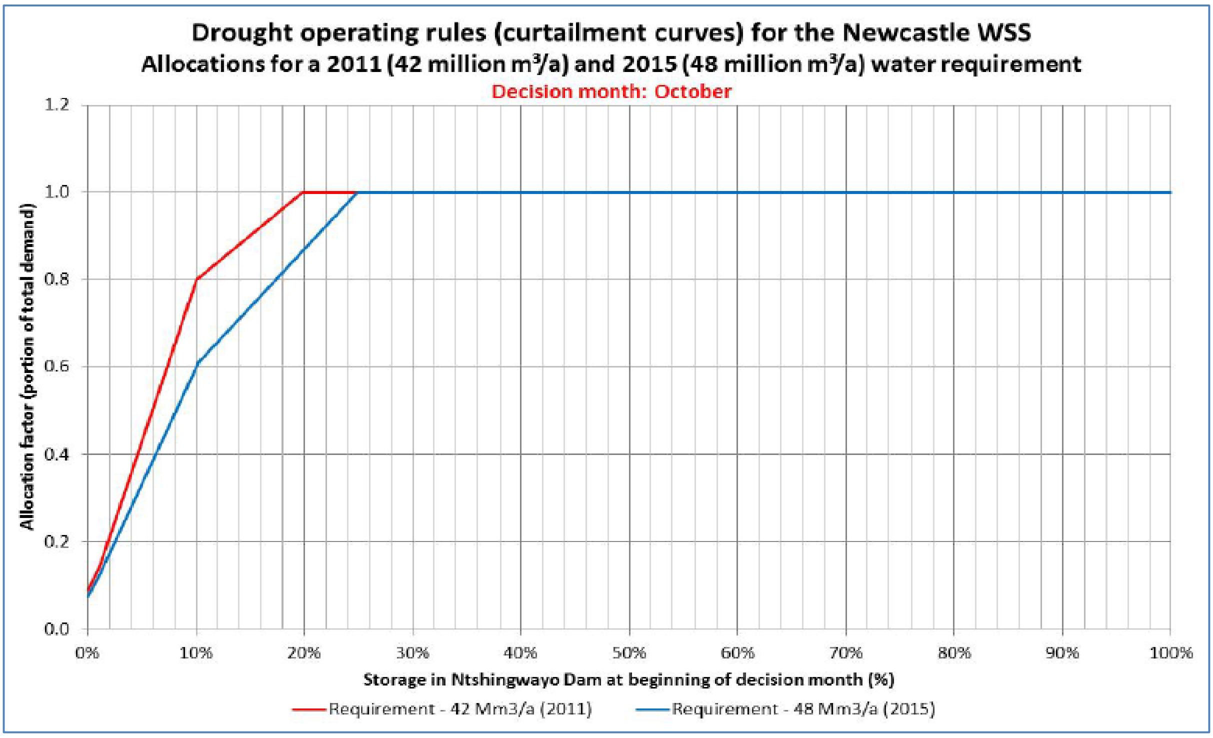

Figure 14.18 Drought operating rules for the Newcastle WSS (May decision month).

Based on work conducted as part of the DWS, 2013 study the following key recommendations were made:

a) Determination of water demand patterns
Water demand projections developed as part of The Development of a Reconciliation Strategy for All Towns in the Eastern Region should be taken up in the Maintenance of the All Towns Study that is planned to follow-up the recently completed Development of a Reconciliation Strategy for All Towns in the Eastern Region. The updated demand projections should inform the revision of drought operating rules so that they remain current.

b) Water losses
It is essential that the water losses within both the Newcastle WSS and Glencoe & Dundee WSS be quantified in future in order to improve the modelling of the system and support with future planning of water resources developments or transfers. The eradication of these losses can also be a meaningful intervention to improve assurance of water supply.

c) Water conservation and demand management (WC/WDM)
The results of the investigation by the Amajuba and Umzinyathi District Municipalities should be incorporated in future studies of the operating rule of the Buffalo River Catchment as the high growth in water requirements of the two WSS can be offset somewhat by implementing water conservation and demand management (WC/WDM) in this system.

The Zaaihoek sub-system is operated by DWS and is modelled annually in the Integrated Vaal River System (IVRS) model:

- It comprises the Zaaihoek Dam on the Slang River, and a pumping station and pipelines across the watershed to the Majuba Power Station and the Vaal River Basin.
- Water designated for irrigation and to supplement the Ngagane River Government Scheme is released into the Slang River (compensation releases).
- Water for Majuba Power Station, the town of Volksrust, and transfers to the Vaal River System is pumped over the basin-divide upstream of the Mahawane Dam.
- Water for Volksrust is released upstream of the Mahawane Dam when required.
- From the basin-divide the water flows via a gravity main to Majuba Power Station
- Water to be transferred to the Vaal River can be released into a tributary of the Schulpspruit upstream of Amersfoort Dam. This water passes through Amersfoort Dam before it flows into the Rietspruit and then into the Vaal River upstream of Grootdraai Dam.
- Releases are also made to augment the Ngagane WW supply in the Newcastle area and for irrigators downstream of the dam. Water is released from the dam to Skurwepoort weir, Buffalo River, where it is diverted to Ngagane.
- Zaaihoek Dam has a fixed operating rule for releases, **Table 14.15**. Water is released as per the monthly schedule for as long as the dam is more than 19% full. If the dam is between 15 and 19 % full, 12 and 15% full, and less than 12% full, supply to the farmers is curtailed by 50%, 70% and 100%, respectively.

Table 14.15 Operating rule for Zaaihoek Dam showing releases (DWS 2001).

Month	Releases for irrigation (m^3/s)	Releases for Ngagane WW (m^3/s)	Total (m^3/s)
October	0.143	0.304	0.447
November	0.341	0.304	0.645
December	0.440	0.304	0.744
January	0.682	0.304	0.986
February	0.828	0.304	1.132
March	0.627	0.304	0.931
April	0.432	0.304	0.736
May	0.253	0.304	0.557
June	0.170	0.304	0.474
July	0.090	0.304	0.394
August	0.070	0.304	0.374
September	0.068	0.304	0.372

Water Requirements:

- The maximum compensation volume from Zaaihoek Dam is 16.7 million m^3 (11.4 million m^3/annum based on normal flow and an additional release of 5.1 million m^3/annum).
- The Zaaihoek to Grootdraai maximum transfer rate is 0.66 m^3/s, transferred when Grootdraai Dam is below 75% in the first year (2019/2020) and thereafter when Grootdraai Dam is below 90%.
- The demand at the Majuba Power Station varies annually depending on Eskom's projections and this ranges between 24 and 27 million m^3/annum.
- Volkrust town: 6.22 million m^3/annum only released when required.

(DWS 2020 personal communication)

14.3 Supply Systems

14.3.1 Description of the Buffalo System

There are three primary bulk water supply schemes (BWSS) within the Buffalo System:

- Ntshingwayo BWSS – Ngagane Water Treatment Plant (WTP)
- Biggarsberg BWSS – Biggarsberg WTP
- Nqutu BWSS – Vant's Drift WTP

There are other smaller water supply schemes (WSS) within the Buffalo System:

- Dannhauser WSS – Dannhauser WTP
- Durnacol WSS – Durnacol WTP
- Utrecht WSS – Utrecht WTP
- Charlestown WSS – Charlestown WTP
- Qudeni BWSS – Qudeni WTP "uMzinyathi DM"
- Qudeni BWSS – Qudeni WTP "King Cetshwayo DM"
- Isandlwana BWSS – Isandlwana WTP

(Please note: the information contained in this section 14.3.1 (a) and 14.3.1 (b) is via written communication [emails] with uThukela Water (Pty) Ltd, and clarity confirmed through verbal communication. uThukela Water are the current operators of the Ngagane and Biggarsberg WTPs. Previously, they also operated other WTPs of the Buffalo Region including Vants Drift, Dannhauser, Durnacol, uTrecht and Charlestown).

The following is a brief description (locality and supply area) of the three primary bulk WTPs within the Buffalo System:

- **Ngagane WTP**: The Ngagane WTP is located 9.3km (driving distance) South East of Newcastle central (City of Newcastle). It is located 400m from the banks of the iNgagane River (its source), and falls within the Newcastle Local Municipality boundary. It is operated by uThukela Water and supplies the primary areas of Newcastle central business district (CBD), industrial area and suburbs, Madadeni, Osizweni, Emadlangeni, Blaauwbosch, Waterval, Alcockspruit, Northdown, Signal Hill and a number of other smaller areas.

- **Biggarsberg WTP**: The Biggarsberg WTP is located 5.8km (driving distance) North East of Dundee central (Dundee town). It is located 26.85km (distance along raw water pipeline) from its primary water source, the Buffalo River (also referred to as the Buffels Rivier) and falls within the Endumeni Local Municipality, which is within the uMzinyathi DM (the WSA). It is operated by uThukela Water and supplies the primary areas of Dundee, Glencoe, Hattingspruit, Verdruk, Springlake Collieries, Sibongile, Sithembile and Wasbank.

- **Vant's Drift WTP**: The Vant's Drift WTP is located 17km (driving distance) West of Nqutu town, or 35km East of Dundee town (driving distance). It is located on the banks of the Buffalo River (its source) and falls within the Nqutu Local Municipality. It is operated by uMzinyathi DM and supplies the areas of Nqutu including the Nqutu CBD, Bambisinani, Ndatshane, Ndindindi, Telezini, Izicole, Maceba, Ngonini, Ngobhoti, Jabavu, Masotsheni and St Augustines.

- **Dannhauser**: The Dannhauser WTP is located 2km (driving distance) North East of the Dannhauser town. It is located 400m on the banks of the TweedieDale Dam (previous source), and falls within the Amajuba District Municipality (ADM) boundary, under Dannhauser LM. It is operated by ADM and supplies the primary areas of Dannhauser town and suburbs, including NLK (maize depo) and Emafusini. Water supply to the outlying areas (beyond the town and suburbs) is further supplemented by a series of production boreholes (rudimentary water schemes). The Durnacol WTP currently provides treated water to the Dannhauser town and surrounds thanks to an interlinking of bulk supply pipelines, whilst the ADM is arranging for the Dannhauser plant to be repaired/refurbished.

- **Durnacol**: The Durnacol WTP is located 1km (driving distance) North East of the Durnacol town. It falls within the Amajuba District Municipality (ADM) boundary under Dannhauser LM. It is operated by ADM and supplies water to the areas of Durnacol, Targo village, Taiwan, Skomplaz, Durnacol number 2, 3 & 7. It also supplies water to Dannhauser, in the event of Dannhauser being offline (as per current situation, May 2020).

- **Utrecht**: The Utrecht WTP is located 1km (driving distance) South of its water source (Dorps Dam), and is on the Northern boundary of the Utrecht town. It falls within the Amajuba District Municipality (ADM) boundary under Emadlangeni LM. It is operated by ADM and supplies water to the areas of Utrecht town, Khayalethu, Bensdorp, White City, Balgray (pump station). Water supply to the outlying areas (beyond the town of Utrecht) is further supplemented by a series of boreholes.

- **Charlestown**: The Charlestown WTP is located 1km (driving distance) North West of Charlestown. Its water source is purely production boreholes and it falls within the Newcastle LM boundary. It is operated by Newcastle LM and supplies water only to the areas of Charlestown. Water supply to the outlying areas (beyond the town of Charlestown) is further supplemented by a series of boreholes.

More detailed information on each of the treatment plants and systems follow below in sub-section a) to sub-section g).

(a) Ngagane Water Treatment Plant and Supply System

The primary sources of raw water for the Ngagane WTP **(Figure 14.1, Table 14.16)** are the Ntshingwayo Dam and the Buffalo River. The iNgagane River is also used to supplement the raw water supply to the Ngagane WTP. Neither the Buffalo River, nor the iNgagane River are reliable sources. The rivers can drop to very low levels during the Winter months, making it difficult to extract water from these sources. The iNgagane River originates just outside of the Newcastle Municipal area (in the Amajuba DM area), in the high-lying south-western parts of the landscape where it meets the Ncandu before it flows into the Buffalo River. The Ngagane WTP is operated by uThukela Water, who confirm that the WTP draws 80% of its raw water from the Ntshingwayo Dam.

Figure 14.19 Photo of Ntshingwayo Dam (Primary Source of Ngagane WTP), May 2016

The Ntshingwayo Dam was built as a storage dam for Newcastle and surrounding areas within Amajuba DM. The Ntshingwayo System is situated in the uThukela River system, and the Buffalo catchment is the main northern tributary of the uThukela River. uThukela Water also confirm that the Ngagane WTP currently has a capacity of 130 Mℓ/day. The Ngagane WTP supplies the primary areas of the Newcastle central business district (CBD), the industrial areas and suburbs, Madadeni, Osizweni, Emadlangeni, Blaauwbosch, Waterval, Alcockspruit, Northdown, Signal Hill and a number of other smaller areas (The Dorpsdam and Nywerheids Dam is on the Dorpsruit river and supplies water to the Utrecht WTW, but these off channel dams dry up during the Winter months and potable water supply for Utrecht reverts to the Ngagane WTP). The Ngagane WTP capacity can be increased to 153 Mℓ/day by refurbishing the filter units and implementing alterations to the settling tanks. This item of work is included in a business plan that is currently being compiled by an engineering consultants for Newcastle LM.

Table 14.16 Characteristics of the Ngagane WTP

WTP Name:	Ngagane WTP
System:	Tugela River System / Buffalo River Catchment
Maximum Design Capacity:	130 Mℓ/day*
Current Utilisation:	101 Mℓ/day (restricted supply volumes) Currently taking 86 Mℓ/day from the Ntshingwayo dam, then daily taking 27Mℓ/day from the Buffalo River, **or** take from the iNgagane river (30 Mℓ/day big pump or 17 Mℓ/day from the small pumps – currently using small pumps). *
Raw Water Storage Capacity:	Ntshingwayo Dam – DWS Dam, 194.6 million kℓ
Raw Water Supply Capacity:	Ntshingwayo Dam, Buffalo River and Ngagane River together provides 173.5 Mℓ/day in terms of official DWS allocations, but supply capacity is rated at 179 Mℓ/day. *
Pre-Oxidation Type:	Pre-chlorination
Primary Water Pre-Treatment Chemical:	Polymeric Coagulant*
Total Coagulant Dosing Capacity:	750 kg/day*
Rapid Mixing Method:	Flash Mixer
Clarifier Type:	Vertical-flow Candy tanks and horizontal-flow settling tank*
Number of Clarifiers:	28*
Total Area of all Clarifiers:	3354 m^2
Total Capacity of Clarifiers:	140 Mℓ/day*
Filter Type:	Rapid Gravity Filters*
Number of Filters:	19*
Filter Floor Type	Plate Design*
Total Filtration Area of all Filters	944 m^2*
Total Filtration Design Capacity of all Filters:	130 Mℓ/day *
Average Recovery Backwash water volume:	1445 m^3/day (Capacity of Pit 6 Mℓ/day) *
Total Capacity of Sludge Dams:	20 000 m^3/hr *
Capacity of Used Wash Water System:	4 Mℓ/day*
Primary Post Disinfection Type:	Post Chlorination
Disinfection Dosing Capacity:	10 kg/hr
Disinfectant Storage Capacity:	8 x 1-ton full chlorine cylinders
Total Treated Water Storage Capacity:	33 Mℓ*

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

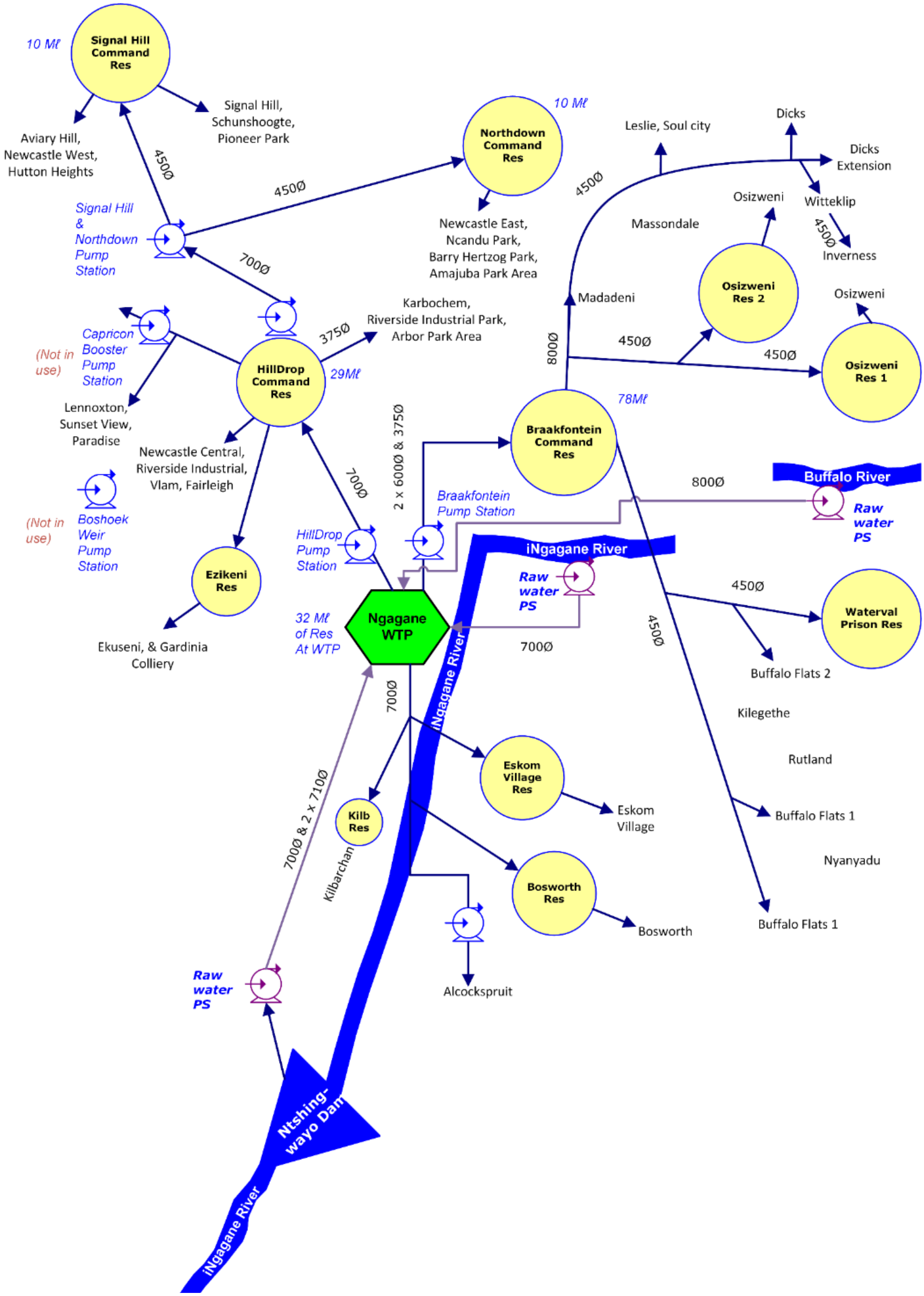

Figure 14.20 Ngagane WTP Supply System Schematic (not to scale; uThukela Water bulk infrastructure)

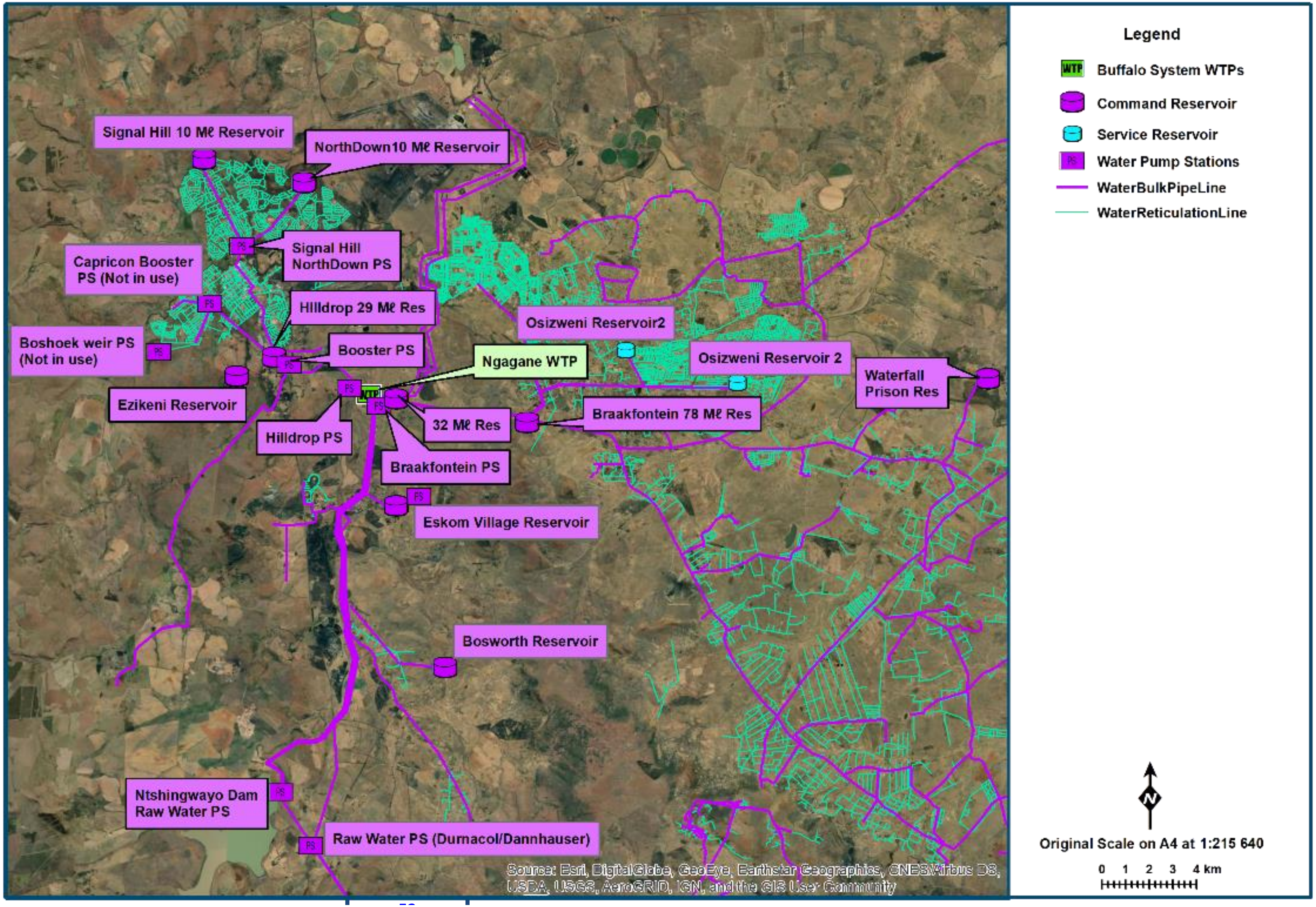

Figure 14.21 Newcastle Supply System Layout (Ngagane WTP System) (NGI 2014; Umgeni Water 2020)

Raw water infrastructure for the three sources of the Ngagane WTP are summarised below[5] and in **Table 14.17** and **Table 14.18**:

- **Ntshingwayo Dam:** Two raw water gravity fed pipelines from the Ntshingwayo Dam, delivering an average of ± 84 Mℓ/day to Ngagane Water Treatment Plant. The pipeline lengths are approximately 20 km each. The one pipeline is a pre-stressed concrete pipeline with internal diameter 690 mm, and the second pipe is a steel pipe with internal diameter 590 mm for 15.3 km and an AC pipe with internal diameter 590 mm for 4.7 km. The present allocation from the Ntshingwayo Dam is 113.5 Mℓ/day via the pipelines.

- **Buffalo River:** The raw water gravity feed from the Buffalo River is via an 800mm diameter mild steel pipeline (32km in length), from a weir higher up on the Buffalo River in the direction of Volksrust (Schurwepoort weir). This line was installed in 1983. The allocation from the Buffalo River is 30 Mℓ/day, but the system's capacity varies dependent on the season and on the upstream users. At present the average supply volume from this source (late 2019 to April 2020) was 23 Mℓ/day, but it is unreliable during Winter months, which is when uThukela Water will revert to raw water pumping from the Ngagane River (to supplement the raw water abstracted from Ntshingwayo Dam).

- **Ngagane River:** The raw water gravity feed from the Ngagane River is via a 700mm diameter, steel epoxy coated pipeline (pumping main) to the plant and can deliver a design capacity of ± 36 Mℓ/day. The abstraction point is located downstream of the Ntshingwayo Dam. The present delivery is determined by the pump capacity at the raw water pump station. The present extraction permit allows for 30 Mℓ/day. The Ngagane River pumps were upgraded with three 18 Mℓ/day (220 ℓ/s) axial flow pumps (2 duty, 1 standby) including connection pipe work, switchgear, etc. This source was not used regularly during the past few years (2015-2020) as a result of water restrictions that were imposed, in lieu of the drought and budget restrictions from the Newcastle Water Service Authority. The source was only used during planned maintenance situations when the Ntshingwayo supply was restricted. Both pumps (36 Mℓ/day) are used when supply from the Buffalo River is problematic.

[5] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Table 14.17 Pump Station Details: Ntshingwayo System, Raw Water.

System	Pump Station Name	Pump Set	Pump Status		Pump Description	Supply From	Supply To	Static Head (m)	Duty * Head (m)	Duty* Capacity (Mℓ/day)	Approx Age*	Approx. * Condition
			Duty	Stand by								
Ntshingwayo	Ngagane River Pump Station	1	✓		KSB Axial flow	Ngagane River	Ngagane WTP	12	15	18	1 yr	Good
	Ngagane River Pump Station	2	✓		Axial flow	Ngagane River	Ngagane WTP	12	15	18	8yrs	Good
	Ngagane River Pump Station	3		✓	Hidrostal, submersible	Ngagane River	Ngagane WTP	12	15	19.8	8yrs	Excellent (new)

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Table 14.18 Pipeline Details: Ntshingwayo System, Raw Water Supply Pipelines.

System	Pipeline Name	From	To	Length* (km)	Nominal Diameter* (mm)	Material*	Capacity * (Mℓ/day)	Age* (years)
Ntshingwayo	Ngagane Raw water	Ntshingwayo Dam	Ngagane WTP	15.28	710	Steel	64.62	52
	Ngagane Raw water	Ntshingwayo Dam	Ngagane WTP	19.97	700	Concrete	47.24	52
	Ngagane Raw water	Ntshingwayo Dam	Ngagane WTP	4.672	710	AC	64.62	52
Buffalo	Buffalo Raw water	Schurwepoort Weir	Ngagane WTP	26	800	Steel	86.86	34
Ngagane	Ngagane Raw water	Ngagane River	Ngagane WTP	0.6	700	Steel	64.62	32

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Potable water supply systems downstream of the Ngagane WTP are listed below[6] and in **Table 14.19:**

- **Hilldrop Reservoirs:** The Ngagane WTPs primary supply point is Hilldrop reservoirs, to which an average of 33 Mℓ/day (current, April 2020) is pumped to the reservoirs that supply Newcastle Town and the surrounding Hilldrop area. A 375mm diameter Asbestos Concrete (AC) and a 700mm steel 5.5 km pumping pipeline supplies potable water to Hilldrop reservoirs. Both these pipelines require urgent replacement, as high water losses are being experienced throughout, especially the steel pipeline. uThukela Water has not been able to undertake this, due to lack of CAPEX budget over the last six years. The cathodic protection on the steel

[6] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

pipeline should be reinstated urgently, to prevent further deterioration/corrosion of the pipeline.

- **Braakfontein Reservoirs:** The second primary supply point is Braakfontein Reservoir/s, to which an average of 62 Mℓ/day (current, April 2020) is pumped. These reservoirs feed Madadeni, Osizweni and the Buffalo Flats area in Amajuba DM. Three supply pumping mains supply potable water to Braakfontein reservoirs: a 600mm diameter steel, 375 AC and a 600mm diameter glass fibre reinforced plastic (GRP) pumping main.

- **Eskom and Kilbarchan Reservoirs:** A third supply point is the Eskom pumping main (a 315mm diameter uPVC pipeline), that supplies potable water to Eskom Village. The pipe reduces to a 150mm diameter uPVC pipeline on the section that feeds Kilbarchan and Bosworth area and then reduces to a 125mm diameter uPVC line when extending up to the Alcockspruit Area which falls in Amajuba DM. An average supply volume of 1.7 Mℓ/day (current, April 2020) is supplied through this final pipeline.

The advanced age of the pipelines in **Table 14.18** and **Table 14.19** are indicative of the condition of these pipelines, with most of the pipelines in need of refurbishment or quite possibly replacement. uThukela Water had been in the process of appointing a service provider to undertake condition assessments on these lines until financial constraints prevented this project. The lack of cathodic protection across some steel pipelines will decrease the lifespan of those pipelines.

Table 14.19 Pipeline Details: Ntshingwayo Potable Supply Pipelines

System	Pipeline Name	From	To	Length* (km)	Nominal Diameter* (mm)	Material*	Capacity * (Mℓ/day)	Age* (years)
Ngagane	Braakfontein	Ngagane WTP	Braakfontein Reservoir	6.6	600	Steel	48.86	47
Ngagane	Braakfontein	Ngagane WTP	Braakfontein Reservoir	6.6	600	GRP	48.86	47
Ngagane	Braakfontein	Ngagane WTP	Braakfontein Reservoir	6.6	375	AC	19.01	47
Ngagane	Hilldrop	Ngagane WTP	Hilldrop Reservoir	8.8	700	Steel	64.62	47
Ngagane	Hilldrop	Ngagane WTP	Hilldrop Reservoir	8.8	400	AC	21.71	47
Ngagane	Eskom	Ngagane WTP	Eskom Reservoir	1.8	700	Steel	64.62	47
Ngagane	Kilbarchan	Ngagane WTP	Kilbarchan Reservoir	2.0	300	Steel	12.21	47
Ngagane	Ballengiegh	Ngagane WTP	Balangeigh Reservoir	18.6	300	Steel	12.21	47
Ngagane	Ekuseni	Ngagane WTP	Ekuseni Pump station	5.5	375	Steel	19.01	47

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Table 14.20 Pump Details: Ngagane/Ntshingwayo Potable Water Pump Stations

System	Pump Station Name	Pump Set	Pump Status		Pump Description*	Supply From	Supply To	Static Head (m)	Duty Head* (m)	Duty Capacity* (Mℓ/day)	Approx Age*	Approx. Condition*
			Duty	Standby								
Ngagane WPP	Main p/station	A-1 Pump	✓		Weir-Environtech (Uniglide) SDCH 400/450	Ngagane WPP	Braakfontein reservoirs	114	155	45	20	Good
Ngagane WPP	Main p/station	A-2 Pump		✓	Weir-Environtech (Uniglide) SDCH 400/450	Ngagane WPP	Braakfontein reservoirs	114	155	45	20	Good
Ngagane WPP	Main p/station	B-1 Pump	✓		Sulzer split casing	Ngagane WPP	Hilldrop reservoirs/Braakfontein	135	175	30	15-20	Average
Ngagane WPP	Main p/station	B-2 Pump		✓	Sulzer split casing	Ngagane WPP	Hilldrop reservoirs/ Braakfontein	135	175	30	15-20	Average
Ngagane WPP	Main p/station	C-1 Pump	✓		Sulzer split casing	Ngagane WPP	Hilldrop reservoirs	135	175	35	15-20	Being Recon.
Ngagane WPP	Main p/station	C-2 Pump		✓	Sulzer split casing	Ngagane WPP	Hilldrop reservoirs	135	175	35	15-20	Being Recon.
Ngagane WPP	Main Pump station	D-1 pump	✓		KSB split casing	Ngagane WPP	Hilldrop reservoirs	80.4	105	25.92	10	Good
Ngagane WPP	Main Pump station	D-2 pump	✓		KSB split casing	Ngagane WPP	Hilldrop reservoirs	80.4	105	25.92	10	Good

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Table 14.21 Reservoir Details: Ntshingwayo System

System	Reservoir Site	Reservoir Name*	Capacity* (Mℓ)	Reservoir Function	TWL* (mASL)	FL (mASL)
Ngagane WPP	Ngagane WTP	Ngagane Plant Reservoir 1	2	Bulk	1180.70	1176.7
Ngagane WPP	Ngagane WTP	Ngagane Plant Reservoir 2	9	Bulk	1180.70	1177.0
Ngagane WPP	Ngagane WTP	Ngagane Plant Reservoir 3	12	Bulk	1180.72	1176.85
Ngagane WPP	Ngagane WTP	Ngagane Plant Reservoir 4	10	Bulk	1180.30	1176.6
Ngagane WPP	Kilbarchan Village	Kilbarchan Reservoir	0.5	Bulk	1250.0**	1247.0**
Ngagane WPP	Newcastle Town	Hilldrop Reservoir 1	11	Terminal	1260.4	1252.4
Ngagane WPP	Newcastle Town	Hilldrop Reservoir 2	4	Terminal	1260.4	1252.4
Ngagane WPP	Newcastle Town	Hilldrop Reservoir 3	4	Terminal	1260.4	1252.4
Ngagane WPP	Newcastle Town	Hilldrop Reservoir 4	10	Terminal	1260.4	1252.4
Ngagane WPP	Newcastle Town	Hilldrop Reservoir 5 (new)	10	Terminal	1260.4	1252.4
Ngagane WPP	Newcastle Town	Siyahlala Reservoir	10	Distribution	1331.5	1323.5
Ngagane WPP	Madadeni Area	Braakfontein reservoir 2	13.5	Terminal	1294.2	1285.1
Ngagane WPP	Madadeni area	Braakfontein reservoir 3	13.5	Terminal	1294.2	1285.1
Ngagane WPP	Madadeni Area	Braakfontein reservoir 4	45	Terminal	1294.2	1285.1

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)
**Estimate: Ascertained from Google Earth (2005)

Figure 14.22 Photo of High Lift Pump Station at Ngagane WTP (May 2020)

(b) Biggarsberg Water Treatment Plant and Supply System

Figure 14.23 Photo of Biggarsberg WTP, Clarifiers (July 2019)

The **Biggarsberg WTP** is dependent on two sources of raw water supply (**Figure 14.1**):

- **The Buffalo River:** The Buffalo River Augmentation Scheme (Tayside Pump Station) was designed in 1982 to deliver 13.75 Mℓ/day of raw water abstracted from the Buffalo River, to the Biggarsberg WTP. The Tayside Pump Station currently delivers 13 Mℓ/day (average). An intake tower and low lift pumps are constructed above the high flood level and abstracts water from the Tayside Weir in the Buffalo River. The Low Lift Pumps consist of a duty plus a standby pump and a submersible pump utilised during times of low river levels. An upward flow clarifier was constructed to remove suspended silt from the raw water abstracted from the Buffalo River. Settled raw water is pumped to the balancing dam at the Biggarsberg WTP by two Sulzer, two-stage, type 54-25, horizontal spindle, centrifugal pumps. The pumps and switchgear have been sized for a capacity of 13.75 Mℓ/day. The raw water is pumped approximately 26 km to the Biggarsberg WTP through a 400mm diameter steel raw water pumping main.

- **Six dams:** these six dams are in close proximity to the Biggarsberg WTP in the Buffalo River catchment:
    - **Tom Worthington Dam and Verdruk Dam:** Water is pumped from the raw water pumping stations to a 1.3 Mℓ capacity balancing dam from where it gravitates to the raw water balancing dam at the WTP.
    - **The Sterkstroom River:** Includes the Donald Mchardy Dam and the Preston Pan. It is estimated that the total available water from the Sterkstroom River is 2.5 Mℓ/day.

- **The Mpate catchment dams:** Comprises of two small dams located near the WTP. Raw water flows under gravity from both the upper and lower Mpate Dams directly into the water treatment works. The Mpate Dams, with a storage capacity of approximately 380,000m³, act as balancing storage during periods of low flow in the Buffalo River and are kept full by pumping from the raw water balancing dam at the Plant (to the Upper Mpate Dam).

The capacity of the 6 dams listed above has been estimated at 2.3 million m^3/annum based on the 25% live storage capacity of the dams as the dams are very small[7]. The Biggarsberg WTP is operated by uThukela Water and supplies the primary areas of Dundee, Glencoe, Hattingspruit, Verdruk, Springlake Collieries, Sibongile, Sithembile and Wasbank. The potential historical firm yield of these various dams, amount to a daily supply volume of 7 Mℓ/day[8]. However, the primary source of the Biggarsberg WTP is the Tayside Pump Station with a daily average supply volume of 13 Mℓ/day. Upgrades over the years, at the Biggarsberg WTP, have increased the design capacity to 16 Mℓ/day.

The plant reservoir complex consists of five reservoirs having a combined storage capacity of 17 Mℓ. The water stored in reservoirs 1 to 3 is used for plant water (such as back washing). Note that reservoir 1 to 3 are continuously interlinked and also serve the WTP (backwashing). It is possible to link reservoir 1, 2, 3, 4 and 5, when the need arises. The storage reservoirs at the treatment works (reservoir 4 and 5) provide total reservoir storage for Dundee and the lower parts of Sibongile and pump storage for the Glencoe supply volumes and further distribution to Wasbank and Hattingspruit. A new reservoir was constructed for the higher lying areas of Sithembile (in Glencoe), of 1.7 Mℓ capacity in late 2017. The layout of the Biggarberg WSS is presented in **Figure 14.25**. The details of the WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.22, Table 14.23, Table 14.24, Table 14.25** and **Table** 14.26**.**

Potable water supply systems downstream of the Biggarsberg WTP are presented in **Table 14.25** and discussed below.

Dundee: Water flows under gravity from the reservoirs at the treatment works to Dundee (including Sibongile) via four pipelines (two 400mm diameter AC pipes, a 225mm diameter AC pipe and a 230mm diameter cast iron pipeline. The 225mm AC and the cast-iron pipelines are seldom used. The total Dundee reservoir storage is provided at the treatment works. Manifolds have been supplied at each end of the pipeline allowing any of the pipelines to be isolated without affecting the supply through the other pipelines. This seeks to increase levels of reliability. During the 2016/2017 financial year an average of 7.9 Mℓ/day of potable water was supplied to Dundee /Sibongile. This increased to 9 Mℓ/day in 2017/2018 and then decreased again to 8.5 Mℓ/day in the 2018/2019 financial years[9]. The current (April 2020) demand of 8.9 Mℓ/day, is being supplied to the Glencoe and surrounding areas.

[7] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020, DWS do not manage these dams)
[8] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020, DWS do not manage these dams)
[9] Annual production figures in this paragraph obtained through personal communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Glencoe: Water is drawn from the interconnected reservoirs at the treatment plant and then pumped via three rising mains (225mm and 300mm diameter AC pipelines, as well as a new 400mm ductile iron pipe line commissioned early in 2017), to the Glencoe Reservoir Complex. There is a 75mm diameter AC tee-off from this rising main to Hattingspruit. From the Glencoe Reservoir Complex water is supplied to Glencoe/Sithembile, Wasbank, Northfield Prison and Corobrik. The total supply from the reservoir complex is supplied under gravity apart from a small portion around the reservoir in Glencoe which is supplied to an elevated water tower. During the 2016/2017 financial year, an average of 5.8 Mℓ/day was supplied to the Glencoe and surrounding areas. During the 2017/2018 financial year, an average of 5.5 Mℓ/day was supplied and this decreased to 5,3 Mℓ/day in the 2018/2019 financial year. The current (April 2020) demand is 6.5 Mℓ/day[10].

Figure 14.24 Photo of Chlorine Dosing Point at Biggarsberg WTP (July 2019)

[10] Annual production figures in this paragraph obtained through personal communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

Table 14.22 Characteristics of the Biggarsberg WTP

WTP Name:	Biggarsberg WTP
System:	Buffalo River Catchment
Maximum Design Capacity:	16 Mℓ/day*
Current Utilisation:	15.37 Mℓ/day (restricted supply volumes)*
Raw Water Storage Capacity:	380,000m^3*
Raw Water Supply Capacity:	19.3 Mℓ/day*
Pre-Oxidation Type:	Pre-chlorination and Cascade Aeration*
Primary Water Pre-Treatment Chemical:	Polymeric Coagulant
Total Coagulant Dosing Capacity:	180 kg/day*
Rapid Mixing Method:	Flash Mixer
Clarifier Type:	Rectangular, Clari-flocculator and two circular up-flow clarifiers
Number of Clarifiers:	4
Total Area of all Clarifiers:	1059 m^2*
Total Capacity of Clarifiers:	23.9 Mℓ/day*
Filter Type:	Rapid Gravity Filters
Number of Filters:	8
Filter Floor Type	Lateral pipe Design
Total Filtration Area of all Filters	218 m^2*
Total Filtration Design Capacity of all Filters:	26 Mℓ/day (filters require urgent refurbishment – currently the bottleneck at the plant)*.
Average Recovery Backwash water volume:	910 m^3/day (Capacity of Pit 1 Mℓ/day) *
Total Capacity of Sludge Drying beds & Dam:	416m^3
Capacity of Used Wash Water System:	1 Mℓ/day
Primary Post Disinfection Type:	Post Chlorination
Disinfection Dosing Capacity:	5 kg/hr*
Disinfectant Storage Capacity:	6 x 1-ton full chlorine cylinders
Total Treated Water Storage Capacity:	17.06 Mℓ*

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)

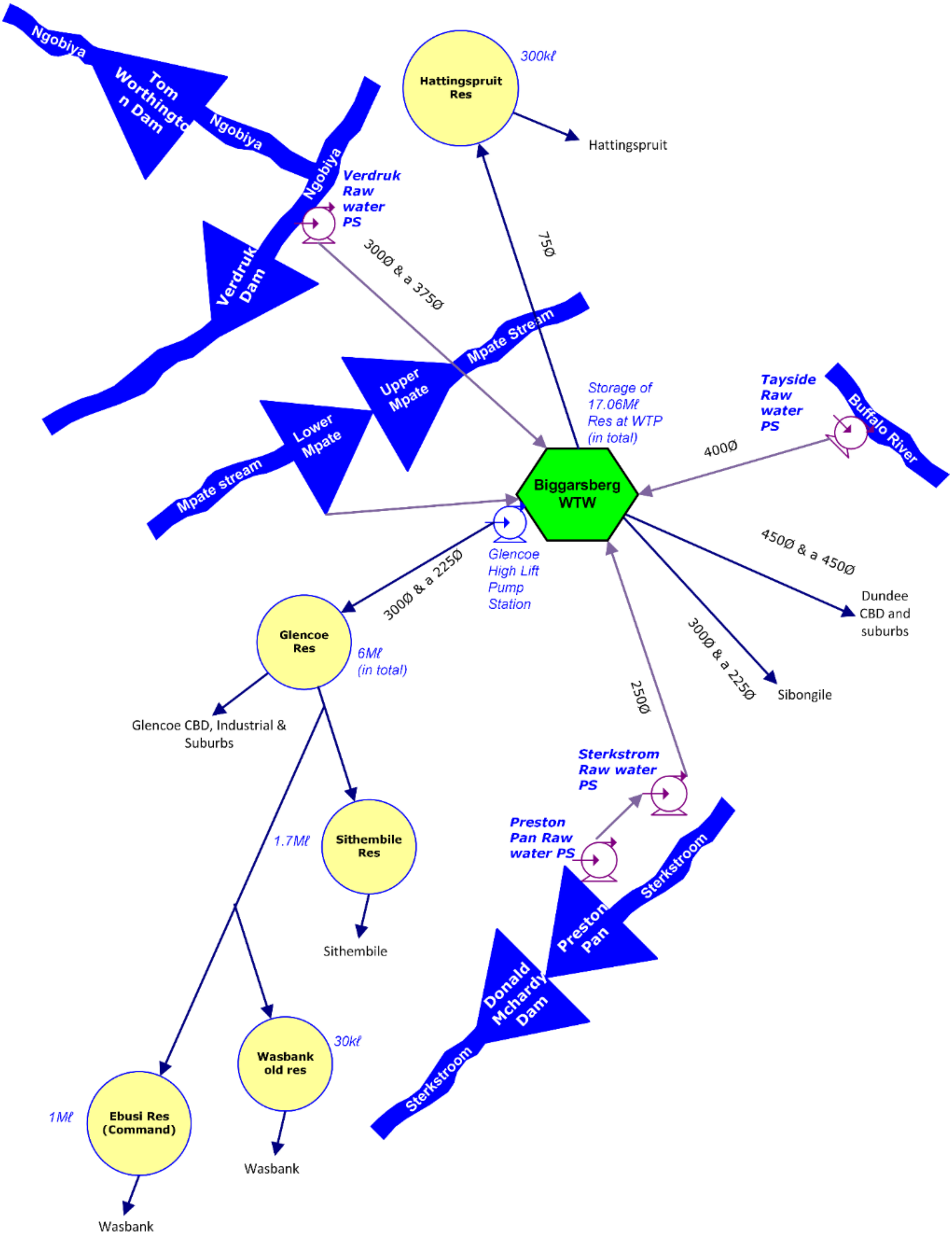

Figure 14.25 Biggarsberg WTP Supply Schematic (not to scale; uMzinyathi bulk infrastructure)

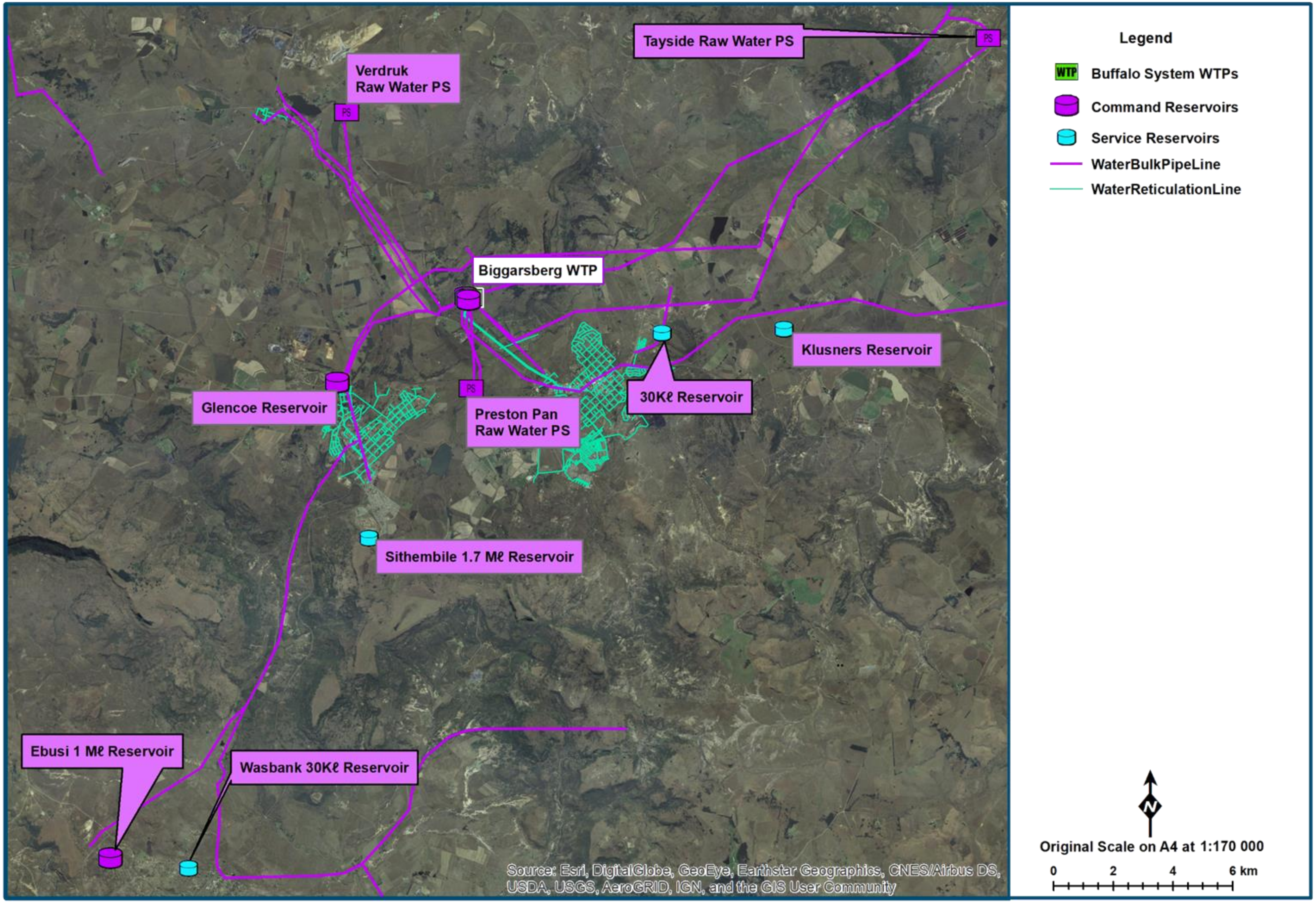

Figure 14.26 Dundee/Glencoe Supply System Layout (Biggarsberg WTP System) (NGI 2014; Umgeni Water 2020)

Table 14.23 Pump Station Details: Biggarsberg Raw Pump Stations

System	Pump Station Name	Pump Sets	Pump Status		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head * (m)	Duty Capacity (Mℓ/day)	Approx. Age*	Approx. Condition*
			Duty	Standby								
Biggarsberg	Tayside High lift raw water	2	1	1	Sulzer HPH 54 Multistage	Tayside Pump station	Biggarsberg WPP	182	300	13*	20	Good
	Verdruk raw water	2	1	1	KSB WKLn 80/2	Verdruk raw water pump station	Biggarsberg WPP	32	91**	4.5**	9	Good
	Sterkstroom RW	2	1	1	KSB WKLn 80/3	Sterkstroom RW pump station	Biggarsberg WPP	87	121**	4.8**	11	Good

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)
**Estimate, based on the pump curves, static head, pipe length, pipe diameter, and rpm

Table 14.24 Pump Station Details: Biggarsberg Potable Water Pump Station

System	Pump Station Name	Pump Sets	Pump Status		Pump Description*	Supply From	Supply To	Static Head (m)	Duty Head* (m)	Duty Capacity* (Mℓ/d)	Approx. Age*	Approx. Condition*
			Duty	Standby								
Biggarsberg	Glencoe	Pump 1	2		KSB Multistage (Model TBC)	Biggarsberg WPP	Glencoe reservoirs	64	11	4	10-15	Average
	Glencoe	Pump 1	1		KSB Multistage (Model TBC)	Biggarsberg WPP	Glencoe reservoirs	64	11	1.5	10-15	Average
	Glencoe	Pump 2		1	KSB Multistage (Model TBC)	Biggarsberg WPP	Glencoe reservoirs	64	11	1.5	10-15	Average

* Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water (April 2020)

Table 14.25 Pipeline Details: Biggarsberg WTP Supply System

System	Pipeline Name	From	To	Length* (km)	Nominal Diameter* (mm)	Material*	Capacity * (Mℓ/day)	Age* (years)
Biggarsberg	Tayside raw water	Tayside Pump Station	Biggarsberg WTP	26.85	400	Steel	21,71	37
Biggarsberg	Mpate raw water	Lower Mpate	Biggarsberg WTP	0.5	225	CI	6.87	47
Biggarsberg	Donald McHardy raw water	Donald McHardy Dam	Sterkstrom Pump station	2.2	300	AC	12.21	47
Biggarsberg	Preston Pan raw water	Preston Pan Dam	Sterkstrom Pump station	0.35	300	AC	12.21	47
Biggarsberg	Sterkstrom Raw water	Sterkstrom Pump Station	Biggarsberg WTP	3.38	250	AC	8.48	47
Biggarsberg	Verdruk Raw water	Verdruk pump station	Biggarsberg WTP	7.85	300	AC	12.21	47
Biggarsberg	Verdruk Raw water	Verdruk Pump Station	Biggarsberg WTP	7.85	375	AC	19.01	47
Biggarsberg	Dundee	Biggarsberg WTP	Dundee	1.5	450	AC	27.48	47
Biggarsberg	Dundee	Biggarsberg WTP	Dundee	1.5	450	AC	27.48	47
Biggarsberg	Dundee	Biggarsberg WTP	Sibongile	1.5	225	CI	6.87	47
Biggarsberg	Dundee	Biggarsberg WTP	Sibongile	1.5	225	AC	6.87	47
Biggarsberg	Glencoe	Biggarsberg WTP	Glencoe Reservoir	5.625	300	AC	12.21	47
Biggarsberg	Glencoe	Biggarsberg WTP	Glencoe Reservoir	5.625	300	Steel	6.87	47
Biggarsberg	Hattingspruit	Glencoe Main	Hattingspruit Reservoir	8	75	AC	0.76	47

*Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water (April 2020)

Table 14.26 Reservoir Details: Biggarsberg System

System	Reservoir Site	Reservoir Name*	Capacity* (Mℓ)	Reservoir Function	TWL (mASL)	FL (mASL)
Biggarsberg	Biggarsberg Plant	Reservoir 1	0.46	Bulk	1322	1320
Biggarsberg	Biggarsberg Plant	Reservoir 2	0.91	Bulk	1322	1320
Biggarsberg	Biggarsberg Plant	Reservoir 3	1.14	Bulk	1323	1321
Biggarsberg	Biggarsberg Plant	Reservoir 4	4.55	Bulk	1323.7	1320.7
Biggarsberg	Biggarsberg Plant	Reservoir 5	10.00	Bulk	1323	1318
Biggarsberg	Glencoe Town	Reservoir 1 and 2	0.547	Distribution	1388	1385
Biggarsberg	Glencoe Town	Reservoir 3	0.798	Distribution	1388.6	1384.6
Biggarsberg	Glencoe Town	Reservoir 4	4.56	Distribution	1387	1383
Biggarsberg	Sithembile	Reservoir 1	1.7	Distribution	1371	1365.6
Biggarsberg	Washbank	Reservoir 1	0.500	Break Pressure Tank	TBC unknown	TBC unknown
Biggarsberg	Washbank	Reservoir 2	1	Distribution	1142	1138
Biggarsberg	Hattingspruit	Town Reservoir	0.300	Distribution	1318	1315

* Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water (April 2020)

(c) Vants Drift Water Treatment Plant and Supply System

*(Please note: the information contained in this section 14.3.1 (c) is via written communication [emails] with uMzinyathi DM, and clarity confirmed through verbal communication. In the Buffalo system, uMzinyathi DM are the current operators of the **Vants Drift WTP**, as well as the Isandlwana WTP and Qudeni WTP)*

The primary source of raw water for the Vants Drift WTP **(Figure 14.3, Table 14.27)** is the Buffalo River. Boreholes at Vants Drift were, historically, used to supplement raw water to the Vants Drift WTP although these have collapsed (and there is no plan to redrill them). Neither the Buffalo River nor the boreholes at Vants drift are reliable sources in Winter. The Blood River flows into the Buffalo River 1.5 km upstream of Vants drift. However, the river can drop to very low levels during the dry periods, making it difficult to extract water from this source. Typical abstraction in Winter is 5 Mℓ/day, and production ceased for a few months during the 2015/2016 drought. The Vants Drift WTP is currently operated by uMzinyathi DM. The layout of the Nqutu WSS is presented in **Figure 14.28** and **Figure** 14.29**.**

Figure 14.27 Photo of Vants Drift WTP (March 2020)

The Ntshingwayo Dam (iNgagane River) was built as a storage dam primarily for Newcastle and surrounding areas within Amajuba DM. Releases from the Ntshingwayo Dam assist with low levels at the abstraction point of Vants Drift, as the iNgagane River feeds/discharges into the Buffalo River. The Vants Drift WTP supplies the areas of Nqutu including the Nqutu CBD, Bambisinani, Ndatshane, Ndindindi, Telezini, Izicole, Maceba, Ngonini, Ngobhoti, Jabavu, Masotsheni and St Augustines. The Vants Drift WTP capacity can be increased to 18 Mℓ/day by refurbishing the abstraction points (and low lift pumps) and implementing alterations/upgrades to the three high lift pumps, electrical motors and panels)[11]. This item of work is included in a business plan, submitted recently by uMzinyathi DM to DWS for appraisal. The details of the WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.27, Table 14.28, Table 14.29, Table 14.30** and **Table 14.31**.

Table 14.27 Characteristics of the Vants Drift WTP.

WTP Name:	Vants Drift WTP
System:	Buffalo River Catchment
Maximum Design Capacity:	14Mℓ/day
Current Utilisation:	9Mℓ/day (restricted supply volumes)
Raw Water Storage Capacity:	0 Mℓ (no raw water storage capacity)
Raw Water Supply Capacity:	14Mℓ/day. lowest is 9Mℓ/day, maximum is 14Mℓ/day, based on raw water pumps (which is seasonal dependant)
Pre-Oxidation Type:	N/A
Primary Water Pre-Treatment Chemical:	Rheofloc
Total Coagulant Dosing Capacity:	Usually 100kg/day
Rapid Mixing Method:	Injected into raw water pipeline
Clarifier Type:	5Mℓ round concrete structure used as settling tank (temporary- meant to be clear water storage); 6 steel clarifiers of 3Mℓ total capacity; 7 Mℓ clarifier
Number of Clarifiers:	7
Total Area of all Clarifiers:	392.16m^2
Total Capacity of Clarifiers:	14Mℓ/day (based on upflow rate of 1.5 m/hr)
Filter Type:	Rapid Gravity Filters (air lift)
Number of Filters:	4
Filter Floor Type	110mm uPVC, Laterals, adjustable
Total Filtration Area of all Filters	122.4m^2
Total Filtration Design Capacity of all Filters:	14Mℓ/day (based on filtration rate of 4.8 m/hr)
Average Recovery Backwash water volume:	0m^3/day (No recovery pit) No recovery facility.
Total Capacity of Sludge Dams:	0 m^3/hr (No sludge dams)
Capacity of Used Wash Water System:	0 Mℓ/day No recovery facility.
Primary Post Disinfection Type:	Post Chlorination
Disinfection Dosing Capacity:	1.6kg/hr
Disinfectant Storage Capacity:	24 x 70kg
Total Treated Water Storage Capacity:	1.5 Mℓ

Note: The information in this table was obtained from personal communication (emails & phone calls) with uMzinyathi Area Engineer Pieter Earle (April 2020). (Also previously employed at uThukela Water, when Vants Drift WTP was operated by uThukela Water).

[11] Personal Communication, Pieter Earle, Area Engineer, uMzinyathi DM, Endumeni & Nqutu LMs (April 2020)

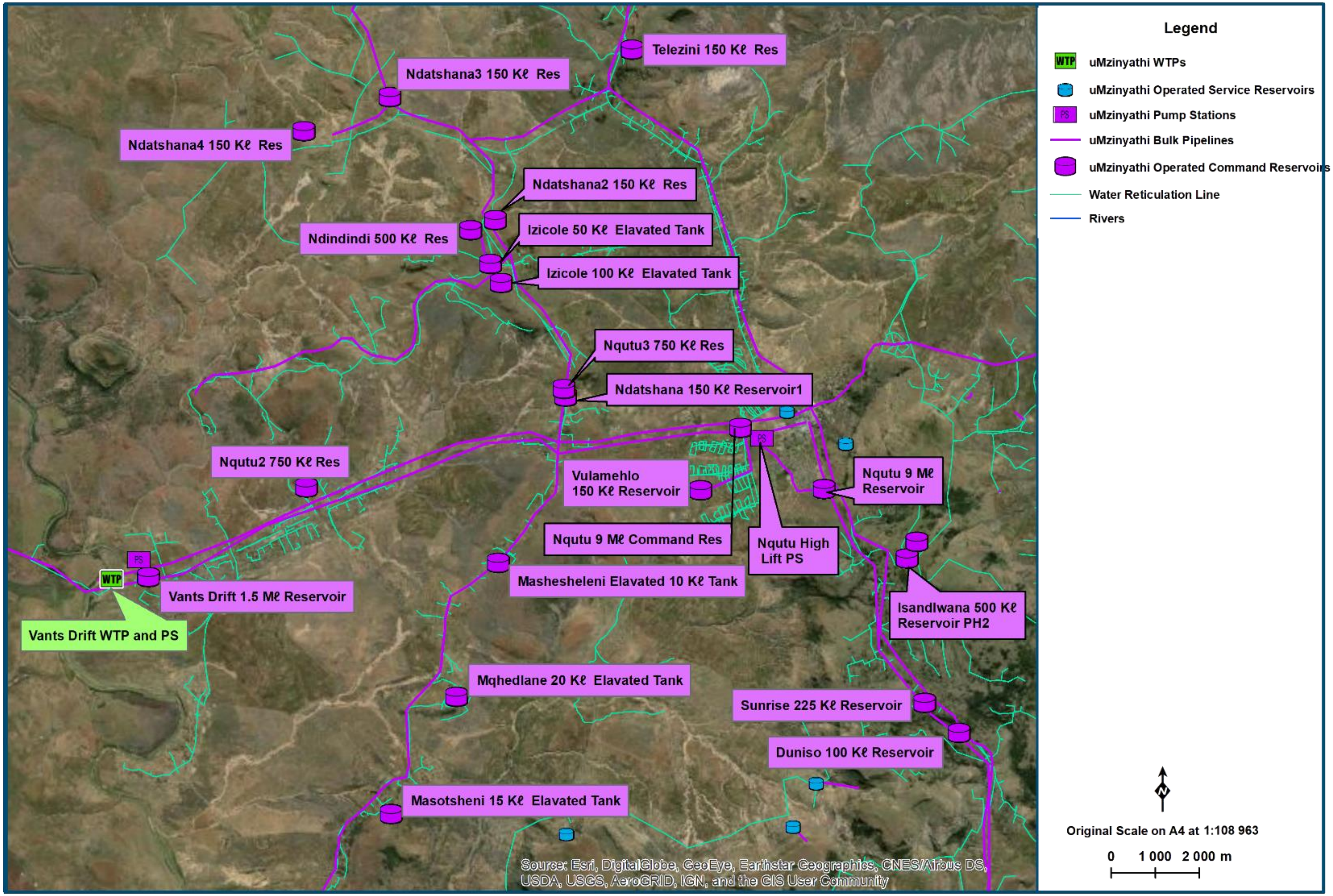

Figure 14.28 Nqutu Supply System Layout (Vants Drift WTP System) (NGI 2014; Umgeni Water 2020)

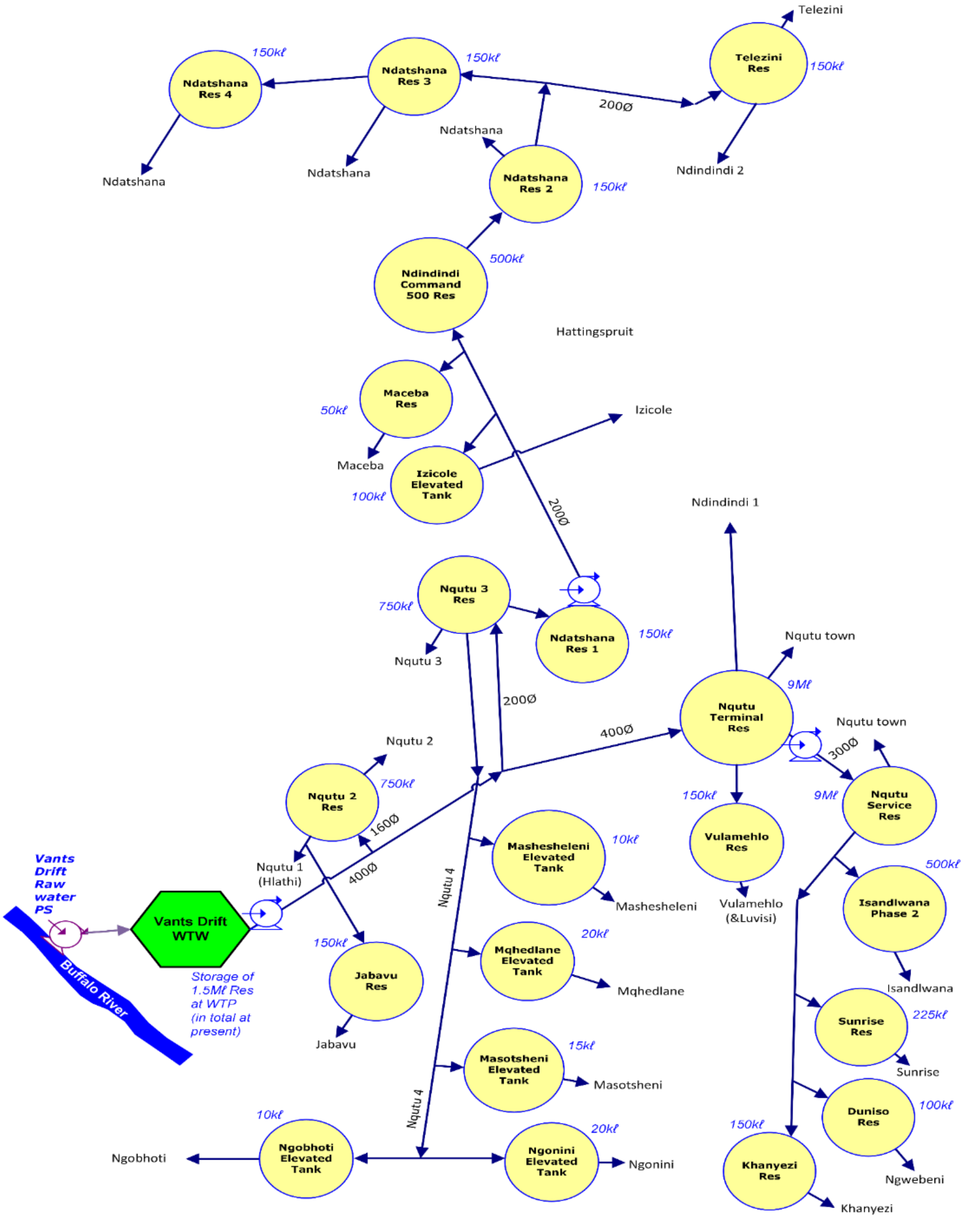

Figure 14.29 Vants Drift WTP Supply Schematic (not to scale; uMzinyathi DM infrastructure)

Raw water infrastructure for the two sources of the Vants Drift WTP are summarised below and in **Table 14.31**:

- **Ntshingwayo Dam:** Periodic releases from the Ntshingwayo Dam (iNgagane River) assist with mitigating the low levels at the abstraction point of Vants Drift, as Vants Drift is downstream of the confluence of iNgagane and Buffalo River.

- **Buffalo River:** The raw water abstraction from the Buffalo River is via five submersible pumps in an abstraction well (20kW each). The abstraction from the Buffalo River varies between 10Mℓ/day and 12Mℓ/day, but the system's capacity varies dependent on the season and on the upstream users. At present (April 2020) the average supply volume from this source, over the past months, was 8. Mℓ/day. Supply is unreliable during Winter months and could be as low as 5Mℓ/day when the flow in Buffalo River is low.

Potable water supply systems downstream of the Vants Drift WTP are listed below and in **Table 14.28**, **Table 14.29, Table 14.30** and **Table 14.31**:

- **Nqutu Command Reservoir** (9 Mℓ): This reservoir feeds Luvisi and Vulamehlo in Nqutu. This reservoir serves as storage for the Nqutu Water Supply Scheme, and water is pumped from this reservoir to the service reservoir on the southern section of the town.

- **Nqutu Service Reservoir** (9 Mℓ): This reservoir feeds the Nqutu town and housing projects immediately surrounding the Nqutu CBD, government buildings, schools and including the mall. It also feeds the Ndindindi Phase 1 Area, and a number of areas south of the Nqutu Town including part of Isandlwana, Kwanyezi, Sunrise and Magongaloza.

- **Nqutu 3 Reservoir (750kℓ):** This reservoir feeds Nqutu 3. Through the Nqutu 3 pump station (also referred to as the Ndatshana pump station), it also feeds Ndatshana and Ndindindi (which includes the areas of Telezini, Izicole and Maceba). The Nqutu 3 reservoir also feeds the Nqutu 4 area (serviced by a series of elevated tanks) that includes Bambisinani, Masheshеleni, Mqhedlane, Masotsheni, Ngonini, Ngobhoti.

- **Nqutu 2 Reservoir (750kℓ):** The primary supply area of this reservoir is the Nqutu 2 area, up to and including Jabavu. This reservoir also feeds the Nqutu 1 Area (immediately above Vants Drift), as there is no Nqutu 1 reservoir.

Table 14.28 Pipeline Details: Nqutu Potable Supply Main Pipelines

System	Pipeline Name	From	To	**Length (km)	***Nominal Diameter (mm)	Material	*Capacity (Mℓ/day)	Age (years)
Nqutu BWSS	Nqutu CW RM 1	Vants Drift WTP	Nqutu Command Reservoir	15	400	Steel	16.3	40
	Nqutu CW RM 2	Nqutu Command Reservoir	Nqutu Service Reservoir	2.6	300	AC	9.16	40
	Nqutu 2 RM	Nqutu CW RM 1	Nqutu 2 Reservoir	0.66	160	uPVC cl16	1.9	25
	Nqutu 3 RM	Nqutu CW RM 1	Nqutu 3 Reservoir	1.5	200	uPVC cl16	2.72	16
	Ndindindi/ Ndatshaha RM	Nqutu 3 Res PS	Ndindindi 500kl Res	4.6	200	uPVC cl16	9.16	25
	Telezini Gravity Main	Ndindindi 500kl Res	Telezini 150kl Res	6.8	160	Klambon	2.29	15

*Estimate: based on a velocity of 1.5 m/s
**Estimate: Ascertained from UAP GIS data (May 2020)
***Figures provided by Pieter Earle, Area Engineer, uMzinyathi DM (May 2020)

Table 14.29 Reservoir Details: Nqutu System

System	Reservoir Site	Reservoir Name	Capacity (Mℓ)	Reservoir Function	**TWL (mASL)	*FL (mASL)
Nqutu BWSS	Vants Drift WTP	WTP Reservoir	1.5	Sump/Storage	1088	1082
	Nqutu Command	Nqutu Command reservoir	9	Terminal	1346	1338
	Nqutu Service	Nqutu Service reservoir	9	Distribution	1387	1379
	Telezini	Telezini 150kℓ Reservoir	0.75	Distribution	1414	1410
	Nqutu 2	Nqutu 2 Reservoir	0.75	Distribution	1212.7	1208.7
Ndatshana/ Nqutu 3/ Nqutu 4/ Ndindindi BWSS	Nqutu 3	Nqutu 3 Reservoir	0.75	Distribution	1344	1340
Ndatshana/ Ndindindi BWSS	Ndindindi	Ndindindi Reservoir	0.5	Distribution	1440.9	1436.9
Ndatshana/ Ndindindi BWSS	Nqutu 3	Ndatshana Res 1	0.15	Sump (for PS)	1328.5	1325.8

*Estimate: Ascertained from UAP GIS data (May 2020)
**Estimate: based on reservoir heights provided by staff of the WSA

Table 14.30 Pump Details: Nqutu Potable Water Pump Stations

System	Pump Station Name	Pump Status		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Duty	Standby						
Nqutu BWSS	Vants Drift High Lift Pump Station	2		Sulzer HPL28-15-4STG (both converted to work on a 400 Volt motor) Imp dia 257mm	Vants Drift WTW	Nqutu Command reservoir	256	350** no info on pump plate	4.5 per pump* no info on pump plate
			1	Sulzer HPL28-15-4STG (original 3300 Volt motor)	Vants Drift WTW	Nqutu Command reservoir	256	350** no info on pump plate	4.5 per pump* no info on pump plate
Nqutu BWSS (Ndatshana/ Ndindindi BWSS)	Nqutu 3 p/station	1	1	KSB WKLn 65/3 (Imp dia 192mm)	Nqutu 3 reservoir	Ndindindi 500kl reservoir	97	141	1.2
Nqutu BWSS	Main Nqutu town p/station	1	1	KSB ETA 80-250 (Imp dia 232mm)	Nqutu Command reservoir	Nqutu Service reservoir	41	7* no info on pump plate	7* no info on pump plate
		1		Samco pump*** CSO4X3X11	Nqutu Command reservoir	Nqutu Service reservoir	41	no info on pump plate	no info on pump plate

*Figure provided by Pieter Earle (based on actual flow), Area Engineer, uMzinyathi DM (May 2020)
** Calculated Estimate
***Not in operation for recent years. Powered by diesel motor.

Table 14.31 Pump Details: Nqutu Raw Water Pump Stations

System	Pump Station Name	Pump Set	Pump Status		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
			Duty	Standby						
Nqutu BWSS	Vants Drift low lift p/station	A-1 Pump	4	1	Grindex AB MatadorH (20kW, 400V)	Buffalo river sump at Vants Drift	Vants Drift WTP	20	65	14 (all pumps running) 3.8 for one

(d) Dannhauser Water Treatment Plant and Supply System

The Dannhauser WTP (**Figure 14.30**, **Table 14.32**) was built in 1949 to supply water to the Dannhauser Water Supply Scheme (**Figure 14.31**, **Figure 14.32**) and is situated in Dannhauser. The design capacity is 2 Mℓ/day and the plant has been producing 1.8Mℓ/day [12]for the 4 months prior to being temporarily decommissioned in March 2020 (refurbishment of the plant and raw water pipeline). Water meter records are reported to be good.

Figure 14.30 Aerial Image of Dannhauser Water Treatment Plant (ADM O&M Manual May 2016)

The Dannhauser WTP supplies water to the areas of Dannhauser, NLK (maize depo), Emafusini and Dannhauser Town. Water supply to the outlying areas (beyond the town and suburbs) is further supplemented by a series of production boreholes (rudimentary water schemes). The Durnacol WTP currently provides treated water to Dannhauser Town and surrounds thanks to an interlinking of bulk supply pipelines, whilst the ADM is arranging for the Dannhauser WTP to be repaired/refurbished. The layout of the Dannhauser WTP Supply System is illustrated in **Figure 14.31**.

[12] Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

Table 14.32 Characteristics of the Dannhauser WTP.

WTP Name:	Dannhauser WTP
System:	Buffalo System (Ntshingwayo Dam)
Maximum Design Capacity:	2 Mℓ/day
Current Utilisation (March 2020):	1.8 Mℓ/day (prior to being side-lined in March 2020)
Raw Water Source	Ntshingwayo Dam (via uThukela Water pipelines)
Raw Water Storage Capacity:	1.5 Mℓ
Raw Water Supply Capacity:	Currently rated at 2Mℓ/day
Pre-Oxidation Type:	N/A
Primary Water Pre-Treatment Chemical:	The Coagulant also serves as a pre-treatment chemical
Coagulant	WET FLOC 7386
Total Coagulant Dosing Capacity:	Duty dosing pump capacity = 6 ℓ/h Standby dosing pump capacity = 6 ℓ/h
Rapid Mixing Method:	mechanical mixer
Slow Mixing Method :	horizontal flow flocculation channels
Clarifier Type:	Rectangular
Number of Clarifiers:	2
Total Area of all Clarifiers:	216 m^2
Total Capacity of Clarifiers:	For a design upflow rate of 0.39 m/hr, clarifiers are currently able to treat a capacity of 1.8 Mℓ/day with acceptable quality results, with a production of more than 1.8 Mℓ/day, the quality deteriorates.
Filter Type:	Pressure Filter
Number of Filters:	2 in operation, (an additional two is available but not connected to the system)
Total Filtration Area of all Filters	12.6 m^2
Total Filtration Design Capacity of all Filters:	At 6.6 m/hr with all filters operational, 2 Mℓ/day
Total Capacity of Backwash Water Tanks:	64m^3
Total Capacity of Sludge Treatment Plant:	42m^2
Capacity of Used Wash water System:	64 m^3 per day
Primary Post Disinfection Type:	70 kg chlorine gas
Disinfection Dosing Capacity:	0.8kg/hr Chlorinator (Currently dosing 0.2[13] kg/hr)
Disinfectant Storage Capacity:	10x 70kg cylinders
Total Treated Water Storage Capacity:	450 kℓ

[13] Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

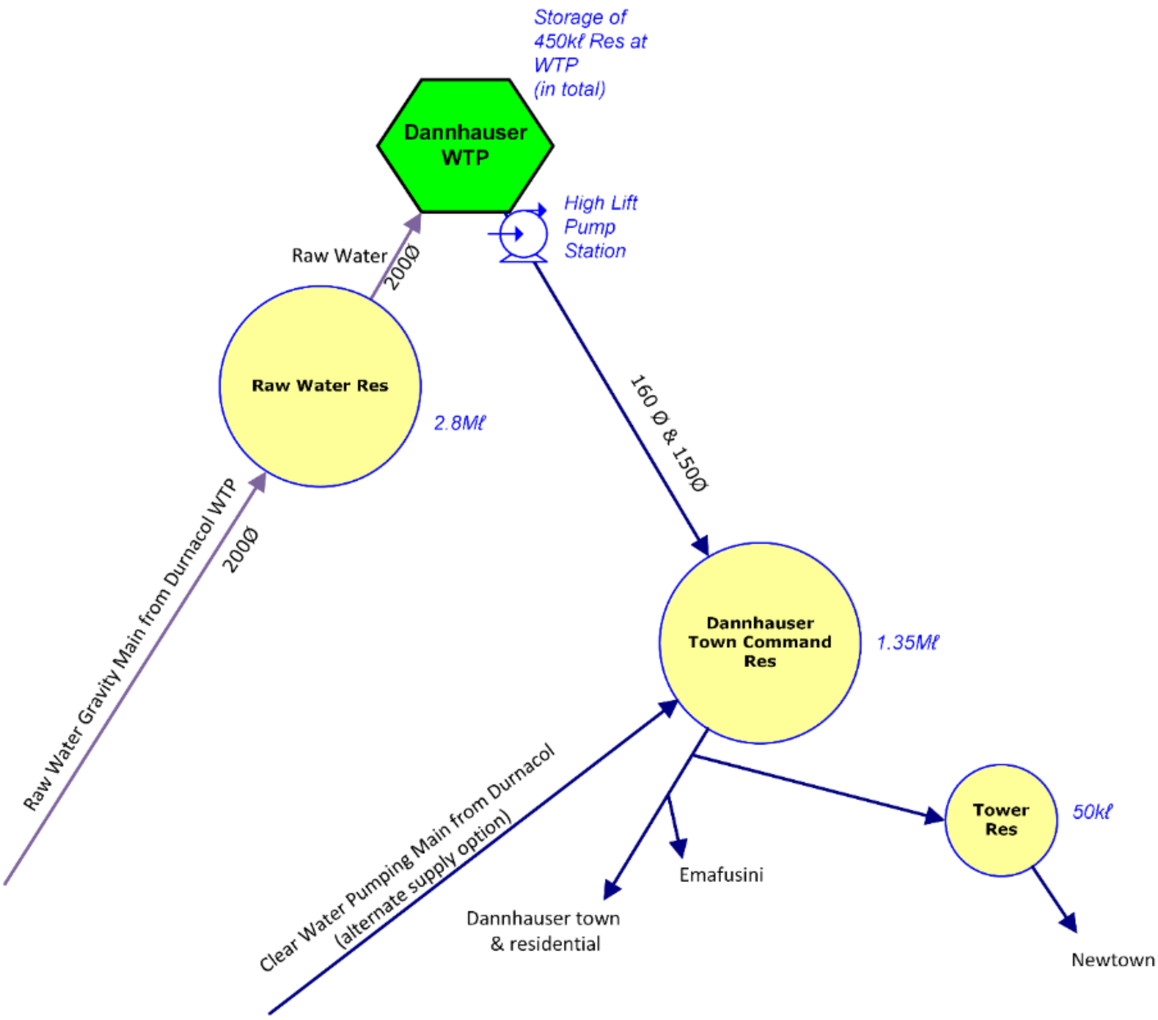

Figure 14.31 Dannhauser WTP Supply Schematic (not to scale; Amajuba DM Water bulk infrastructure)

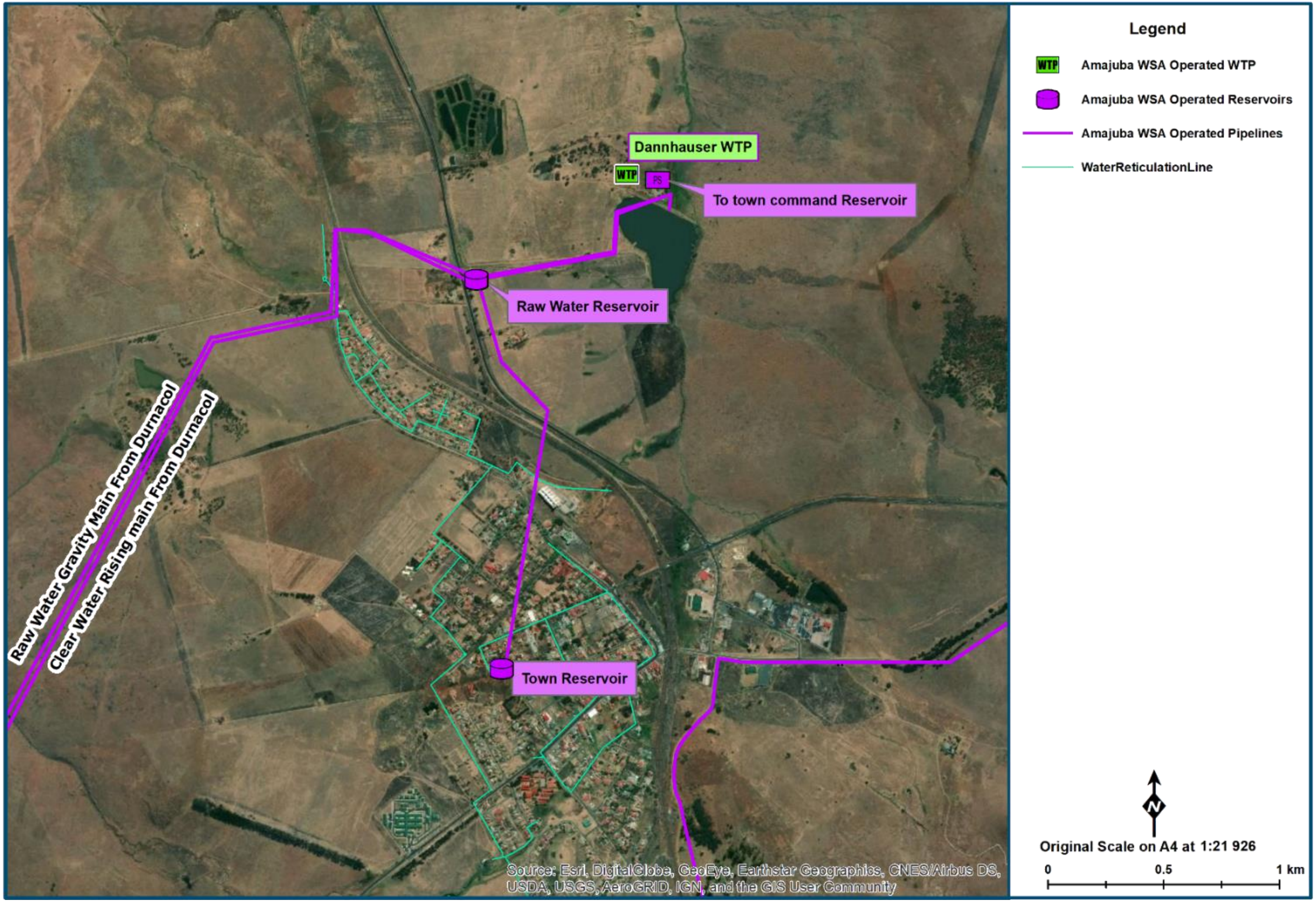

Figure 14.32 Dannhauser Supply System Layout (Dannhauser WTP System) (NGI 2014; Umgeni Water 2020)

Raw water is abstracted from the Ntshingwayo Dam by uThukela Water, and pumped to the Durnacol raw water reservoir at Durnacol treatment plant. The raw water gravitates to the Dannhauser raw water storage reservoir. From the raw water storage reservoir, it gravitates down to the head of works. The details of the Dannhauser WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.33, Table 14.34, Table 14.35, Table 14.36** and **Table 14.37.**

The water treatment comprises[14]:

- A 2.8Mℓ raw water storage reservoir.
- A raw water inlet with coagulant dosing.
- A mixing tank, where rapid mixing takes place.
- 2x Flocculation channels
- 2x Rectangular clarifiers
- 2x Pressure sand filters
- Disinfection (chlorine gas)
- 2x 225 kℓ clear water reservoirs at the plant (at ground level); and
- a high-lift pumping installation to the 750kℓ and 600kℓ command reservoirs that feed the town

The Dannhauser WTP process is summarised as follows:

> "Water is gravity fed to the head of works. The coagulant is dosed over hydraulic jump and mixing takes place, then to the flocculation channels and to the clarifiers. The clarified water is filtered in two pressure filters. The clear water is disinfected at the inlet of the first on-site reservoir and moves onwards to the second on-site reservoir.[15]"

Water is pumped from the Dannhauser WTP Clear Water Pump Station via both a 150mm diameter AC or a 160mm diameter HDPE cl12 pipeline to the town reservoirs (750kℓ and 600kℓ command reservoirs).

Table 14.33 Pipeline details: Dannhauser Raw Water Mains

System	Pipeline Name	From	To	Length (km)	Nominal Diameter (mm)	Material	Capacity (Mℓ/day)	Age (years)
Dann-hauser	Dannhauser Raw Water Gravity Main	Durnacol WTP	Dannhauser WTP (via Dannhauser Raw Water Reservoir)	6.8	200	AC	4.07	70

Based on a velocity of 1.5 m/s

[14] Personal communication, Mr M Cele, Process Controller, Dannhauser LM, ADM staff (May 2020)

[15] Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

Table 14.34 Pump Details: Dannhauser Clear Water Pump Station (High Lift)

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Dannhauser	High Lift Pump Station at WTP	1	1	KSB ETA NORM 080-065-250 GG 1A PO (Imp dia 260mm)	High Lift Pump Station at WTP	Town Command Reservoirs	45.5	No info on plate	No info on plate

Table 14.35 Reservoir Details: Clear Water System Reservoirs

System	Reservoir Site	Reservoir Name	Capacity (Mℓ)	Function	*TWL (mASL)	*FL (mASL)
Dannhauser	WTP	WTP 2 x 225	0.225*2	Command	1316.5	1313.5
	Town Command	Round Command	0.75	Command	1364	1362
	Town Command	Square Command	0.6	Command	1364	1362

*Based on heights of reservoirs (heights reported by ADM staff May 2020)
**Estimate: Ascertained from UAP GIS data (2005)

Table 14.36 Pipeline Details: Clear Water Bulk Pipeline.

System	Pipeline Name	From	To	Length (km)	**Nominal Diameter (mm)	Material	*Capacity (Mℓ/day)	Age (years)
Dannhauser	Rising Main to Town Command Reservoirs	High Lift Pump Station at WTP	Town Command Reservoirs	2.84	150	AC	2.29	70
				2.84	160	HDPE	2.23	20

*Based on a velocity of 1.5 m/s
** Personal communication, Mr R Fourie, Superintendent, Dannhauser LM, ADM staff (May 2020)

Table 14.37 Dannhauser WTP Metered Water Sales for October 2019 – March 2020*

Meter Description (bulk delivery points to suburbs)	Oct 2019 (Mℓ/day)	Nov 2019 (Mℓ/day)	Dec 2019 (Mℓ/day)	Jan 2020 (Mℓ/day)	Feb 2020 (Mℓ/day)	Mar 2020 (Mℓ/day)
Clean water from onsite reservoir to the distribution reservoir	1,112	1,1	0,852	0,721	0,942	0,653

* Personal communication, Mr M Cele, Process Controller, Dannhauser LM, ADM staff (May 2020)

(e) Durnacol Water Treatment Plant and Supply System

The Durnacol WTP (**Figure 14.33**, **Table 14.38**) was built in [16]1985 to supply water to the Durnacol Water Supply Scheme (**Figure 14.34**, **Figure 14.35**) and is situated just outside Durnacol, within the Dannhauser LM. The plant was upgraded to a 5Mℓ/day plant in May 2018 (commissioned). The design capacity is officially 5 Mℓ/day and the plant has been producing 3.5Mℓ/day [17] for the two months of March and April 2020. The Dannhauser WTP has been offline since March 2020 and the Durnacol WTP has since been feeding the Dannhauser area. Water meter records are reported to be good.

Figure 14.33 Photo of Durnacol Water Treatment Plant (May 2020).

The Durnacol WTP supplies water to the areas of Durnacol, Targo village, Taiwan, Skomplaz, Durnacol number 2, 3 & 7. It also supplies water to Dannhauser, in the event of Dannhauser being offline (as per current situation, May 2020).

The Durnacol WTP currently provides treated water to Dannhauser Town and surrounding areas, whilst the ADM is arranging for the Dannhauser plant to be repaired/refurbished. Note that Durnacol could continue feeding the town of Dannhauser, as a permanent arrangement and in this instance, the Dannhauser WTP could take on the duty of supplying Skombaren and Alcockspruit[18]. This would reduce the need for water tankering and and would assit in eradicating water backlogs. This is under discussion by ADM at present. The layout of the Durnacol WTP Supply System is illustrated in **Figure 14.34**

[16]Personal communication, Mr R Fourie, Superintendent, Dannhauser LM, ADM staff (May 2020)
[17] Personal communication, Mrs Rethabile, Process Controller, ADM staff (May 2020)
[18] Personal communication, Mr M Cele, Process Controller, Dannhauser LM, ADM staff (May 2020)

Table 14.38 Characteristics of the Durnacol WTP.

WTP Name:	Durnacol WTP
System:	Buffalo System (Ntshingwayo Dam)
Maximum Design Capacity:	5 Mℓ/day
Current Utilisation (March 2020):	3.5 Mℓ/day (1.4 Mℓ/day prior to Dannhauser WTP being side-lined)
Raw Water Source	Ntshingwayo Dam (via uThukela Water pipelines)
Raw Water Storage Capacity:	3.4Mℓ
Raw Water Supply Capacity:	Currently rated at 2,5 Mℓ/day
Pre-Oxidation Type:	Ozonation
Primary Water Pre-Treatment Chemical:	Lime dosing is in place (but not always in use)*
Coagulant	WETfloc 7386
Total Coagulant Dosing Capacity:	Duty Dosing Pump Capacity = 1,5 ℓ/hr Standby Dosing Pump Capacity = 1,5 ℓ/hr
Rapid Mixing Method:	Rapid mixer method (mechanical mixer)
Slow Mixing Method :	N/A (done in the clarifier)
Clarifier Type:	lamella plate (rectangular, hopper bottom)
Number of Clarifiers:	5
Total Area of all Clarifiers:	102 m^2
Total Capacity of Clarifiers:	For a design upflow rate of 2 m/hr, clarifiers are able to treat a capacity of 5 Mℓ/day.
Filter Type:	rapid gravity sand filters
Number of Filters:	5
Total Filtration Area of all Filters	26 m^2
Total Filtration Design Capacity of all Filters:	At 8 m/hr with all filters operational, 5 Mℓ/day
Total Capacity of Backwash Water Tanks:	4.5m^3
Total Capacity of Sludge Treatment Plant:	1,84 m^3
Capacity of Used Washwater System:	recycles all backwash water to head of works*
Primary Post Disinfection Type:	chlorine gas 70 kg cylinders
Disinfection Dosing Capacity:	0.8kg/hr Chlorinator (0,33 kg/hr Currently*)
Disinfectant Storage Capacity:	8 x 70 kg cylinders
Total Treated Water Storage Capacity:	3400 kℓ

* Personal communication, Mrs Rethabile, Process Controller, ADM staff (May 2020)

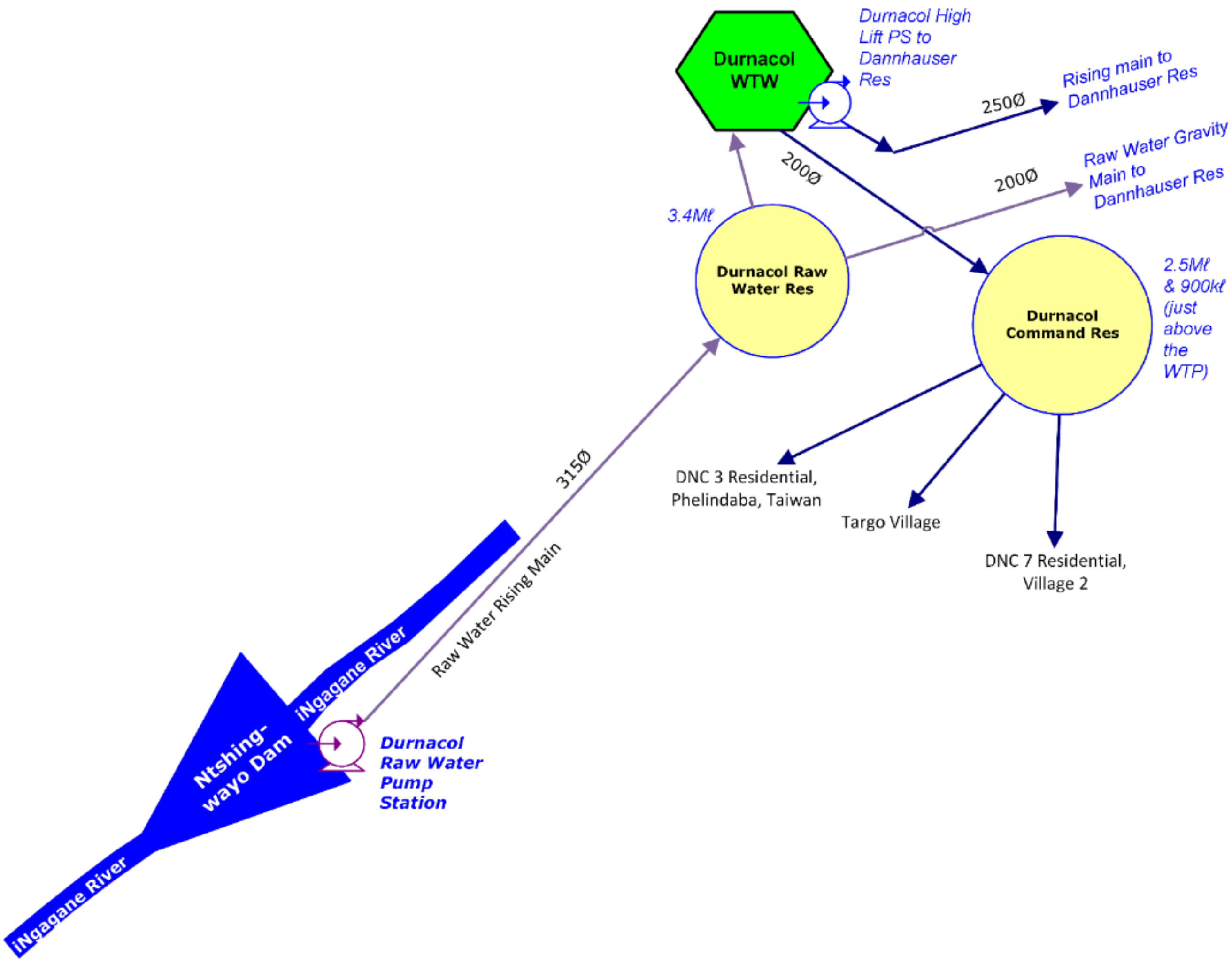

Figure 14.34 Durnacol WTP Supply Schematic (not to scale; Amajuba DM Water bulk infrastructure)

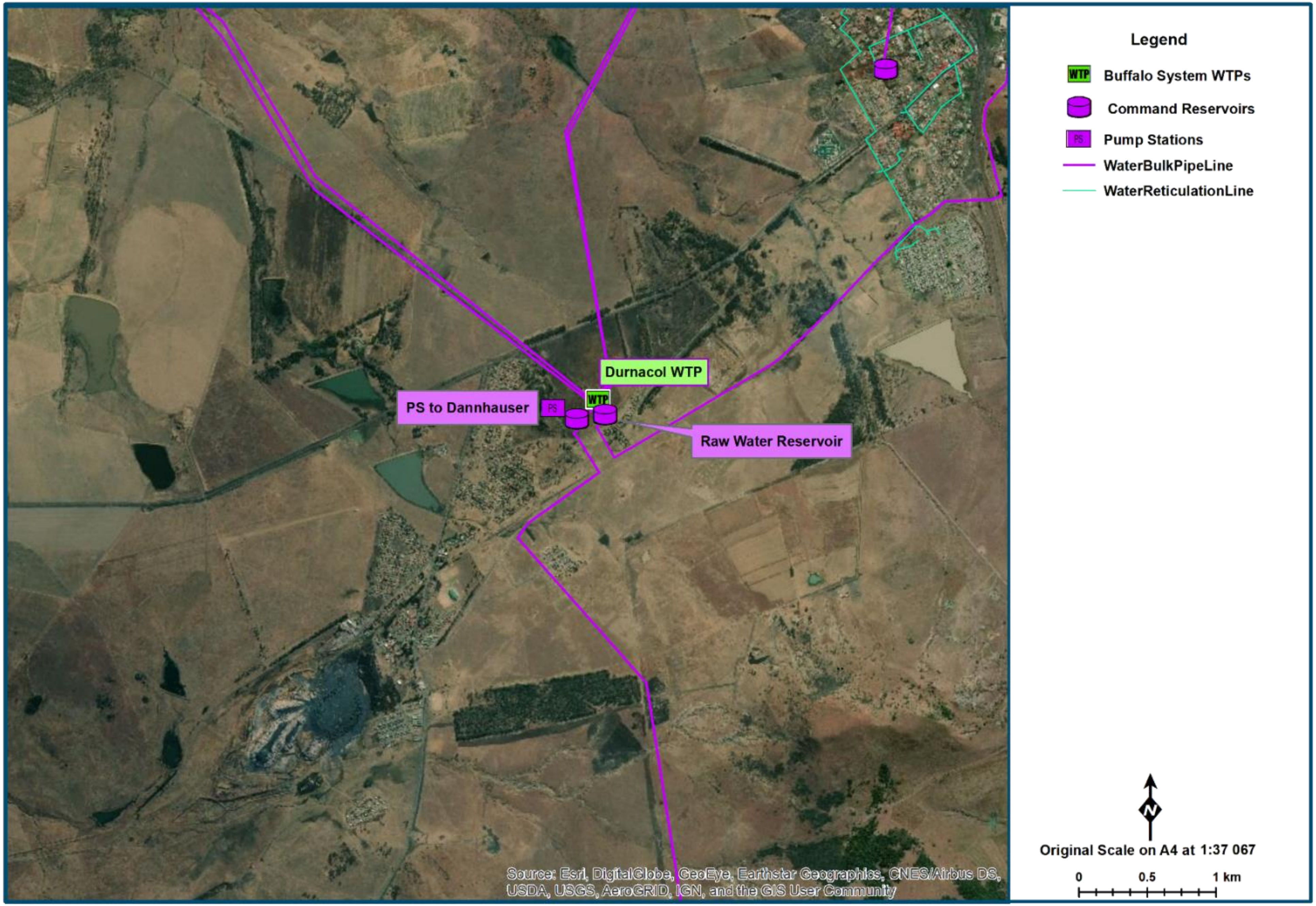

Figure 14.35 Durnacol Supply System Layout (Durnacol WTP System) (NGI 2014; Umgeni Water 2020)

Raw water is abstracted from the Ntshingwayo Dam by ADM, and pumped to the Durnacol raw water reservoir at Durnacol WTP. ADM pumps the raw water from the Durnacol raw water reservoir to the head of the works. The details of the Durnacol WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.39**, **Table 14.40**, **Table 14.41**, **Table 14.42**, **Table 14.43** and **Table 14.44**.

The water treatment comprises[19]:

- A 3400Kℓ raw water storage reservoir
- Inlet with coagulant dosing
- Mechanical mixer, where slow mixing takes place (stirrer)
- 5x clarifiers
- 5x pressure filters
- Chlorine gas disinfection;
- A high-lift pumping installation to a 900kℓ and 2500kℓ clear water reservoirs just above the plant that serve as command reservoirs for Durnacol areas (**Figure 14.36**).
- A high-lift pumping installation to a 750kℓ command reservoir that feeds the Dannhauser town

The Durnacol WTP process is summarised as follows[20]:

> "Water is pumped to the head of works. It passes through the Ozonation unit. The coagulant is dosed to the raw water and mixed in a mixing tank by a mechanical mixer. The water proceeds straight to the clarifiers. The clarified water is filtered through pressure filters. Disinfection by chlorine gas follows and the final water is stored in an on-site reservoir."

Figure 14.36 Durnacol Clear Water Pump Station (May 2020)

[19] Personal communication, Mr M Cele, Process Controller, Dannhauser LM, ADM staff (May 2020)

[20] Personal communication, Mrs Rethabile, Process Controller, ADM staff (May 2020)

Through this WTP, the Amajuba District Municipality (ADM) supplies water to[21]:

- Taiwan and Phelindaba
- Targo village
- Skoomplaz
- Durnacol areas (area numbers 2, 3 and 7)

Table 14.39 Pump details: Durnacol Raw Water Pump Station

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Upper uThukela	Chelmsford Raw Water Pump Station	2	1	KSB WKLn 80/3 (Imp dia 220mm)	Ntshingwayo Dam	Durnacol WTP	119	No info on plate	No info on plate

Table 14.40 Pipeline details: Durnacol Raw Water Rising Main

System	Pipeline Name	From	To	Length (km)	Nominal Diameter (mm)	Material	Capacity (Mℓ/day)	Age (years)
Upper uThukela	Durnacol Raw Water Rising Main	Durnacol Raw Water Pump Station (Ntshingwayo Dam)	Durnacol WTP	12.8	315*	Steel	9.16	35

*Pipeline needs to be replaced as it is rusted and it leaks (Personal Communication, Richard Fourie, ADM, May 2020)

Table 14.41 Pump details: Durnacol Clear Water Pump Station (High Lift)

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Durnacol	Durnacol Clear Water Pump Station	1	1	Grundfos NB 125-315/317 A-F2-A-BQQE	Durnacol WTP	Durnacol Command reservoirs	31.8	31.8	5.7
	Durnacol WTP High Lift Pump Station to Dannhauser	1	1	Wilo NL 125/315/ 22/4/12	Durnacol WTP High Lift Pump Station (at Durnacol Command reservoirs)	Dannhauser Command reservoirs	4	24.65	3.6

[21] Personal communication, Mr R Fourie, Superintendent, Dannhauser LM, ADM staff (May 2020)

Table 14.42 Reservoir details: Durnacol Water System Reservoirs

System	Reservoir Site	Reservoir Name	Capacity (Mℓ)	Function	*TWL (mASL)	**FL (mASL)
Durnacol	Durnacol WTP	Durnacol WTP Raw Water Res	3.4	Raw Water Storage Res	1364	1360
	Durnacol WTP	Durnacol WTP Clear Water Res	3.4 (0.9 + 2.5)	Command Res (treated water)	1365.2	1359.2

*Based on height of reservoir, as reported by ADM staff Richard Fourie (May 2020)
** Estimate: Ascertained from UAP GIS data (May 2020)

Table 14.43 Pipeline Details: Durnacol Clear Water Bulk Pipeline

System	Pipeline Name	From	To	Length (km)	*Nominal Diameter (mm)	*Material	**Capacity (Mℓ/day)	*Age (years)
Durnacol	Durnacol Rising Main	Durnacol WTP	Durnacol Command reservoirs	0.18	200	HDPE cl 10	3	2
	Rising main to Dannhauser	Durnacol WTP High Lift Pump Station (at 2.5 Res, pumping from 0.9 Res)	Dannhauser Command reservoirs	3.8	250	uPVC cl16	5.2	1

*Personal communication, Mr R Fourie, Superintendent, Dannhauser LM, ADM staff (May 2020)
** Based on a velocity of 1.5m/s

Table 14.44 Durnacol WTP metered water sales for October 2019 – March 2020

Meter Description (bulk delivery points to suburbs)	Oct 2019 (Mℓ/day)	Nov 2019 (Mℓ/day)	Dec 2019 (Mℓ/day)	Jan 2020 (Mℓ/day)	Feb 2020 (Mℓ/day)	Mar 2020 (Mℓ/day)
Clean water from the onsite reservoir to the distribution reservoir	1,349	1,395	1,89	2,3	1,863	2,513

(f) Utrecht Water Treatment Plant and Supply System

The Utrecht WTP (**Figure 14.37**, **Table 14.45**) was built in 1996[22] to supply water to the Utrecht Water Supply Scheme (**Figure 14.38**, **Figure 14.39**) and is situated 1.2km downstream of the Dorps Dam (Balele Dam) and the Nwyerheids Dam. Currently (May 2020), the Nwyerheids Dam is not in use by ADM, and the uThukela Water Supply Pipeline supplements the Utrecht WTP when necessary (to mitigate shortfalls in raw water volumes). The design capacity is 4.5 Mℓ/day, and the plant has been producing ±3Mℓ/day for the last 12 months and is currently producing 2.7 Mℓ/day(May 2020)[23]. Water meter records are reported to be good.

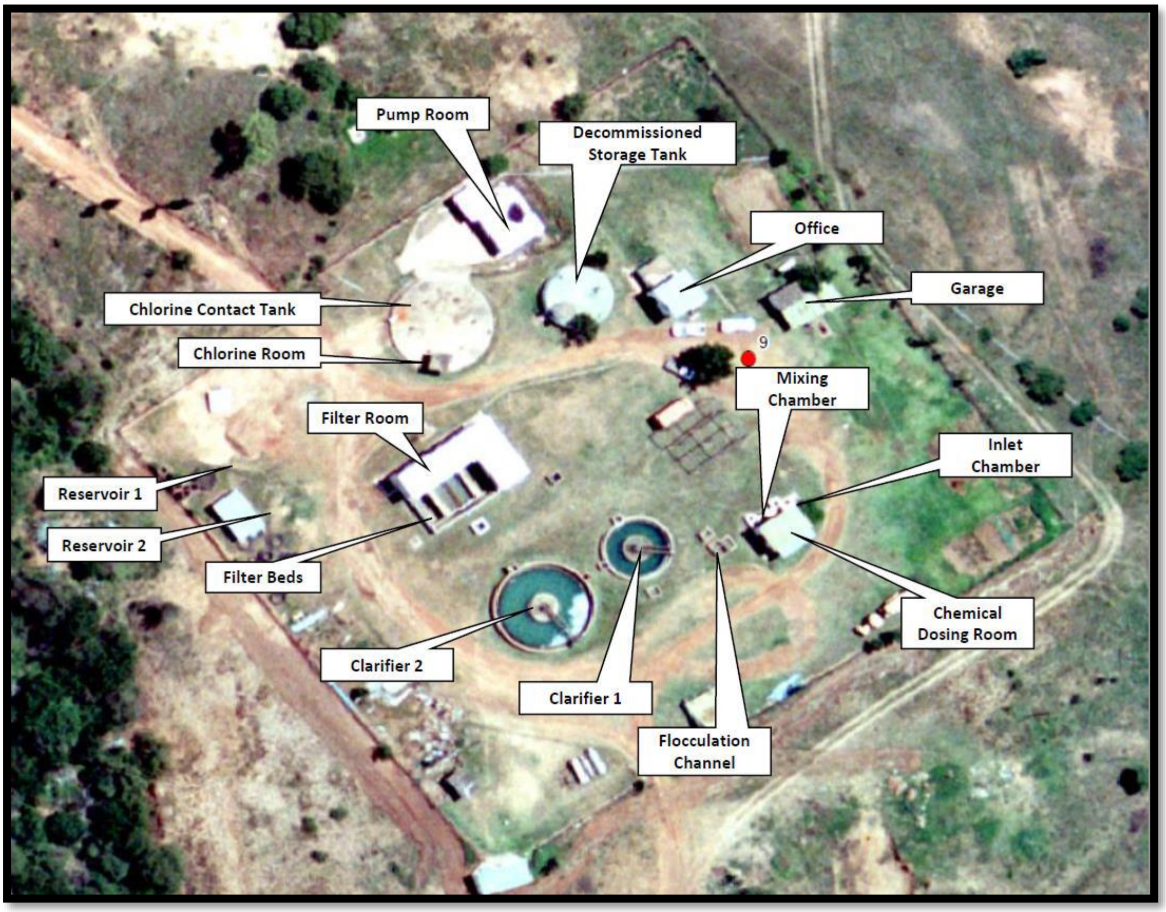

Figure 14.37 Aerial Image of Utrecht Water Treatment Plant (ADM O&M Manual May 2016)

The Utrecht WTP supplies water to the areas of[24]:

- Utrecht town
- Khayalethu
- Bensdorp
- White City
- Balgray (pump station)

[22]Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

[23] Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

[24] Personal communication, Mr Sphamandla Buthelezi, Bulks Superintendent, Emadlangeni LM, ADM staff (May 2020)

Water supply to the outlying areas (beyond the town of Utrecht) is further supplemented by a series of production boreholes. The layout of the Utrecht WTP Supply System is illustrated in **Figure 14.38**. The details of the WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.46**, **Table 14.47**, **Table 14.48**, **Table 14.49**, **Table 14.50** and **Table 14.51**.

Table 14.45 Characteristics of the Utrecht WTP.

WTP Name:	Utrecht WTP
System:	Buffalo System (Dorps River)
Maximum Design Capacity:	4.5 Mℓ/day
Current Utilisation (April 2020):	2.7 Mℓ/day
Raw Water Source	Dorps Dam (Balele Dam)
Raw Water Storage Capacity:	None at the plant (as the Balele Dam is 800m away)
Raw Water Supply Capacity:	Currently rated at 4.5 Mℓ/day (but drawing 2.8 Mℓ/day*,*)*
Pre-Oxidation Type:	N/A
Primary Water Pre-Treatment Chemical:	The Coagulant is a pre-treatment chemical
Coagulant	WET floc 7386*
Total Coagulant Dosing Capacity:	Duty Dosing Pump Capacity = 6 ℓ/hr Standby Dosing Pump Capacity = 6 ℓ/hr
Rapid Mixing Method:	mechanical mixer
Slow Mixing Method :	Vertically baffled tank
Clarifier Type:	circular tank
Number of Clarifiers:	2
Total Area of all Clarifiers:	$340m^2$
Total Capacity of Clarifiers:	For a design upflow rate of 0.55 m/hr, clarifiers are able to treat a capacity of 4.5Mℓ/day.
Filter Type:	Rapid gravity sand filters
Number of Filters:	3
Total Filtration Area of all Filters	56 m^2
Total Filtration Design Capacity of all Filters:	4.7 Mℓ/day, at 3.5 m/hr with all filters operational
Total Capacity of Backwash Water Tanks:	N/A (goes back to river)
Total Capacity of Sludge Treatment Plant:	N/A (goes back to river)
Capacity of Used Washwater System:	N/A (goes back to river)
Primary Post Disinfection Type:	Chlorine gas
Disinfection Dosing Capacity:	0.8kg/hr Chlorinator (Currently dosing 0.2* kg/hr)
Disinfectant Storage Capacity:	±6 (70kg cylinders)
Total Treated Water Storage Capacity:	641 kℓ on-site reservoir

*Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

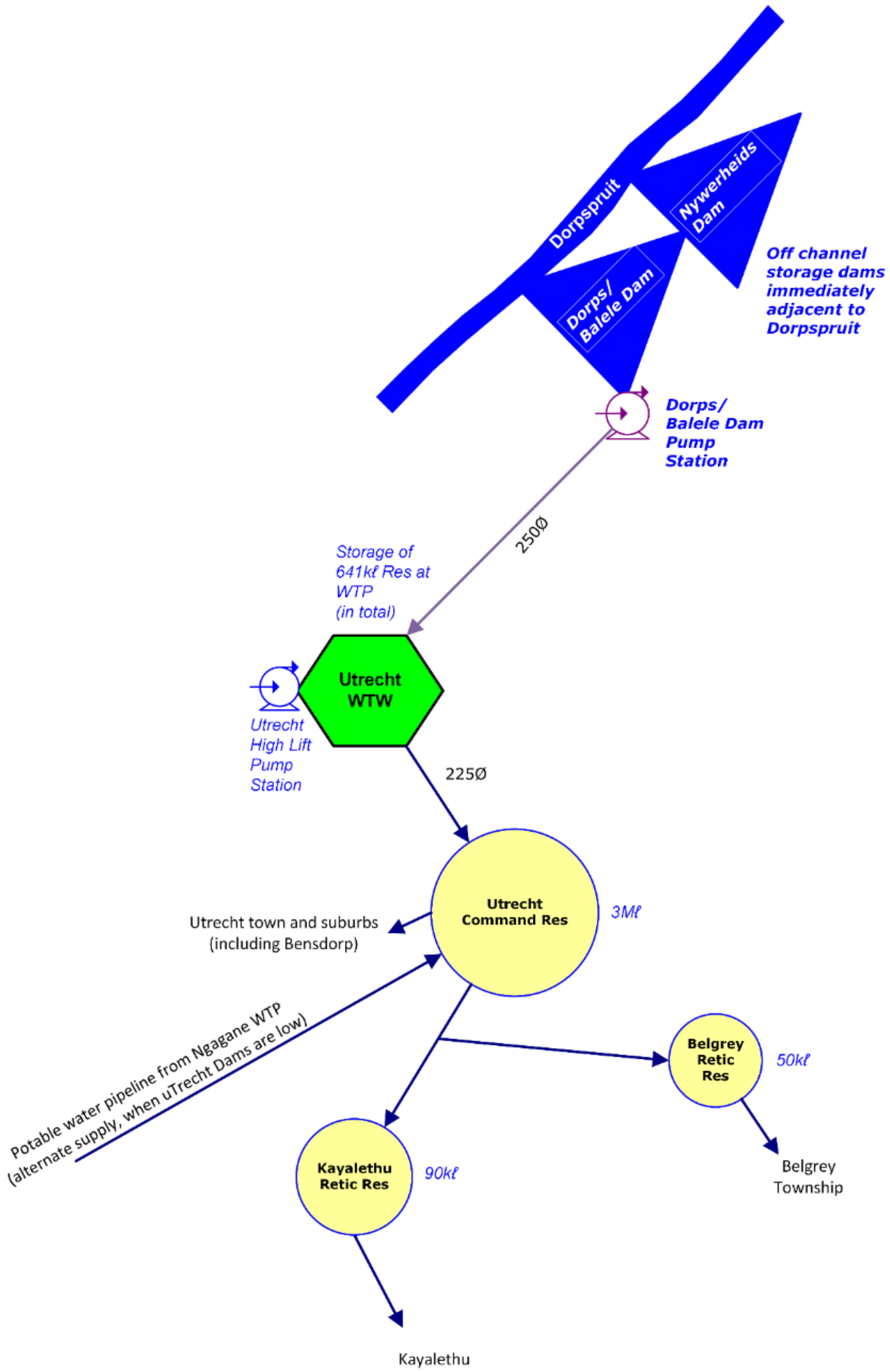

Figure 14.38 Utrecht WTP Supply Schematic (not to scale; Amajuba DM Water bulk infrastructure)

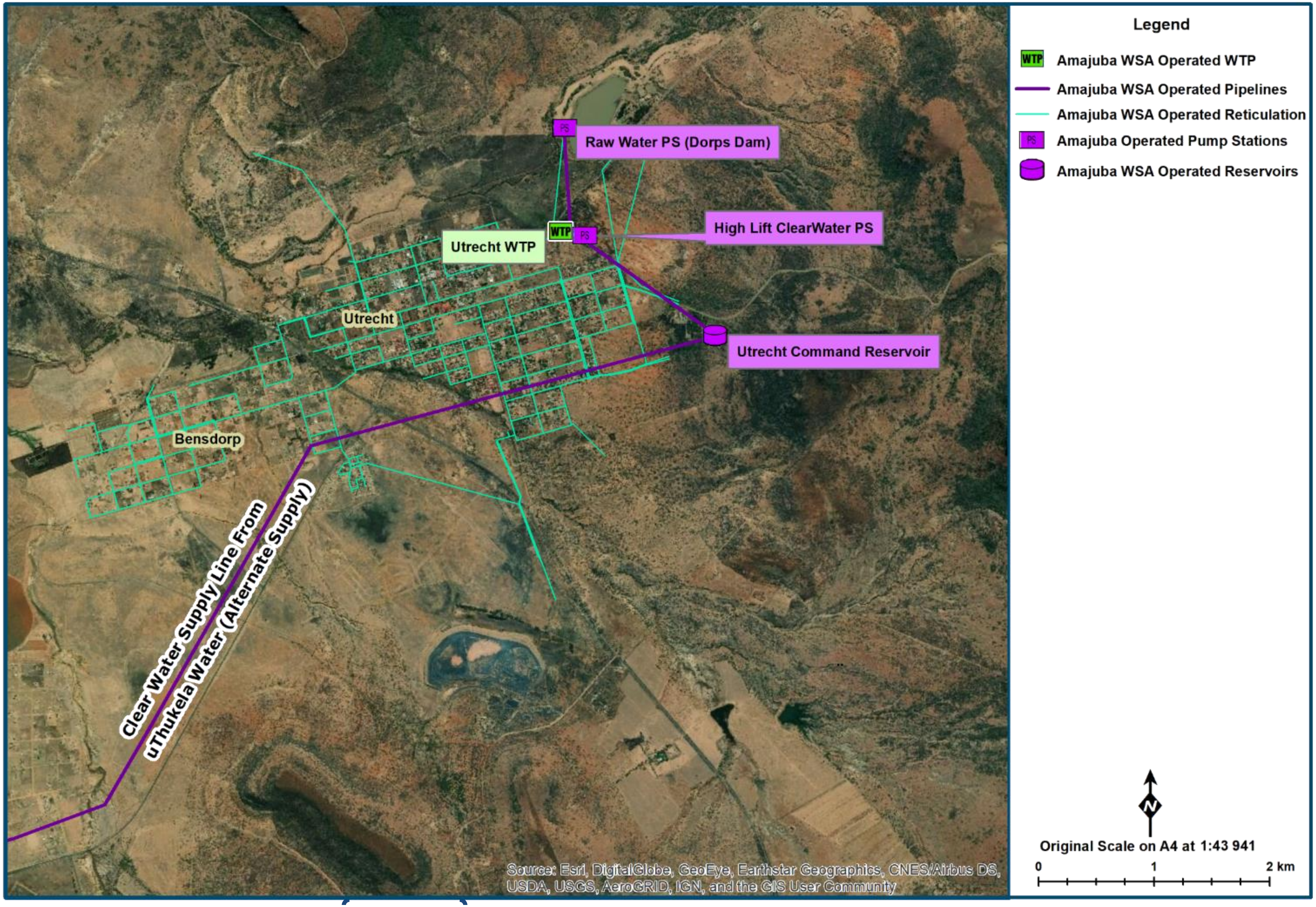

Figure 14.39 Utrecht Supply System Layout (Utrecht WTP System) (NGI 2014; Umgeni Water 2020)

Raw water is abstracted from the Utrecht Dam via a 250mm diameter steel pipeline (rising main). This plant is run for 16 hours per day (currently), in order to align with current demand of the town.

The water treatment comprises:

- A raw water inlet with coagulant dosing;
- A concrete mixing tank with a mechanical mixer where mixing takes place;
- 2 Clarifiers
- 3 Rapid gravity sand filters
- Chlorine gas dosing system where disinfection takes place;
- 641 m^3 clear water reservoir at the plant (**Figure 14.41**); and
- A high-lift pumping installation (**Figure 14.40**) to a 3Mℓ command reservoir that feeds the town

The Utrecht WTP process is summarised as follows[25]:

> "Water is pumped to the head of works from Dorps Dam. Coagulant is added and aided by a mechanical mixer, followed by flocculation. The flow is then directed to a vertically baffled tank for slow mixing. The water is clarified in two circular clarifiers (upflow). The clarified water is filtered in three rapid gravity sand filters. Disinfection with chlorine gas takes place at this stage, and the final water is stored in an on-site reservoir."

Figure 14.40 Utrecht Clear Water Pump Station

Water is pumped from the Utrecht Reservoir Pump Station via a 225 AC or 150 Steel mm diameter pipeline (two pipelines, alternated) from which Amajuba District Municipality supplies water to[26]:

- Utrecht town
- Khayalethu
- Bensdorp
- White City and Belgray

[25] Personal communication, Mrs Rethabile, Process Controller, Emadlangeni LM, ADM staff (May 2020)

[26] Personal communication, Mr Sphamandla Buthelezi, Bulks Superintendent, Emadlangeni LM, ADM staff (May 2020)

Figure 14.41 Utrecht Clear water Reservoir

Table 14.46 Pump details: Utrecht Raw Water Pump Station

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Buffalo, Utrecht	Balele Raw Water Pump Station	1	1	KSB 125/40	Utrecht Raw Water Pump Station at Dorps Dam (Balele Dam)	Utrecht WTP	18	no info on pump plate	no info on pump plate *5

*Estimation by ADM staff, Mrs Rethabile, Process Controller, based on maximum incoming to date (May 2020). Pump curve shows that this should be 6 Mℓ/day (lower estimate can be attributed to headloss caused by strainers, meters etc.).

Table 14.47 Pipeline details: Utrecht Raw Water Rising Main

System	Pipeline Name	From	To	Length (km)	*Nominal Diameter (mm)	*Material	Capacity (Mℓ/day)	*Age (years)
Buffalo, Utrecht	Utrecht Raw Water Rising Main	Utrecht Raw Water Pump Station at Dorps Dam (Balele Dam)	Utrecht WTP	0.840	250	Steel	6.36	24

*Personal communication, Mr Sphamandla Buthelezi, Bulks Superintendent, Emadlangeni LM, ADM staff (May 2020)

Table 14.48 Pump details: Utrecht Clear Water Pump Station (high lift).

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Buffalo, Utrecht	Utrecht clean water pumpstation	1	1	KSB WKLn 100/6 (imp dia full size)	Utrecht water plant	Utrecht command Reservoir	113	no info on pump plate	no info on pump plate

Table 14.49 Reservoir details: Utrecht Clear water system Reservoirs

System	Reservoir Site	Reservoir Name	Capacity (Mℓ)	Function	**TWL (mASL)	*FL (mASL)
Buffalo, Utrecht	Utrecht WTP	Utrecht WTP Clear Water Reservoirs	0.641	Command Reservoir	1220	1217
Utrecht	Utrecht Command Reservoir	Utrecht Command Reservoir	3	Command Reservoir	1326.8	1322.8

**Based on height of reservoir, as reported by ADM staff Mr Sphamandla Buthelezi, Bulks Superintendent (May 2020)
*Estimate: Ascertained from UAP GIS data (May 2020)

Table 14.50 Pipeline Details: Utrecht Clear Water Bulk Pipeline.

System	Pipeline Name	From	To	Length (km)	*Nominal Diameter (mm)	*Material	**Capacity (Mℓ/day)	Age (years)
Buffalo, Utrecht	Utrecht Rising main to Command Res	Utrecht water plant	Utrecht command Reservoir	1.75	225	AC	5.16	24

*Personal communication, Mr Sphamandla Buthelezi, Bulks Superintendent, Emadlangeni LM, ADM staff (May 2020)
**Estimate: based on a velocity of 1.5 m/s

Table 14.51 Utrecht WTP metered water volumes for October 2019 – March 2020

Meter Description (bulk delivery points to suburbs)	Oct 2019 (Mℓ/day)	Nov 2019 (Mℓ/day)	Dec 2019 (Mℓ/day)	Jan 2020 (Mℓ/day)	Feb 2020 (Mℓ/day)	Mar 2020 (Mℓ/day)
Clean water from the on-site reservoir to the distribution reservoir.	2.325	2.405	2.857	2.805	2.570	2.618

*Personal communication, Mr Sphamandla Buthelezi, Bulks Superintendent, Emadlangeni LM, ADM staff (May 2020)

(g) Charlestown Water Treatment Plant and Supply System

The Charlestown WTP (**Figure 14.42**, **Table 14.52**) was commissioned in 2018 to supply water to the Charlestown Water Supply Scheme and is poistioned 1.2km North West of Charlestown. The plant is an ultrafiltration plant, and does not include conventional components (no clarifiers or sand filters). The design capacity is 2 Mℓ/day, however the plant has been producing 0.6Mℓ/day for the past 6 months and is currently producing 0.5 Mℓ/day (May 2020). Some production boreholes have failed (mechanical issues) and this has affected the total availability of raw water which should be supplied to the plant. Water meter records are reported to be good.

Figure 14.42 Photo of Charlestown Water Treatment Plant (July 2018).

The Charlestown WTP supplies water to the areas of Charlestown. Water supply to the outlying areas (beyond the town of Charlestown) is further supplemented by a series of boreholes. The layout of the Charlestown WTP Supply System is illustrated in **Figure 14.43** and **Figure 14.44**. This plant is run for 16 hours per day (currently), in order to align with the current demand of the town. The details of the WTP, pump stations, reservoirs, and pipelines are tabled in **Table 14.52, Table 14.53, Table 14.54, Table 14.55, Table 14.56** and **Table 14.57.**

The water treatment plant comprises:

- Raw water tank (400 kℓ)
- A raw water inlet with chemical dosing;
- Ultra Filtration units (24)
- Chlorine gas dosing system, where disinfection takes place;
- 2 x 260 kℓ clear water tanks at the plant; and
- A high-lift pumping installation to a command reservoir of a combined 0.92Mℓ that feeds the town.

Table 14.52 Characteristics of the Charlestown WTP

WTP Name:	Charlestown WTP
System:	Buffalo System (Boreholes)
Maximum Design Capacity:	2.0 Mℓ/day
Current Utilisation (April 2020):	0.5 Mℓ/day
Raw Water Source	Production Boreholes, in the Buffalo System
Raw Water Storage Capacity:	400 kℓ reservoir at the plant
Raw Water Supply Capacity:	Rated at 1.2 Mℓ/day (but drawing ±0.55 Mℓ/day)
Pre-Oxidation Type:	Chlorine (Sodium Hypochlorite)
Rapid Mixing Method:	injection into pipeline
Prefilters:	2 self-cleaning filters
Number of Ultra Filtration units:	24 (outside-in filters)
Total Area of all Ultra Filtration units:	1440m^2 (60m^2 each)
Total Capacity of Ultra Filtration units:	2Mℓ/day (58 ℓ/m^2/h)
Total Capacity of Backwash Water Tanks:	72m^3 (same tanks used for any waste water)
Total Capacity of Sludge Treatment Plant:	72m^3
Capacity of Used Wash water System:	72m^3 (no recycle pumps fitted as yet)
Primary Post Disinfection Type:	Chlorine gas
Disinfection Dosing Capacity:	10ℓ/hr Chlorinator (Currently dosing 2.67ℓ/hr)
Back Wash Blowers:	2
Chemically enhanced backwash (CEB):	Backwash pump supplied/CEB pump (recovery); CEB chemicals
Total Treated Water Storage Capacity:	520 kℓ on-site tank (2 x 260 kℓ)

*Personal communication, Mr , Process Controller, Dannhauser LM, ADM staff (May 2020)

The Charlestown WTP process is summarised as follows:

> Water is pumped to the 400 kℓ raw water tank from the production boreholes. Chemical dosing takes place prior to the Prefilters. After passing through the 2 Prefilters, the water is subjected to 24 Ultra Filtration units. Disinfection with chlorine gas then takes place, and the final water is stored in 2 x 260 kℓ clear water tanks at the plant.

Water is pumped from the Charlestown Reservoir High Lift Pump Station via a 160mm diameter uPVC pipeline to the command reservoirs in Charlestown. The command reservoirs consist of two elevated steel tanks (40kℓ and 380kℓ), and one steel tank at ground level (500kℓ). They feed the various pressure zones of Charlestown and are in good condition.

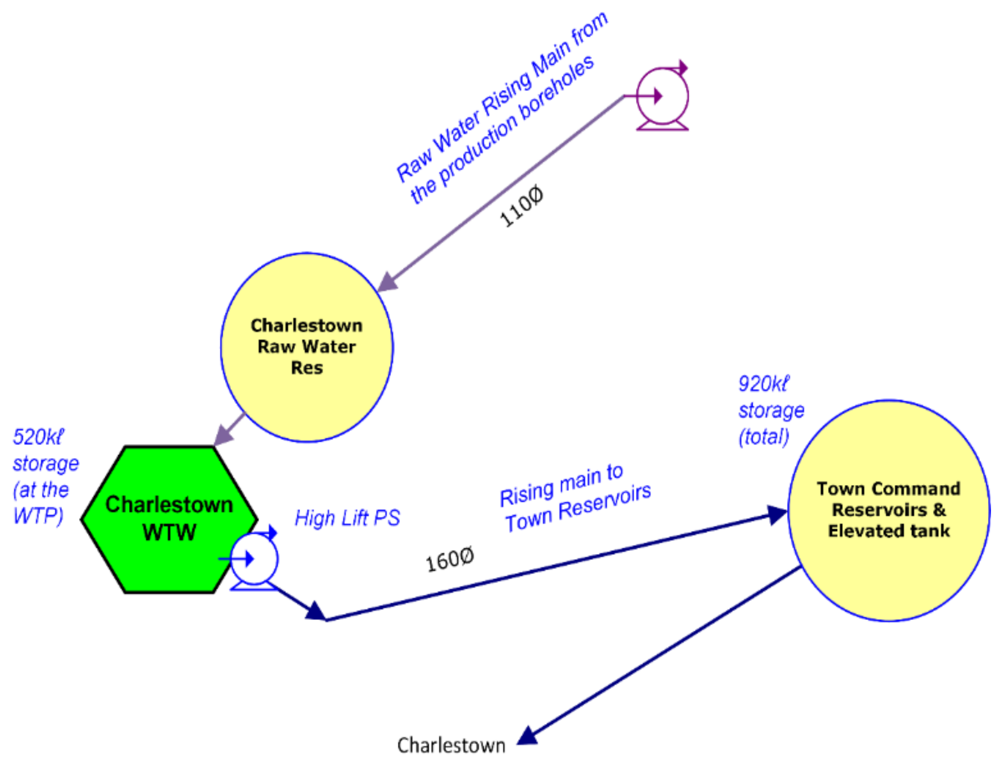

Figure 14.43 Charlestown WTP Supply Schematic (not to scale; Newcastle LM Water bulk infrastructure)

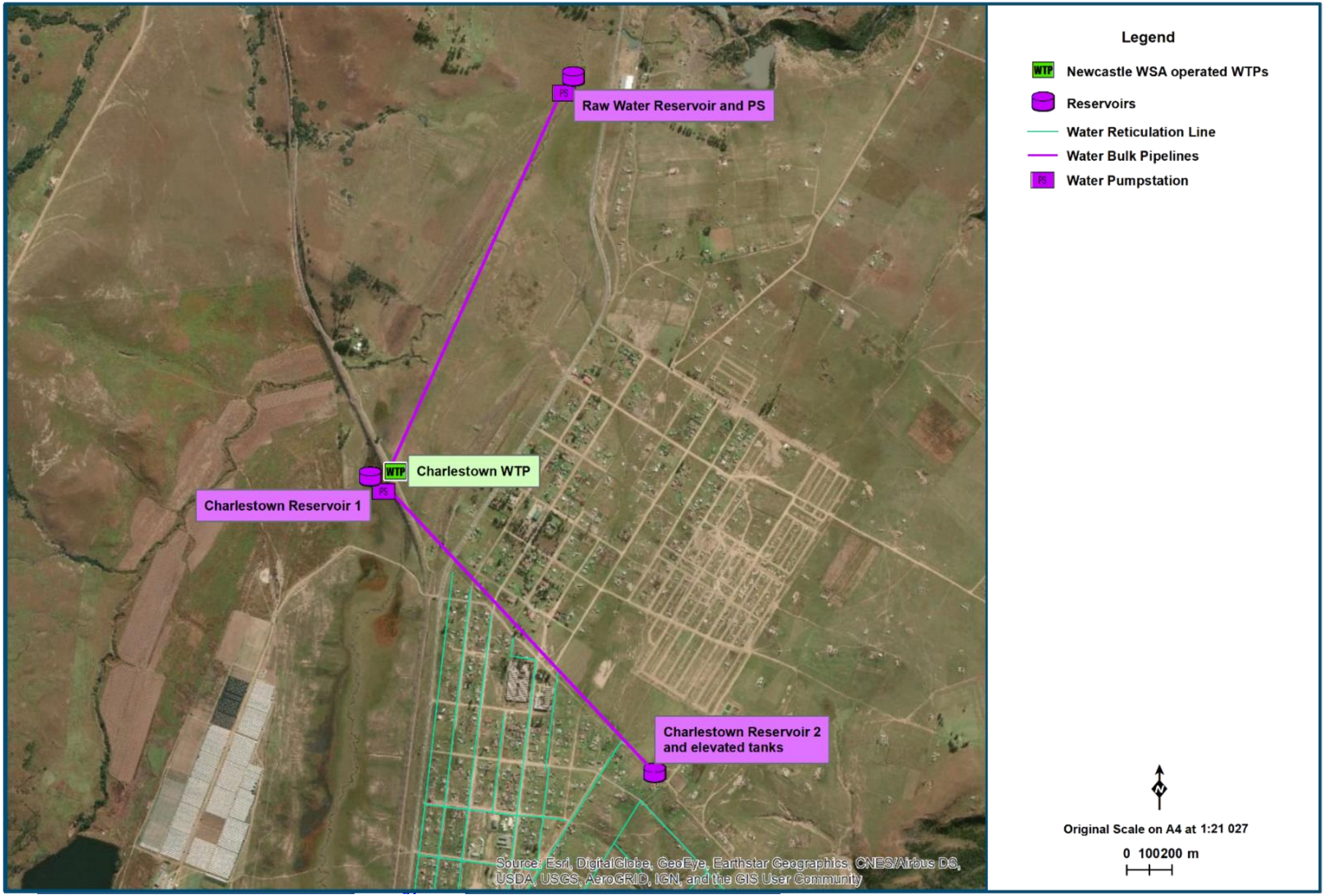

Figure 14.44 Charlestown Supply System Layout (Charlestown WTP System) (NGI 2014; Umgeni Water 2020)

Table 14.53 Pump details: Charlestown Raw Water Pump Station

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Charlestown	Raw Water Pump Station	1	1	Foros MN50 – 200C	Charlestown Raw Water Pump Station	Charles-town WTP	9	35*	1.3*

*Calculated, based on static head, friction, pump curve, stated motor rating, as 'duty 'not stated on pump plate (only range)

Table 14.54 Pipeline details: Charlestown Raw Water Rising Main

System	Pipeline Name	From	To	Length (km)	Nominal Diameter (mm)	Material	Capacity (Mℓ/day)	Age (years)
Charles-town	Charlestown Raw Water Rising Main	Charlestown Raw Water Pump Station at Dorps Dam (Balele Dam)	Charles-town WTP	1.5	110	HDPE cl12	1.3*	3

*Based on velocity of 1.5m/s

Table 14.55 Pump details: Charlestown Clear Water Pump Station (high lift).

System	Pump Station Name	Number of Pumps		Pump Description	Supply From	Supply To	Static Head (m)	Duty Head (m)	Duty Capacity (Mℓ/day)
		Number of Duty Pumps	Number of Standby Pumps						
Charles-town	Charlestown clean water pump station	1		SPP XSTREAM 65/16 (Imp dia 264)	Charles-town water plant	Charles-town command Reservoir	45	no info on pump plate TBC	no info on pump plate TBC
			1	SPP XSTREAM 65/20 (Imp dia 264)	Charles-town water plant	Charles-town command Reservoir	45	no info on pump plate TBC	no info on pump plate TBC

Table 14.56 Reservoir details: Charlestown Clear water system Reservoirs

System	Reservoir Site	Reservoir Name	Capacity (Mℓ)	Function	**TWL (mASL)	*FL (mASL)
Charles-town	Charlestown WTP	Charlestown WTP Clear Water Reservoirs	0.520	Command Reservoir	1639.8	1637.8
	Charlestown Command Reservoir	Charlestown Command Reservoir	0.5	Command Reservoir	1687	1683
	Charlestown Command Reservoir	Charlestown Command Reservoir	0.38	Command Reservoir	1705	1683
	Charlestown Command Reservoir	Charlestown Command Reservoir	0.04	Command Reservoir	1701	1683

*Estimate: Ascertained from UAP GIS data (May 2020)
**Estimate: based on reservoir heights provided by staff of the WSA

Table 14.57 Pipeline Details: Charlestown Clear Water Bulk Pipeline.

System	Pipeline Name	From	To	Length (km)	Nominal Diameter (mm)	Material	*Capacity (Mℓ/day)	Age (years)
	Charles-town Rising main to Command Res	Charlestown water plant	Charlestown command Reservoir	2.4	160	uPVC	2.4	10

*Estimate: based on a velocity of 1.5 m/s

14.3.2 Status Quo and Limitations of the Buffalo System

(a) Newcastle LM and Amajuba DM Water Supply Systems

(i) Ngagane WTP:

The population of Newcastle (including Madadeni, Buffalo Flats and Osizweni) is 389 117 people, and is fed by the Ngagane WTP which is the largest WTP in the Newcastle LM (and in Amajuba DM). In recent years, the Ngagane WTP has been in deficit i.e. the WTP has not been able to provide the required demand, which and this was exacerbated by the 2015/2016 drought. The required short term and long term upgrades of the WTP are discussed in detail in the **Section 14.5** below (Recommendations). At present, the required demand is 131.19 Mℓ/day, which is in excess of the design capacity (130 Mℓ/day) of the WTP. The theoretical demand of the areas is higher than this value with areas of Amajuba DM and Newcastle Rural being still a part of the water backlog statistics with no supply from the Ngagane WTP. Furthermore, other smaller package WTPs cannot be decommissioned, and fed by the Ngagane WTP (which would be more efficient). The approval and then addition of a single module (30 Mℓ/day) at the WTP will take up to two years to commission. In the interim, the most practical intervention to reduce demand, is that of water conservation and water demand management (WCWDM).

The real losses being experienced by the Newcastle LM (as reported by the Newcastle LM) is 44% of the 2 737 Mℓ/monthly input volume. Non-revenue water is estimated at 63.4%. To place the real losses into perspective, the Newcastle LM loses 1 206 Mℓ/month to "real water losses". Thus, it is clear that WCWDM will be the most practical and rewarding investment by Newcastle LM, at this point in time, in terms of reducing demand and improving sustainability. This is far cheaper and far more responsible than implementing emergency upgrades at the WTP. The water demand of the Newcastle LM has continued increasing over the past few years. The demand off the Ntshingwayo system is approximately 120 Mℓ/day with no restrictions. **Figure 14.45** illustrates the distribution of the demand between the different areas.

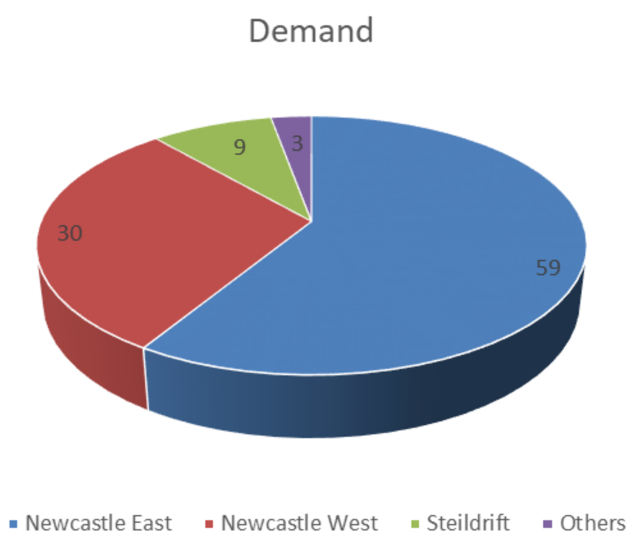

Figure 14.45 Distribution of Water Demand in Newcastle (2020) (uThukela Water 2020)

Newcastle East consists mainly of Madadeni and Osizweni. Newcastle West consists of the CBD and western suburbs. Steildrift is in the Buffalo Flats area of Amajuba District Municipality. Others consist of Ekuseni, Alcockspruit, Waterval, Ngagane village and Kilbarchan village. The Steildrift pipeline is fed from the same reservoirs as Newcastle East (Braakfontein). These reservoirs are controlled by Newcastle Municipality (and not uThukela Water). This arrangement has presented operational problems especially during periods of low flow and high demand. It is difficult for Newcastle to release water to Buffalo flats (which is Amajuba DM) when they cannot meet their own demand in Madadeni and Osizweni. It was therefore proposed to construct a reservoir dedicated to the Buffalo Flats area and this project is currently in progress.

The demand placed on the Ngagane WTP, over the past few years, is presented in **Figure 14.46**. The plant has operated at a peak demand of 120 Mℓ/day in the past although the current average WTP production is approximately 101 Mℓ/day as indicated in **Figure 14.47**. There is a need for urgent revenue enhancement projects to be implemented and this would improve the affordability and efficiency of the scheme. Newcastle has taken steps in this regard and much of the WSIG funding is committed to WCWDM projects as evidenced in **Table 14.66.** During the 2018/2019 financial year the plant operated at an average daily supply volume of 99 Mℓ/d.

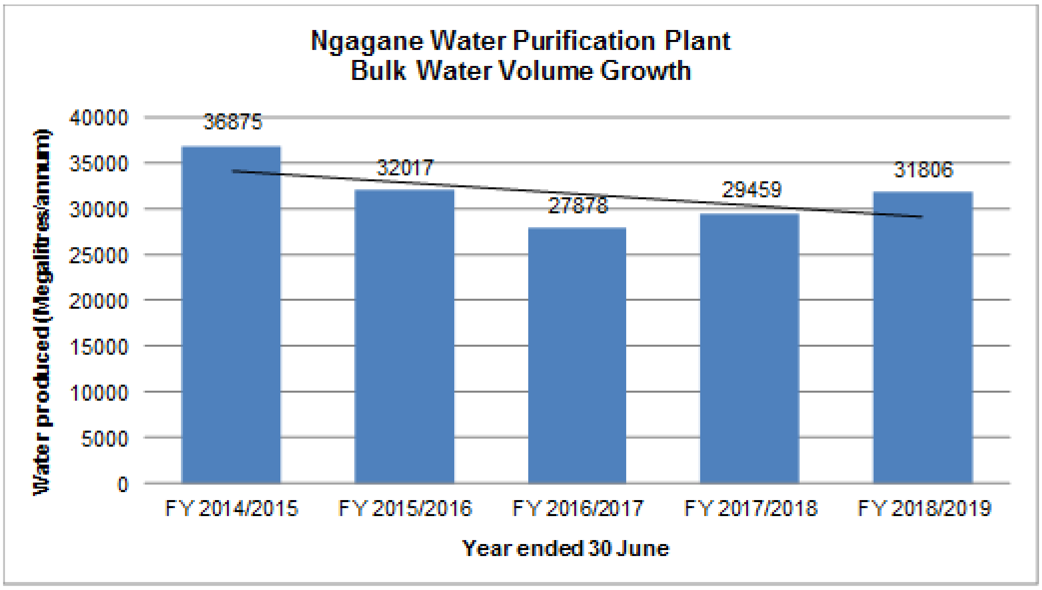

Figure 14.46 Water Demand of Ngagane WTP till 2019 (uThukela Water 2020)

Raw water supply: A recent study indicated that the yield of the Ntshingwayo dam is not sufficient to supply the 2035 demand and hence there is a need to investigate an alternative raw water source. This is discussed in detail in the **Section 14.5** below (Recommendations). The two raw water pipelines are more than 50 years old and leaks are present inside the valve chambers at the scour and air valve pipe sections. The options for refurbishing or replacing these raw water pipelines are discussed in detail in the **Section 14.5** below (Recommendations).

Potable Water Pipelines: The AC Pipeline to Braakfontein is constantly failing and a replacement and an upgrade is urgently needed to cater for future demands and consistent supply. The same applies to the AC pipeline to Hilldrop. Severe water losses are being experienced along the steel pipe to Hilldrop and cathodic protection must be conducted on this pipeline as a matter of urgency (uThukela Water lack funding in this regard, due to the non-payment of customers).

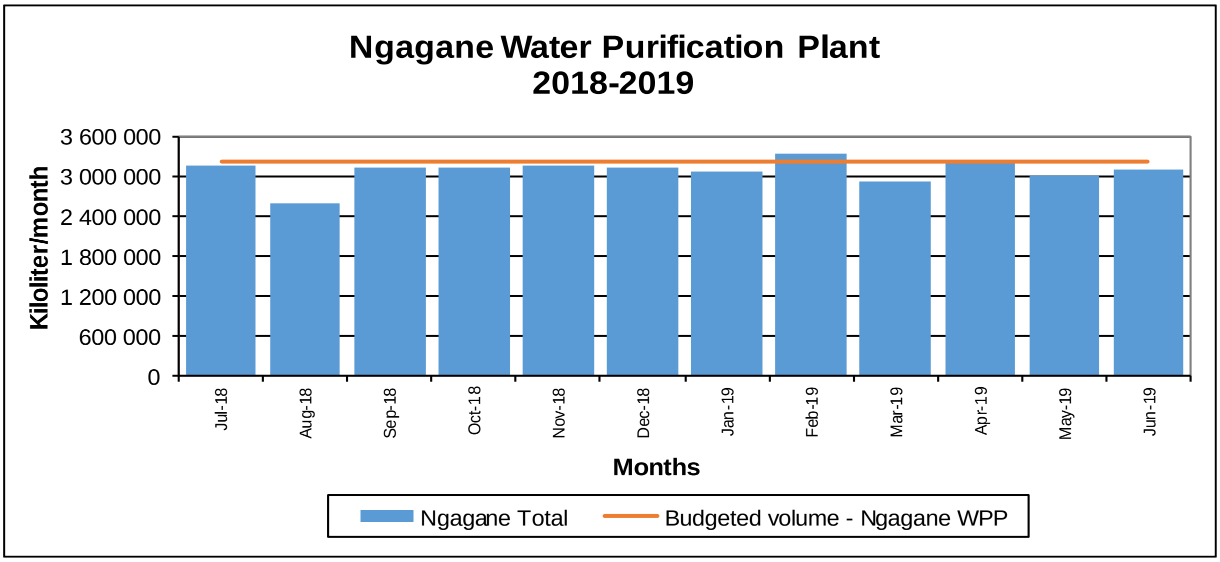

Figure 14.47 Output of Ngagane WTP in 2018/2019 FY (uThukela Water 2020)

In terms of the status quo and limitations of the Ntshingwayo (Ngagane/Newcastle) System, there have been good rainfall events in 2019 and 2020 and these have assisted in maintaining a healthy dam level throughout (**Figure 14.48**). The dam has proven to be resilient over the past few years and abstractions have been well managed by uThukela Water. Gazetted water restrictions imposed by DWS were lifted in 2019. In regards to reducing the limitations of the Ngagane system, the following two projects were completed in 2019:

Emergency filter repair to two filters at Plant 2:

- Removal of the existing filter media and demolishing of the filter beds.
- Installation of new filter beds, new concrete reinforced slabs and filter media.
- Replacement of backwash pumps and blowers.

Installation of the hydrated lime dosing equipment:

- Civil work that includes silo base and road way.
- Electrical, mechanical and instrumentation control systems and equipment.

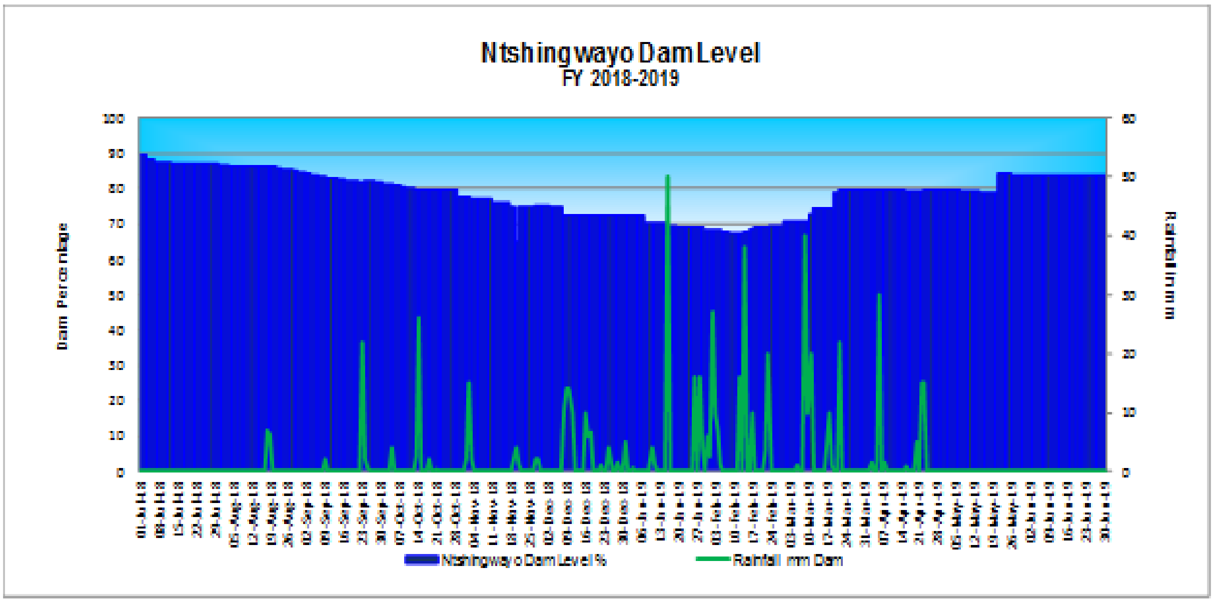

Figure 14.48 Ntshingwayo Dam Level and rainfall figures from July 2018 to June 2019 (uThukela Water 2020)

(ii) Durnacol and Dannhauser WTPs

Durnacol and Dannhauser WTPs fall under Amajuba DM (ADM) and receive raw water from the Ntshingwayo Dam. There has been no deficit in terms of raw water supply, and the current design capacity of the recently upgraded Durnacol WTP is easily providing the required demand of both Durnacol and Dannhauser. This is also providing an opportunity to undertake much needed refurbishments at the aging Dannhauser WTP.

(iii) Utrecht WTPs

Utrecht also falls under ADM, and is only operating at half its design capacity in order to meet the present demand of Utrecht town (and surrounds). However, the local dams on the Dorpsruit can run low in Winter, although ADM have access to potable water from an uThukela Water pipeline that runs all the way to Utrecht (only used in some Winter periods or during emergency shut downs at the Utrecht WTP).

(b) uMzinyathi DM Water Supply System

(i) Biggarsberg:

The Buffalo River Augmentation Scheme (Tayside Pump Station) was designed in 1982 to deliver 13.75 Mℓ/day of raw water, abstracted from the Buffalo River, to Biggarsberg WTP, the largest WTP in the uMzinyathi DM. The plant is dependent on two sources of raw water supply, the Buffalo River and six dams in close proximity to the Biggarsberg WTP (in the Buffalo River catchment).

The **limitations and status quo** of these sources are discussed below:

- **Tayside Pump Station on Buffalo River:** An Intake Tower with Low Lift Pumps is constructed above the high flood level and abstracts water from a pool formed by the Tayside Weir in the Buffalo River. The Low Lift Pumps consist of a duty plus a standby pump and a submersible pump utilised during times of low river levels. An upward flow clarifier was constructed to remove suspended silt from the raw water abstracted from the Buffalo River. The raw water is abstracted and pumped approximately 26 km to the Biggarsberg WTP through a 400mm diameter steel raw water pumping main. This will be a limitation if an application for a greater abstraction at this point is approved by DWS (application in progress by uThukela Water). Settled raw water is pumped to the balancing dam at the Biggarsberg WTP by two Sulzer, two-stage, type 54-25, horizontal spindle, centrifugal pumps. The pumps and switchgear have been sized for a capacity of 13.75 Mℓ/day. These pumps are a limitation, as uThukela Water report that the existing raw water mains have a rated capacity of 21 Mℓ/day. The raw water pipeline from Tayside was commissioned in 1980 and the pipeline is therefore already 40 years old. All the raw water pipelines from the Verdruk, Donald McHardy, Preston Pan, Lower and Upper Mpati Dams are more than 45 years old. They do not pose any major operational problems (managing to provide the required demand) at present but the real losses incurred are a definite concern. There is, therefore, a need for the WSA to plan for pipe replacement projects even though these are likely to be costly and time consuming (working amongst many existing services).

- **Six local dams:** The yield of the six local dams has been estimated at 2.3 million m^3/annum based on a 25% live storage capacity of the dams (dams are very small). This is a limitation in terms of raw water as the dams do not provide the balance of the required demand for Dundee and Glencoe (and surrounds). There is, therefore, a need for urgent augmentation of the Tayside abstraction system.

Production at Biggarsberg WTP: The current demand off the Buffalo System feeding Endumeni and the Hattingspruit area of Amajuba District Municipality is approximately 14.7Mℓ/d. **Figure 14.49** illustrates the distribution of the demand between the different areas.

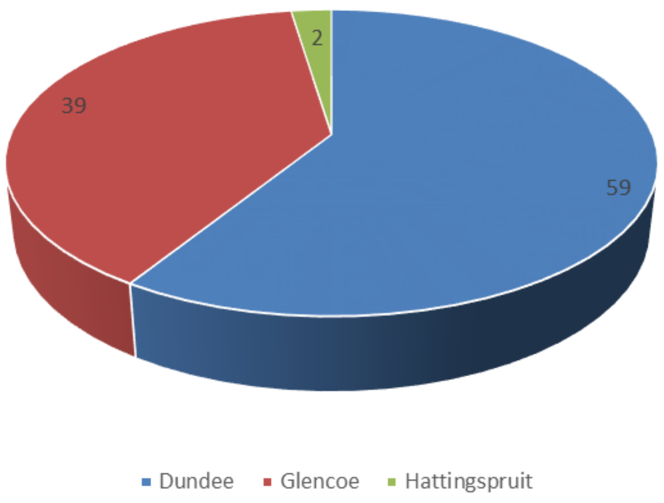

Figure 14.49 Distribution of the Water Demand in Biggarsberg (uThukela Water 2020)

Dundee consists mainly of the town of Dundee and the Sibongile suburb. Glencoe consists of the town of Glencoe and Sithembile suburb as well as Wasbank. With regards to the status quo, uMzinyathi DM maintain that real water losses are reported as high in Sibongile and Sithembile and water demand can also be excessive (whilst revenue collection is minimal). This is causing a strain in the system and resulting in a limitation in supplying other areas of Dundee e.g. Hattingspruit is in the Dannhauser local municipality of Amajuba District Municipality. The area around Hattingspruit is growing with informal settlements and these are connecting to the main line to Hattingspruit Reservoir creating shortages in this area. A study should to be undertaken to determine the demands for this area.

Raw water supply: During periods of low flow in the Buffalo River, water is released from the Ntshingwayo Dam to supplement flow in the river (also upon request, based on level of the Ntshingwayo Dam). There are recommendations to investigate an alternative raw water source for Newcastle so that resources can be freed up to supply other parts of Amajuba (Dannhauser and Durnacol) as well as Endumeni. This is discussed in detail in the **Section 14.5** below (Recommendations).

The peak WTP production was as high as 19 Mℓ/day in the past. From the previous year (2018/2019) the plant has been operating far below this peak due to drought conditions experienced up to January 2019. Water produced at the Biggarsberg WTP amounted to 5062 Mℓ (**Figure 14.50**) for the 2018/2019 financial year (AADD of 15.37 Mℓ/day). The plant's supply volume trend for the past five-years is illustrated in **Figure 14.51.**

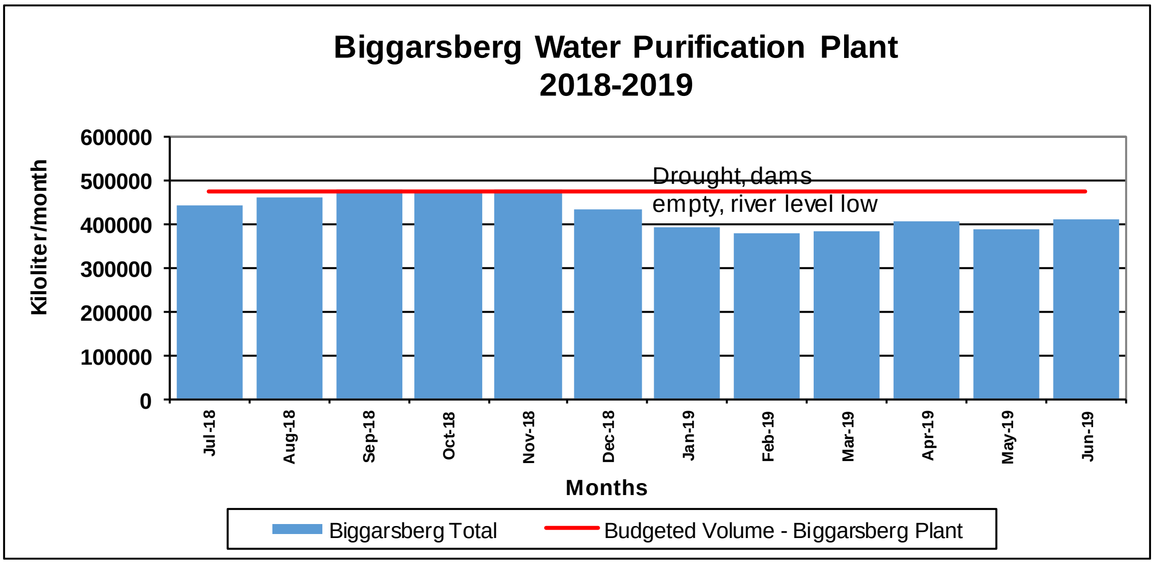

Figure 14.50 Biggarsberg Plant Monthly Production until 2019 (uThukela Water 2020)

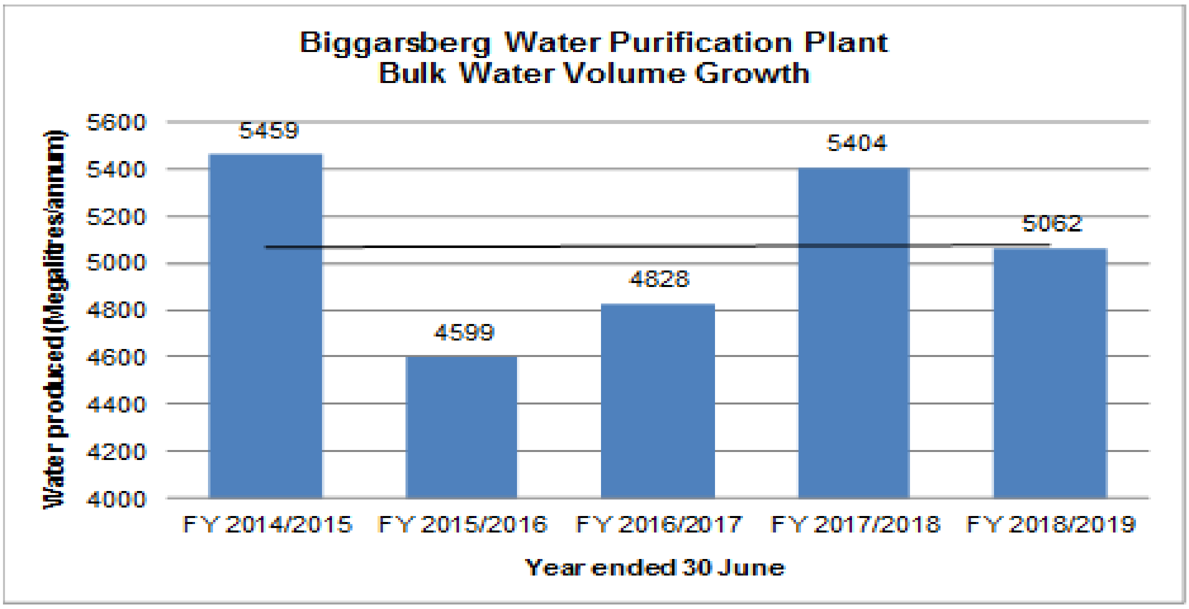

Figure 14.51 Biggarsberg Annual Production until 2019 (uThukela Water 2020)

Potable Water Pipelines: All four pipelines supplying Dundee and Sibongile are more than 44 years old but do not have any maintenance issues to date (supplying required demand), mainly as a result of the low pressure in these pipelines. However, but the real water losses are on the increase. In 2017 a new 300mm diameter Steel pipeline replaced the 300mm diameter AC pipelines to Glencoe. This pipeline is now operational and no infrastructure interruptions are being experienced. As a result, the limitations on water supply to Glencoe can now be actioned.

The Water Treatment Plant: Should the plans to build a new water treatment Plant at Ntshingwayo Dam go ahead (capable of supplying both Amajuba and Endumeni municipalities) then the Biggarsberg WTP would be decommissioned. This is a long-term plan that is unlikely to take place within the next fifteen years. Short to medium term plans to address increased demand should to be implemented. The most critical intervention is the upgrade of the abstraction works at Tayside. This can go hand in hand with the refurbishment of the filter units at Biggarsberg to increase the plant throughput, and then consider upgrading the 400mm diameter rising main. In order to meet demands up to 2035 and beyond and ensure operational efficiency in the distribution system, a number of strategic infrastructure projects will be required. This is discussed in detail in the **Section 14.5** below (Recommendations).

(ii) Vants Drift WTP:

The WTP is not coping with the required demand and is only producing 9Mℓ/day. This can also be attributed to the unprecedented real water losses being experienced in the water supply scheme. The current bottleneck at the Vants Drift WTP is the high lift pumping system, including the electrical components. A dedicated Business Plan is being prepared by the WSA to allow the WTP to pump the full allocation of 14 Mℓ/day to the Nqutu Supply Areas. The water source (Buffalo River) is a challenge during the Winter months and there is thus a need for storage/dams in the area of Vants Drift. These shortcomings are all discussed in detail within the **Section 14.5** below (Recommendations).

14.4 Water Balance/Availability

The water availability of Ntshingwayo Dam is shown in **Table 14.58**.

Table 14.58 Water availability at Ntshingwayo Dam*(DWS 2015).

	million m3/a
System yield (V31A….V31K)	**170.0**
Irrigation agriculture	26.5
Mining & Industries	7.2
Transfers out	55.0
Transfers out for supply to Volksrust	5.0
Water requirements - excluding domestic needs	**93.70**
Yield reduction due to forestry	- 4.0
Available water for domestic	**72.3**
Current Domestic water use	56.8
Available yield	**15.5**

* *1:50 Assurance of supply*

The Buffalo River catchment overall comparison of the available water with the current and future water requirements scenarios is shown in **Figure 14.52**. This is a general impression and does not consider which requirements are met from which source of supply within the catchment

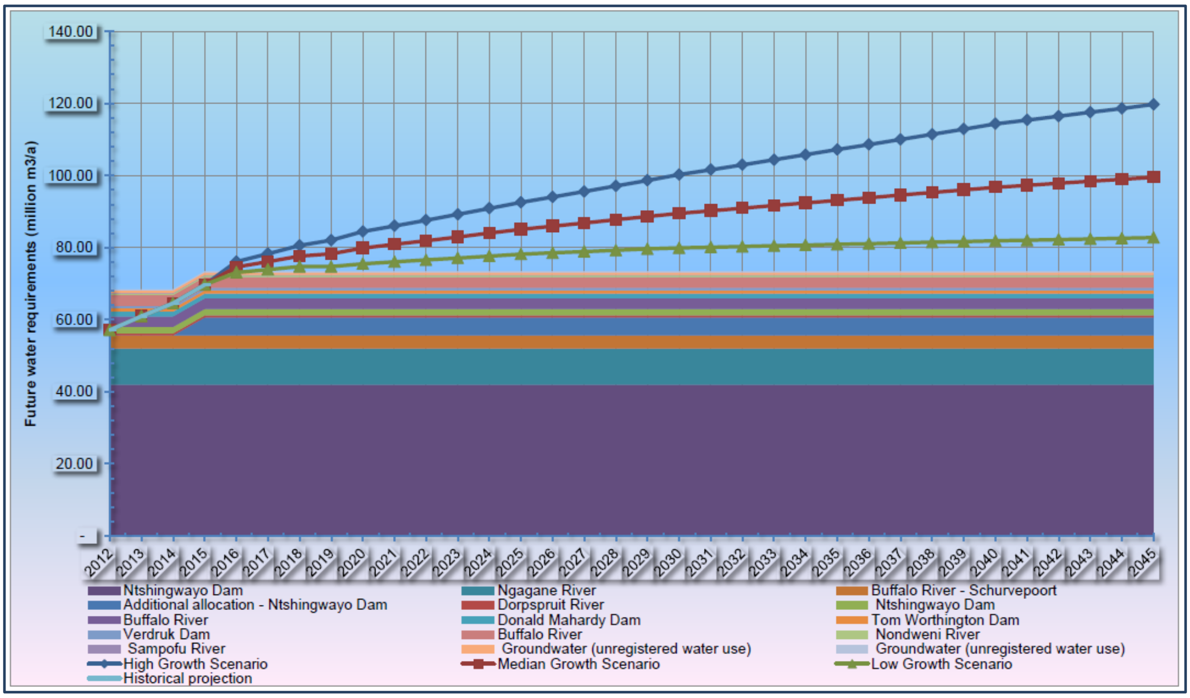

Figure 14.52 Comparison of the future water requirements and the available water supplies in the Buffalo catchment (DWS 2016).

14.5 Recommendations for the Buffalo System

It is recommended that a detailed water resources analysis be undertaken for the entire Buffalo System to confirm the assurance yield of the system and whether this can support the existing and future demand.

Some of the key aspects that should be assessed in detail include:

- Determination of system water demand projections
- System water losses
- Water conservation and demand management (WC/WDM)

14.5.1 Explanatory Note

The National Water and Sanitation Master Plan (**Section 2.5** in **Volume 1**) summarises the relationship between asset maintenance planning and infrastructure planning in **Figure 14.53**.

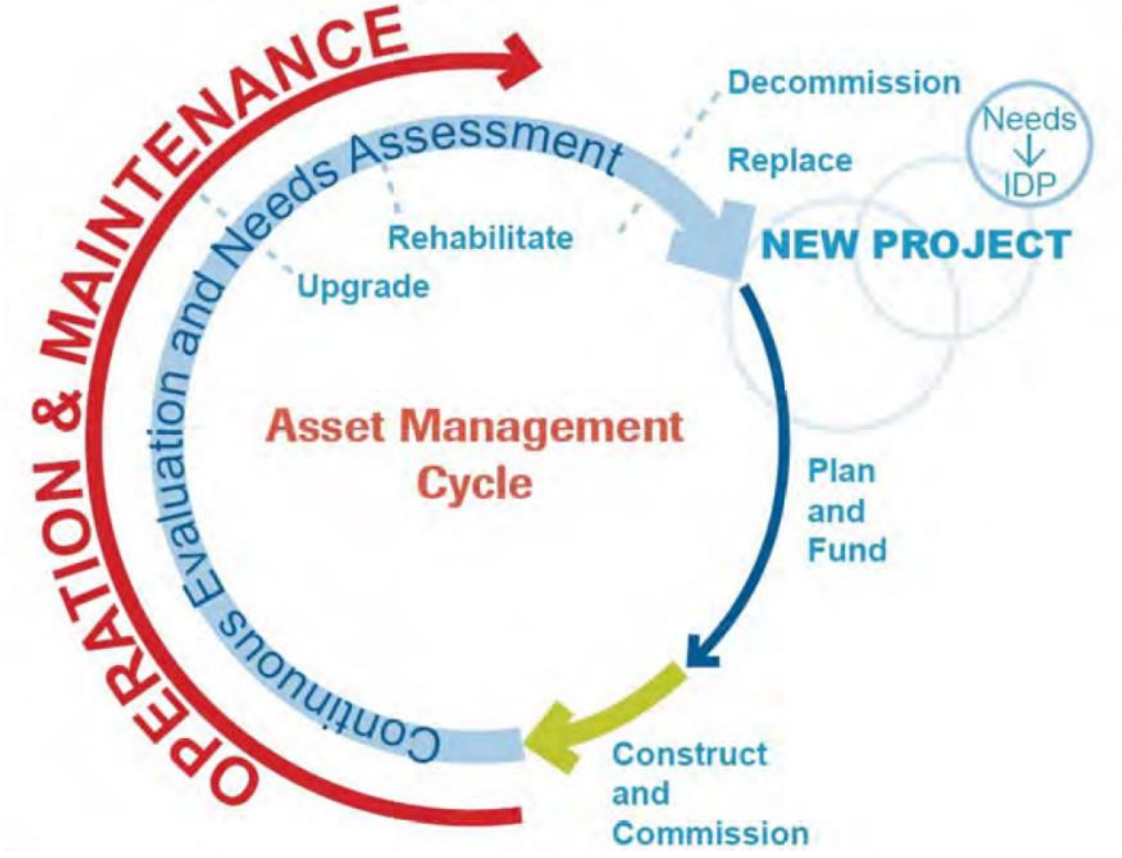

Figure 14.53 Integrated asset management (DWS 2018: 5-14).

The Umgeni Water IMP (All Volumes after Volume 1) discusses the "continuous evaluation and needs assessment that informs new projects and upgrades", as shown in **Figure 14.53**. However, as discussed in **Section 14.3.2**, there are currently significant infrastructure issues within the WTPs and supply systems as a result of poor maintenance over the past few years and the WSAs are now struggling to address these challenges. There is an urgent need to prioritise proper operation and maintenance (O&M) in the district after years of focusing primarily on new capital works. The WSAs in the Buffalo Catchment face a backlog in O&M needs, with regression being realised in the schemes that supply indigent communities. This is as a result of unauthorised connections, vandalism, aging infrastructure,

infrastructure that can no longer cope with the growing demand, excessive water loss and sheer lack of maintenance.

The WSAs update the asset register periodically, and Amajuba DM and uMzinyathi DM were provided with an asset management system in 2016 (water and sanitation) by the Department of Cooperative Governance and Traditional Affairs (CoGTA) KZN. However, this asset management system was not kept up to date/utilized by the WSAs. These WSAs should be using the Infrastructure Management Query Statement (IMQS) system (as promoted by DWS), or a similar equivalent system. This should be prioritized, with all new infrastructure information from the asset register, the GIS, and new projects being inputted into the system. This will allow maintenance tasks to be prioritized and in general the entire asset base and its operations would be run through the IMQS. This system allows for the seamless integration between the "financial" asset register, and the technical daily management and planning for the entire asset base, not just for water and sanitation. By utilizing the IMQS effectively, the municipality will be able to prioritise proper budgets for O&M.

The O&M Plans of the WSAs (Amajuba, uMzinyathi and Newcastle) must detail the O&M standards, policies and procedures so that all schemes are handled in the same manner, and all consultants/contractors involved in projects understand the requirements prior to project commissioning.

It is anticipated that in the coming year (2020/2021), as Umgeni Water continues with data collection in these WSAs, that there will be better information to inform a full needs assessment so that upgrades and new projects can be better identified. The Recommendations section will therefore contain greater detail in the next version of the IMP.

14.5.2 System Components

(a) Buffalo System Treatment Plants and Supply Systems

Umgeni water does not operate any WTPs (at present) in the WSAs of the Buffalo Catchment. However, recommendations have been made in this section based on information gathered to date. Before suggesting recommendations, it was prudent to consider the projected populations and water demands of each water supply scheme, to at least 2050 (in line with bulk planning). The current water supply schemes (current infrastructure) of Amajuba, uMzinyathi and Newcastle WSAs, including live construction projects (listed in **Section 14.5.2**) would not cater for the water demand of 2050, due to the projected population increase within these water supply schemes.

Table 14.59 and **Table 14.60** map out both the current population and associated theoretical water demand, as well as the projected population and water demand for 2050 (a thirty year design horizon). By 2050, the Amajuba DM (including Newcastle LM) would have to supply a combined total of 218 Mℓ/day to their water supply schemes. By 2050, the portion of uMzinyathi DM that falls within the Buffalo catchment would have to supply a combined total of 86 Mℓ/day to their water supply schemes (the Umvoti LM and portions of Msinga and Nqutu LMs do not fall within the Buffalo catchment). The current infrastructure within the existing water supply schemes cannot meet these demands. Hence the inclusion of proposed short, medium and long term interventions in **Section (i)** below.

Table 14.59 Projections: Population and Water Demand in Amajuba and Newcastle WSAs*

WSA_ NAME	Water Scheme Name	Population 2020	Population 2050	Demand 2020 Mℓ/d	Demand 2050 Mℓ/d
NWC	Amajuba Forest WSS	1 620	2 249	0.28	0.43
Amajuba	Skombaren WSS	4 381	6 082	0.92	1.39
Amajuba	Dannhauser WSS	6 489	9 009	2.12	3.03
Amajuba	Dannhauser 3 WSS Hilltop	9 983	13 860	1.59	2.42
Amajuba	Dannhauser Rural	3 273	4 544	0.61	0.91
Amajuba	Dannhauser/Glencoe Rural WSS	1 702	2 363	0.36	0.54
Amajuba	Durnacol WSS	3 866	5 367	1.38	1.96
Amajuba	Emadlangeni Rural Supply Area	31 033	43 082	2.86	7.60
Amajuba	Biggarsberg WSS	1 756	2 438	0.42	0.62
NWC	Charlestown Supply Area	5 249	7 287	1.09	1.65
NWC	Newcastle Madadeni Osizweni WSS	419 408	582 248	114.01	166.73
NWC	Newcastle Rural Supply Area	7 898	10 964	1.35	2.17
Amajuba	Ngagane/Dannhauser 1 WSS Buffalo Flats	90 657	125 856	15.83	24.23
Amajuba	Waterval Ngagane WTW WSS	1 671	2 320	0.61	0.85
Amajuba	Utrecht/Ngagane WSS	8 464	11 750	2.33	3.38
	Totals	**597 450**	**829 416**	**145.75**	**217.89**

*Umgeni Water, UAP Phase 3 data (June 2020)

Table 14.60 Projections: Population and Water Demand in uMzinyathi WSA*

WSA_ NAME	Water Scheme Name	Population 2020	Population 2050	Demand 2020 Mℓ/d	Demand 2050 Mℓ/d
uMzinyathi	Endumeni Scheme Area 2	7 829	10 936	1.62	2.32
uMzinyathi	Ntabankulu	8 367	11 687	1.40	2.03
uMzinyathi	Nocomboshe	11 244	15 705	1.91	2.79
uMzinyathi	Nqutu Scheme Area 1	15 590	21 777	2.76	4.01
uMzinyathi	Nqutu Scheme Area 2	82 047	114 606	15.21	21.99
uMzinyathi	Nqutu Scheme Area 3	49 417	69 027	8.62	12.50
uMzinyathi	Nqutu Scheme Area 5	25 180	35 172	4.30	6.27
uMzinyathi	Nqutu Scheme Area 6	4 450	6 215	0.74	1.08
uMzinyathi	Nqutu Scheme Area 7	9 658	13 491	1.61	2.35
uMzinyathi	Dundee/Glencoe Future WSS *(currently unserved area)*	2 679	3 742	0.44	0.65
uMzinyathi	Dundee (includes Glencoe) *served area*	68 746	96 027	21.23	30.25
	Totals	**285 206**	**398 386**	**60**	**86**

*Umgeni Water, UAP Phase 3 data (June 2020)

With regards to recommendations for these WTPs/schemes, the following apply:

(i) Short-Term to Medium Term Recommendations

1) **WCWDM**: The immediate short-term solution within the existing WSS of these three WSAs would be to implement proper (large scale) Water Demand Management measures. This would include a revenue enhancement project, where unauthorised connections (that are not on pumping mains or gravity mains) are regularised through the installation of domestic meters. Payment for water consumption by the non-indigents will decrease the water demand. Newcastle LM is spending most of its WSIG funding (currently) on WCWDM projects, as evidenced in **Table 14.66**.

2) **Replace Raw water gravity mains to Ngagane WTP**: Two raw water gravity feed pipelines from the Ntshingwayo Dam, delivering an average of ± 84 Mℓ/day to Ngagane Water Treatment Plant. The pipeline lengths are approximately 20 km each. The one pipeline is a pre-stressed concrete pipeline with internal diameter 690 mm, and the second pipe is a steel pipe with internal diameter 590 mm for 15.3 km coupled to an AC pipe with internal diameter 590 mm for 4.7 km. The present allocation from the Ntshingwayo Dam is 113.5 Mℓ/day via the pipelines, but uThukela Water has stated that the most they have ever received in a day from these pipelines is 90 Mℓ[27]. These pipelines are in excess of 50 years old and, although the pre-stressed concrete pipe has undergone some refurbishment/repair in recent years, there are still visible leaks at scour, air and isolating valves on both raw water pipelines.

[27] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (Feb 2020)

It is recommended that these pipelines be replaced as soon as possible in order for Ngagane WTP to reliably extract (via gravity) the **full** allocation from the Ntshingwayo Dam. Hydraulic modelling using the specific pipe route must be undertaken (detailed design) but for preliminary costing, a pair of 750 ND steel pipes has been used (upgrade in volume) and the approximate total project cost is estimated at **R1.17 billion** (current prices). The estimated project duration is **36 months**, and this could qualify for RBIG funding. A feasibility study should be conducted on whether to install a pair of identical pipes, or to install a single larger pipeline. A business plan should then be drafted and submitted to DWS for appraisal before detailed design and construction drawings are undertaken. This project requires some urgency as these pipes are in excess of 50 years old, and show visible signs of disrepair.

Please note that if a decision to construct a new Regional WTP at the Ntshingwayo Dam (within the next ten years) is taken, the proposal of constructing these new raw water gravity mains would fall away. Instead, the short term recommendation would be to then conduct leak detection on the entire 20km length and repair the leaks (where feasible). This should also include the installation of new air, scour, and isolating valves where needed. Cathodic protection should also be checked add new lining inserted in certain sections. This would extend the life of the pipes until the new Regional WTP at the Ntshingwayo Dam is constructed. **Note:** A business plan submitted recently by Newcastle LM is in the process of being appraised by DWS, for an upgrade of 30Mℓ/day to the existing 130Mℓ/day Ngagane WTP. This would also include the installation of a new 1m diameter raw water main from Ntshingwayo Dam to Ngagane WTP and the bulk infrastructure upgrades. If the business plan is approved, then the recommendation put forward here in **Section 14.5.2 a) i) 2,** would no longer be applicable, as this business plan includes the installation of a new 1 m diameter raw water main from Ntshingwayo Dam to Ngagane WTP.

3) **Fast Track Existing MIG and WSIG Water Projects**: There are numerous bulk and reticulation projects currently being implemented by the Amajuba, uMzinyathi and Newcastle WSAs, and these should be fast tracked and taken to completion. Bridge financing could include DBSA, Council funding etc. It is critical to note that these projects cater for the short to medium term but they do not cater for demands beyond the 2050 and are not at the scale of regional bulk. Most of these projects are funded through the municipal infrastructure grant (MIG) as per **Table 14.61, Table 14.62,**

5) **Table 14.63,** which is managed by CoGTA and the water services infrastructure grant (WSIG), as per **Table 14.64, Table 14.65, Table 14.66** and **Table 14.67.** In regards to bulk infrastructure for water supply, the Regional Bulk Infrastructure Grant (RBIG) is a DWS grant with the specific mandate to provide funding for bulk water infrastructure (and not reticulation). However, it is noted with concern that there is no active RBIG funded project in the Buffalo system (Buffalo water resource region). Hence the lack of bulk water projects at a regional scale. However, as mentioned in **2)** above, a business plan submitted by Newcastle LM is in the process of being appraised by DWS. It is highly likely that the project (if approved) could receive its funding through RBIG.

6) **Upgrade Tayside Abstraction, and filter units at Biggarsberg WTP**: The existing raw water 400mm ND steel rising main from Tayside Abstraction on the Buffalo River is 37 years old and the raw water pumps are 20 years old. The existing pumps can deliver 13 Mℓ/day and the capacity of the pipeline is rated at 21.7 Mℓ/day by uThukela Water. This confirms that the rising main is underutilised and that the existing 20 year old pumps could be replaced with larger units in order to provide additional raw water as will be required by the Biggarsberg system[28]. In order to treat this extra volume of raw water (volume depends on allocation to be granted by DWS), the existing rapid gravity filters require a through refurbishment and upgrading. The allocation for abstraction at Tayside weir is 13 Mℓ/day. uThukela Water is currently in the process of preparing a Water Use Licence Application (WULA) application to DWS to request an increase of the allocation at Tayside, in response to the current and future demand of Dundee/Glencoe[29].

   uThukela Water is also preparing a WULA for further or new abstraction volume from Ntshingwayo Dam to service Newcastle West. There is no indication on the possible increase in volumes for abstraction at Tayside, as it depends on a review of both releases from Ntshingwayo Dam and other related matters. The 2050 demand for Endumeni is 33.22 Mℓ/day, and the capacity of Biggarsberg is only 16 Mℓ/day, therefore a completely new WTP would be required with new high lift pumps and bulk pipelines which would cost in the region of R 1.2 billion. If DWS do not increase the abstraction at Tayside by the required volume, the option to supply the required shortfall of 11 Mℓ/day (in order to meet the 2050 demand) from a new raw water main from Ntshingwayo Dam must be explored further (and a feasibility study undertaken in this regard). Pumping would be required from Ntshingwayo Dam up to a new reservoir at a high point in the vicinity of Durnacol. From there, a gravity pipeline would convey the raw water to Biggarsberg.

7) **Replace clear water mains from Ngagane WTP to the Command reservoirs in Newcastle**: The existing clear water mains that emanate from the Ngagane WTP are approximately 50 years old. As such, they are in a poor condition and contribute to water losses and a decreased assurance of supply. The replacement of the clear water mains from Ngagane

[28] Personal Communication, Hannelie Hickley, Senior Manager Ops, uThukela Water Pty Ltd (April 2020)
[29] Personal Communication, Clever Dhliwayo, Manager: Engineering, uThukela Water Pty Ltd (June 2020)

WTP to the Command reservoirs (res) in Newcastle is important in the medium term and planning/design should start in the short term. The clear water pipelines to Braakfontein Reservoir, Hilldrop Reservoir, Kilbarchan Reservoir, Balangeigh Reservoir and Ekuseni Reservoir are in need of replacement. This project would cost in the region of **R1.15 billion**. The estimated project duration is **36 months**, and this could qualify as an RBIG project.

8) **Groundwater exploration at Newcastle**: Newcastle lies in quaternary catchment V31J which has a borehole exploitation potential of 2.32 million m^3/annum or 6.35 Mℓ/day (RHDHV 2016: 62). A series of production boreholes could be implemented (short to medium term recommendation) and would assist to supplement the incoming raw water to the Ngagane WTP. Whilst 6.35 Mℓ/day may appear to be an insignificant daily volume, it exceeds the combined water requirement of smaller towns of Durnacol and Dannhauser in 2050. Surface water (iNgagane River and Buffalo River) has diminished during the Winter months in recent years and this has necessitated formal water restrictions (gazetted by DWS. Groundwater shows more resilience to drought and has been a "saving grace" to many KZN communities during the serious drought of 2015/2016 and hence should be considered as an augmentation option.

   Many small towns/communities supplied by the Ngagane WTP fall in a separate quaternary catchment (to that of Newcastle) and are privy to a strong groundwater exploitation potential to supplement their formal supply from Ngagane WTP. Examples include Utrecht, Dannhauser, Nqutu and Dundee (including Glencoe). These are discussed in the latter points within this section below.

9) **Decommission Dannhauser:** These areas fall under Amajuba DM and are currently supplied with raw water from the Ntshingwayo Dam. There is sufficient resource to supply these areas in the long term (2050) (RHDHV 2016: 61). The raw water can be treated at the existing Durnacol WTP which could be further upgraded if the future demand is realised. This WTP could also be used to supply other neighbouring (small) rural areas of Amajuba DM. Furthermore, the Dannhauser WTP is an old WTP and is not particularly efficient. It is hereby recommended that the Dannhauser WTP be decommissioned, as it is not financially viable to have two small WTP a few kilometres apart, using the same raw water source.

10) **Nqutu:** Nqutu also has the potential to supplement the inflow to the WTP with ground water (production boreholes) as the exploitation potential for quaternary catchment W21G (within which Nqutu lies) equals 1.65 million m^3/annum or 4.52 Mℓ/d. Nqutu has no supply problems as it is downstream of the convergence of the Buffalo and Blood rivers (RHDHV 2016: 65). This is a short to medium term intervention that must be explored with urgency i.e. A thorough geohydrological study, and proper siting methods must precede any drilling of boreholes. With regards to upgrading the Vants Drift WTP, a business plan is being developed for submission to DWS and will address the current bottlenecks of the Vants Drift WTP, namely the clear water high lift pumps, abstraction works, electrical

works and other ancillary works. Details of the business plan were not obtained in time to be included in this report. This work is urgent as the Vants Drift WTP system is currently in deficit (potable water). Note: The investigation of an ideal dam site on either the Buffalo or Blood river is discussed under long term recommendations, in order to ensure security of raw water during periods of low flow in the rivers (Winter).

11) **Charlestown:** The design capacity of the newly constructed Charlestown WTP is 2 Mℓ/day. This exceeds the 2050 water demand of Charlestown. However, the required raw water supply would need to supplemented by further production boreholes. An option also exists to apply to DWS for a licence to abstract some of the required water from the nearby Buffalo River (just beyond the convergence of the Slang and the Buffalo) which borders the eastern portion of Charlestown. This would assist with assurance of supply in the Charlestown area. It is recommended that Newcastle make such application (WULA) to DWS in this regard as soon as possible. The likelihood of it being granted is high as the 2050 water demand of the area is 1.65 Mℓ/day. However, it is likely that the approval would only be granted after a full review of the historic water use licences and allocations of the Buffalo system is completed.

12) **Utrecht:** The Utrecht WTP is only running at half its current design capacity. If the Dorpsruit Dams (there are two) or the Dorpsruit river itself fails, there is a potable water pipeline that Amajuba DM make use of in order to supplement water provision at Utrecht. Utrecht also has the potential to supplement their inflow to the WTP with ground water as the exploitation potential for quaternary catchment V32B (within which Utrecht lies) is 3.48 million m^3/annum or 9.53 Mℓ/d. The design capacity of the current Utrecht WTP is 4 Mℓ/day and this exceeds the 2050 water demand of Utrecht. Consequently, Utrecht is 100% supplied.

13) **Further note on WCWDM**: All of the areas mentioned in the above have the potential for water conservation and water demand management (WCWDM), especially Nqutu. WCWDM is the short-term recommendation that must first be pursued before the implementation of new WTPs or dams [See **Section 14.5.2 a) i) 1** above], and this reduction of water demand would buy valuable time for the proper implementation of medium and long-term interventions.

Table 14.61 Active MIG Projects of uMzinyathi DM (CoGTA, June 2020)

Provincial Reference Number	Project Title (*as per MIG 1 form*)	Project Status	Actual Project Cost (Tender sum + fees)
2009MIGFDC24166709	KwaSenge Sanitation	Design & Tender	5 726 385.00
2009MIGFDC24178897	Ntinini Water Project Geohydrological Survey Drilling and Testing	Construct. 20%	306 639 405.83
2009MIGFDC24184014	Douglas Water Supply Scheme (AFA) MIS 223919	Construct. 80%	49 329 139.00
2010MIGFDC24195759	Msinga Regional Bulk Water Supply	Construct. 80%	286 739 114.69
2010MIGFDC24193444	Mthembu West - Extension	Construct. 60%	31 745 056.00
2011MIGFDC24194324	Msinga Top/ Othame Supply Scheme Geohydrological Investigation	Construct. 80%	1 671 935.40
2012MIGFDC24202816	Refurbishment of Vant's Drift Water Treatment Plant	Construct. 80%	3 784 344.00
2012MIGFDC24205216	Eradication of Sanitation Backlogs in Umvoti LM	Construct. 60%	33 749 795.16
2015MIGFDC24228608	Hlimbithwa Sub-Regional Water Supply Scheme	Construct. 20%	11 434 097.32
2015MIGFDC24235037	UMzinyathi Disaster Management Centre	Construct. 80%	33 838 147.00
2016MIGFDC24244973	Construction of Mbono Bulk Water Supply Project	Construct. 80%	29 980 975.14
2019MIGFDC24339647	Ophathe Water Supply Phase 3	Design & Tender	24 983 544.00

Table 14.62 Active MIG Projects of Amajuba DM (CoGTA, June 2020)

Provincial Reference Number	Project Title (*as per MIG 1 form*)	Project Status	Actual Project Cost (Tender sum + fees)
2008MIGFDC25157145	Buffalo Flats Water Supply Scheme Phase 3 (AFA) MIS 230852	Construct. 60%	142 187 352.00
2015MIGFDC25228245	Emadlangeni Rural Water Supply Phase 1 (Development of Water Sources)	Design & Tender	1 059 750.21
2015MIGFDC25232312	The Amajuba Regional Bulk Water Supply Scheme : Feasibility Study	Construct. 80%	2 899 000.00
2015MIGFDC25236687	Buffalo Flats Water Supply Scheme Phase 3B	Construct. 80%	68 777 282.78
2016MIGFDC25247713	Goedehoop Bulk Water & Sanitation	Construct. 20%	28 251 878.00
2018MIGFDC25265568	Dannhauser Housing Development Bulk Water and Sanitation	Construction	28 665 978.00

Table 14.63 Active MIG Projects of Newcastle LM (CoGTA, June 2020)

Provincial Reference Number	Project Title (*as per MIG 1 form*)	Project Status	Actual Project Cost (Tender sum + fees)
2011MIGFK252199363	Water Conservation and Demand Management Programme	Construct. 80%	24 618 550.00
2014MIGFK252222718	Emergency Upgrade of Ngagane Water Purification Plant and Associated Infrastructure	Construct. 60%	63 286 000.00
2014MIGFK252226030	Blaauwbosch Bulk Water Project	Construct. 20%	69 448 946.00
2014MIGFK252215455	H39 Housing Project Bulk Infrastructure	Construct. 20%	21 673 031.02
2015MIGFK252229048	Pipe Replacement and Upgrade Project	Construct. 40%	33 432 096.00
2016MIGFK252240869	Ngagane Bulk Water Supply Project	Construct. 80%	14 916 486.00

Table 14.64 WSIG MTEF Allocations (Amajuba, Newcastle and uMzinyathi WSAs)

NAME OF WSA	2019/2020 (R)	2020/2021 (R)	2021/2022 (R)	TOTALS (R)
uMzinyathi DM	68 374 000	78 235 000	75 000 000	**221 609 000**
Newcastle LM	40 000 000	45 000 000	50 000 000	**135 000 000**
Amajuba DM	46 000 000	50 000 000	65 000 000	**161 000 000**

Table 14.65 Amajuba DM – WSIG Projects (2019/2020)

Name of project	Estimated project cost	Project stage	2019/2020 Allocation	Transferred as at 22 Nov 2019	Expenditure as at 31 Dec 2019	% Expenditure against transferred
Eastborne and Skobhareni water supply improvements	76,359,438	Construction	13,000,000	21,000,000	5,890,769	32%
Construction of Braakfontein reservoir	25,506,862	Planning	12,000,000		0	
Emergency water supply to Ramaphosa, Skombaren and 2 megalitre reservoir at Hilltop - Emadlangeni LM	179,849,330	Planning	20,000,000		860,248	
TOTAL	**281,715,630**		**46,000,000**	**21,000,000**	**6,751,017**	**32%**

Table 14.66 Newcastle LM – WSIG Projects (2019/2020)

Name of project	Estimated project cost	Project stage	2019/2020 Allocation	Transferred as at 22 Nov 2019	Expenditure as at 31 Dec 2019	% Expenditure against transferred
Osizweni Pressure Management	154,000,000	Planning	8,000,000	R20,000,000	844,213	40%
Newcastle West Pressure Management		Planning	6,000,000		0	
Newcastle Madadeni Metre Replacement		planning	9,000,000		5,275,280	
Non Revenue Water Loss Reduction		Construction	10,000,000		4,769,698	
Newcastle East Water Supply	81,000,000	Planning	6,400,000		982,011	
Awareness Campaign		Ongoing	600,000		99,800	
TOTAL	**235,000,000**		**40,000,000**	**R20,000,000**	**11,971,001**	**40%**

Table 14.67 uMzinyathi DM – WSIG Projects (2019/2020)

Name of project	Estimated project cost	Project stage	2019/2020 Allocation	Transferred as at 22 Nov 2019	Expenditure as at 31 Dec 2019	% Expenditure against transferred
Makhabeleni Water Project	27,160,800	construction	22,160,800	35,000,000	15,614,898	100%
Biggarsberg Water Treatment Works	8,720,186	Tender	8,720,186		0	
Tayside Water Abstraction pipeline	15,179,831	Tender	2,306,409		0	
Lilani Water Scheme	23,940,000	construction	15,940,000		10,469,155	
Othame water Reticulation (Othame & Ngubevu)	2,482,717	construction	2,482,717		2,482,717	
KwaJama Water Supply Scheme	3,693,593	construction	3,693,593		3,693,593	
KwaKopi Water Supply Scheme	25,208,072	construction	13,070,297		3,427,904	
TOTAL	**106,385,199**		**68,374,000**	**35,000,000**	**35,000,000**	**100%**

(i) Long-Term Recommendations

1) **Ncandu Dam:** In 2016, RHDHV conducted a Pre-Feasibility Study for the areas within the Buffalo Catchment. One of the options investigated was the proposed construction of a dam on a major tributary of the Ncandu River. In V31H (quaternary catchment), a dam on a tributary of the Ncandu River has been investigated in other previous studies and was considered in the RHDHV Pre-Feasibility study. **Figure 14.54** shows a Google Earth image of the proposed location of the dam. The catchment of this proposed dam is 54.80 km^2 and it is mainly mountainous terrain. The only land uses in V31H are relatively small areas of afforestation comprising 0.9 km^2 and alien vegetation of 0.8 km^2. These areas of afforestation and alien vegetation have been assumed to be downstream of the proposed site as the upstream areas are very steep.

   A program called "RESNEW" was used by RHDHV to determine the yield of the proposed Ncandu Dam. In order to determine the Ecological Water Requirement (EWR), the Hughes Desktop Reserve model was used. This model requires the naturalised inflow, i.e. without any man-made influence, the management class of the river for that quaternary catchment which is a B class and the region number which is 15. The resulting EWR was calculated as 28% of the mean annual runoff of 11.4 million m^3/annum.

   RESYLD was run from 1920 to 2014 with a constant monthly demand. The historical firm yield, with the EWR, was calculated as 5.04 million m^3/annum (13.8Mℓ/day). Without the EWR the yields would be 7.68 million m^3/a. Newcastle and surrounds will face a deficit in regards to raw water availability in the future (by 2035) (even with WCWDM). The construction of this dam is therefore a medium term option that is being considered at present (affordability studies under way. The total cost of the dam is estimated at **R1 billion** (was estimated by Ncandu Water Pty Ltd in 2013 as R 975 mill excluding VAT). Note that Ncandu Water estimated the storage capacity of this dam to be 19.15 million m^3 with the cost of delivered raw water at R 3.43/kℓ (Ncandu 2013: 28). Further motivation for the construction of the Ncandu Dam is provided by the unreliability of the major rivers in recent years, as per the quote below:
   "Both the Ngagane and Buffalo rivers have run dry on a regular basis in the past decade. This has prevented Newcastle LM to abstract its full allocation of water from these sources, which has exacerbated the existing supply shortages." (Ncandu 2014: 50)

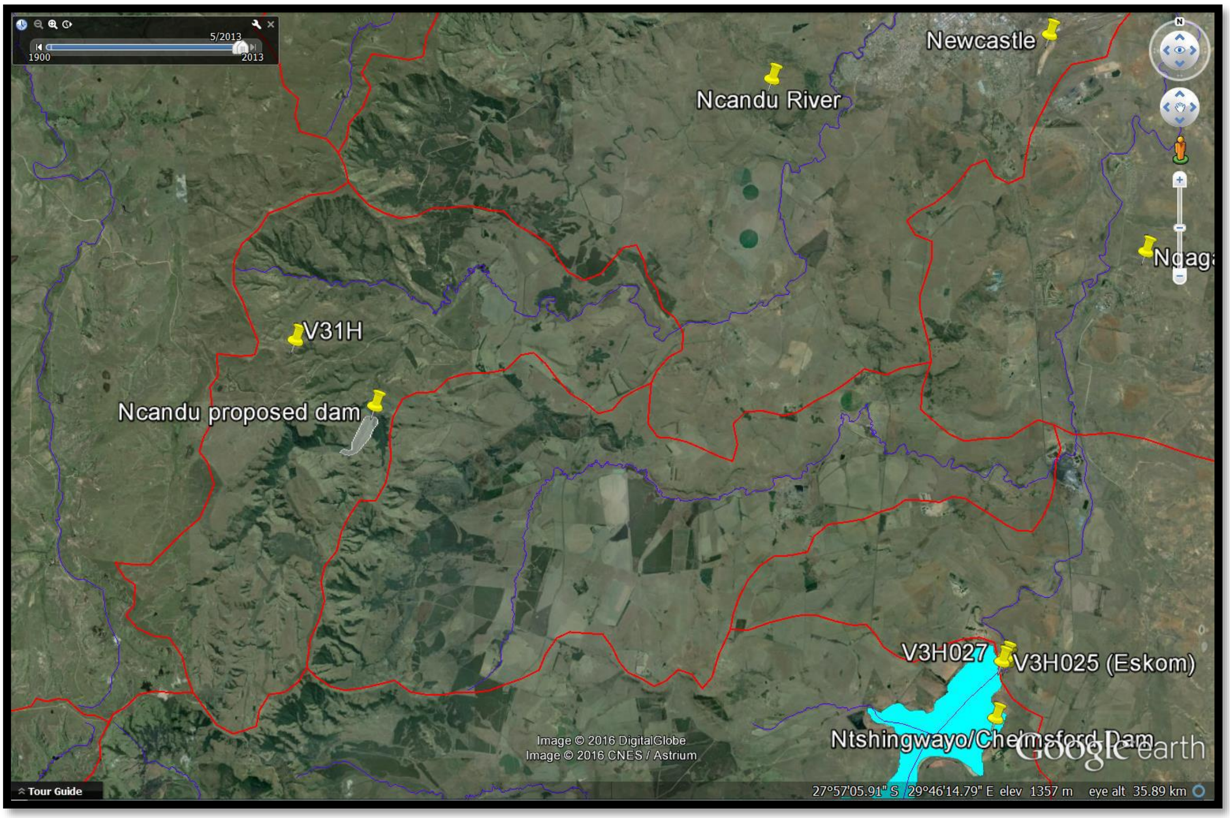

Figure 14.54 Proposed Location of Ncandu Dam (RHDHV 2016: 32)

2) **Investigate the possibility of a dam/s on the Buffalo or Blood river, to benefit Vants Drift WTP.** In order to ensure security of raw water during periods of low flow in the Buffalo and Blood Rivers (Winter), a study should be undertaken to identify sites for a dam on either the Buffalo or Blood Rivers (in the vicinity of the Vants Drift WTP). The Vants Drift WTP is located just after the convergence of these two rivers, and struggles to abstract sufficient volumes of raw water during the Winter months. The rivers carry a high silt load at this point and the uMzinyathi DM has therefore shown greater interest in an off channel dam and preference to a dam upstream of the Vants Drift WTP. The previous administration of uMzinyathi DM had drafted proposals to DWS in regards to a series of coffer dams (off channel) on the Buffalo River but no funding approval was granted. This pre-feasibility study would cost in the region of **R7.5 million**.

3) **Investigate the possibility of a dam on the Ngogo River:** The uThukela Water Bulk Master Plan of 2012 (by Jeffares and Green Pty Ltd) recommends the construction of a dam on the Ngogo River, just upstream of the convergence with the Buffalo River. The yield of this dam would assist the Ngagane WTP to cater for the outer years, as the Buffalo and Ngagane Rivers abstractions are not reliable in the Winter months. This proposed dam would ease the demand on the Ntshingwayo Dam and such a pre-feasibility study should provide and indicative yield and storage capacity. The study would cost in the region of **R7.5 million**.

4) **Upgrade the Ngagane WTP**: The design capacity of the Ngagane WTP is 130 Mℓ/day and urgently requires upgrading as its' design capacity is less than the theoretical demand of its

intended supply area i.e. backlogs in a number of outlying areas cannot be eradicated. Newcastle LM have reported high water losses within the expansive areas of Madadeni and Osizweni. Whilst the WCWDM in Madadeni and Osizweni is a short term (and compulsory) intervention, the need to upgrade the Ngagane WTP is still evident.

At least three more modules (30 Mℓ/day each) could be constructed at (or in the vicinity of) the Ngagane WTP in order to boost the design capacity to 220 Mℓ/day. This would cater for the 2050 water demand of the supply area (Newcastle LM and much of Amajuba DM). The first module should begin as soon as the project is implementation ready due to the current deficit. The second module must be commissioned by 2040, and the third by 2050. This would only be possible with increased raw water supply from the Ntshingwayo Dam, Ngagane River and Buffalo River. A complete review of the historical water use licences and allocations within the Buffalo water resource system should be undertaken. **Note:** A business plan submitted by Newcastle LM is in the process of being appraised by DWS, for an upgrade of 30 Mℓ/day to the existing 130 Mℓ/day Ngagane WTP. This would include the installation of a new 1m diameter raw water main from Ntshingwayo Dam to Ngagane WTP, among other bulk infrastructure upgrades. If the BP is approved, then this recommendation would be reviewed to state that a further two modules (providing a further 60 Mℓ/day in total) would be required at the Ngagane WTP by 2050 (first module must be commissioned by 2040, and the second by 2050).

5) **Build a new WTP at Ntshingwayo Dam (Ntshingwayo WTP):** The uThukela Water Bulk Master Plan of 2012 (by Jeffares and Green Pty Ltd) recommends the construction of a new WTP at the Ntshingwayo Dam and UW support the undertaking of a pre-feasibility study for a variation of this recommendation. It is proposed that the new WTP have a design capacity (at least) equal to the allocation from the Ntshingwayo Dam. The current allocation from the dam is 113.5 Mℓ/day and the new WTP would cost in the region of **R2.7 billion (**based on a 120 Mℓ/day WTP). This price includes high lift pumps, bulk pipes and reservoirs and the project would serve Durnacol, Dannhauser, Buffalo Flats (expansive area), Alcockspruit, Balangeigh, Kilbarchan, Eskom Village, Ingagane and (Ingagane Colliery), Bosworth, Ekuseni, Mpondo, Steildrif, Zenzelani and Gardenia Colliery. Pumping costs of potable water would be decreased considerably for Newcastle and there would be an increase in assurance of supply resulting from a ring-feed bulk system.

   The existing raw water mains from the dam to existing Ngagane WTP would then become potable water gravity pipelines. The existing Ngagane WTP would continue to operate, but only with its existing raw water supply from the Buffalo River and Ngagane River (a cumulative sum of 60 Mℓ/day). The existing Ngagane WTP would then have spare capacity, to cater for increasing water demand in the outer years and Newcastle would have a greater assurance of supply as a result of potable water being obtained from two WTPs. uThukela Water intends requesting an increase in the existing allocation from Buffalo River (would be linked to increase in releases from Zaaihoek dam) and Ngagane River in order to meet future water demand. Further raw water could be sourced from proposed small dams upstream at Ngogo River as described in 3) above (and one possible on the Womeni River). It is recommended that a pre-feasibility study is carried out in order to determine the viability of this option. This pre-feasibility study would cost in the region of R 8 million.

6) **Remote areas**: In order to attain universal access in Amajuba DM (including Newcastle LM) the communities of Groenvlei and Ingogo would have to receive potable water and the following must be investigated:

- **Ingogo**: The settlement of Ingogo is 14kms from the Signal Hill reservoir of Newcastle, but the number of high ridges between the two points renders this option unviable. Therefore, a standalone scheme at the small community of Ingogo, sourcing water from the nearby Ngogo River, should be investigation.

- **Groenvlei**: The settlement of Groenvlei cannot be supplied from the uTrecht WTP due to the required pumping lift being in excess of 800m (to get to Groenvlei) (4 pumping lifts). A standalone scheme, at the small community of Groenvlei, sourcing water from the nearby Slang River, should be investigation.

- **Swartkop and Boeshoek**: Utrecht has a 4 Mℓ/day plant (that could be upgraded) as well as access to potable water from uThukela Water (existing pipeline that terminates at Utrecht). Consequently, the small settlements of Swartkop and Boeshoek could be supplied with water from this scheme. An investigation should be undertaken to determine possible pipe routes and this would then prove the feasibility or non-feasibility of supply from this source.

- All of the areas mentioned above under **5)** are particularly remote and pose a challenge in terms of feasible water supply options. A single feasibility study should be commissioned in order to assess the viability of the various options of feeding the areas of Ingogo, Groenvlei, Swartkop and Boeshoek. The feasibility study would cost approximately **R3 million**.

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