108/114/12/R3

UMKHOMAZI WATER PROJECT

MODULE 3 – POTABLE WATER MODULE

Detailed Feasibility Study

Water Demand Projections and Phasing of Infrastructure

Revision 1

October 2015

Planning Services
Engineering & Scientific Services
Umgeni Water

Prepared By:
Knight Piésold CONSULTING
171 Rodger Sishi Road, Westville, 3630

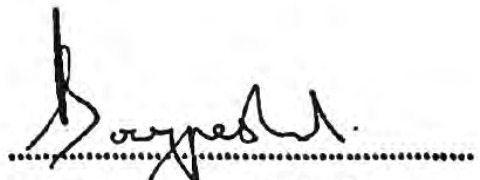
UMGENI WATER **OCTOBER 2015**

uMkhomazi Water Project

Detailed Feasibility Study - Water Demand Projections and Phasing of Infrastructure

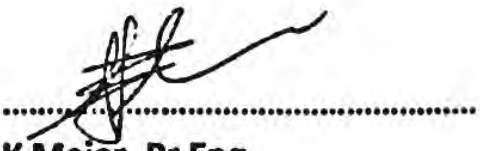
Report No. 108/114/12/R3

Prepared by Knight Piésold Consulting



A Doorgapershad, Pr Eng
Study Leader: Knight Piésold Consulting

Approved for Umgeni Water Planning Services by:



K Meier, Pr Eng
Manager: Planning Services

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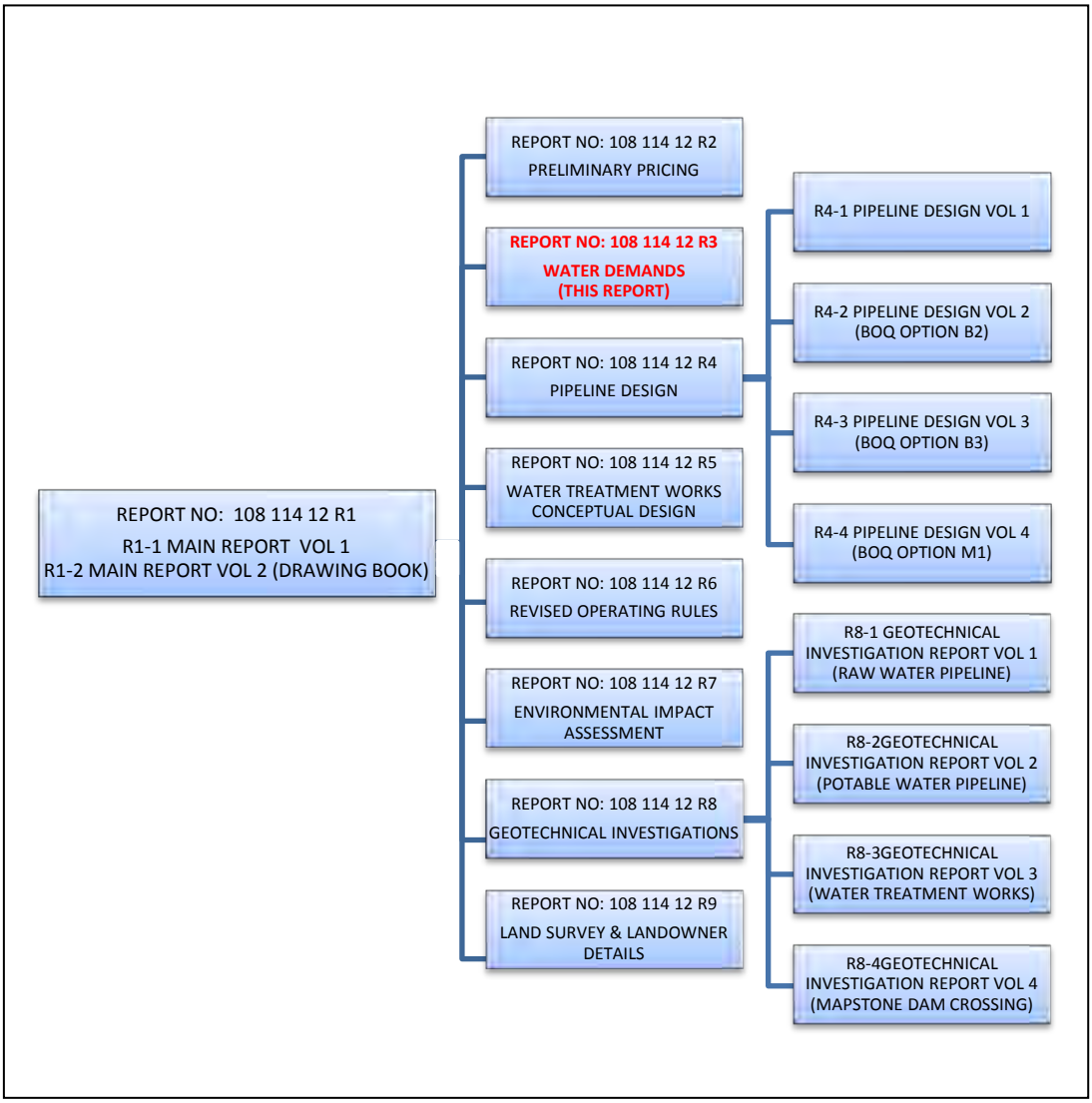
UMKHOMAZI WATER PROJECT

MODULE 3 – POTABLE WATER MODULE

Structure of Suite of Reports



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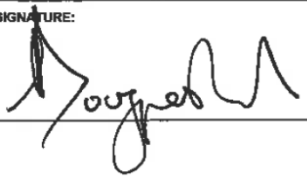
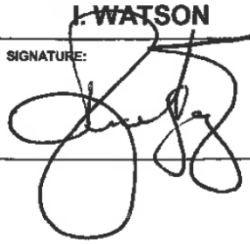
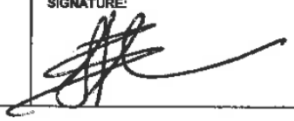
CLIENT APPROVAL	SIGNATURE: 	SIGNATURE: 	SIGNATURE: 

Knight Piésold (Pty) Limited

P O Box 221
RIVONIA
2128
Tel. +27 11 806-7111
Fax. +27 11 806-7100
E mail : enquiries@kprsa.co.za
Web site : www.knightpiesold.com

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List of acronyms used in this report

UW	-	Umgeni Water
EWS	-	eThekwini Water & Sanitation
UDP	-	Ultimate Developable Potential
WTW	-	Water Treatment Works
SDF	-	Spatial Development Framework
THD	-	Tongaat Hulett Developments
AADD	-	Average Annual Daily Demands
WYB	-	Wyebank
PTN	-	Pinetown
NA	-	Northern Aqueduct
WA	-	Western Aqueduct

1. Purpose of this Report

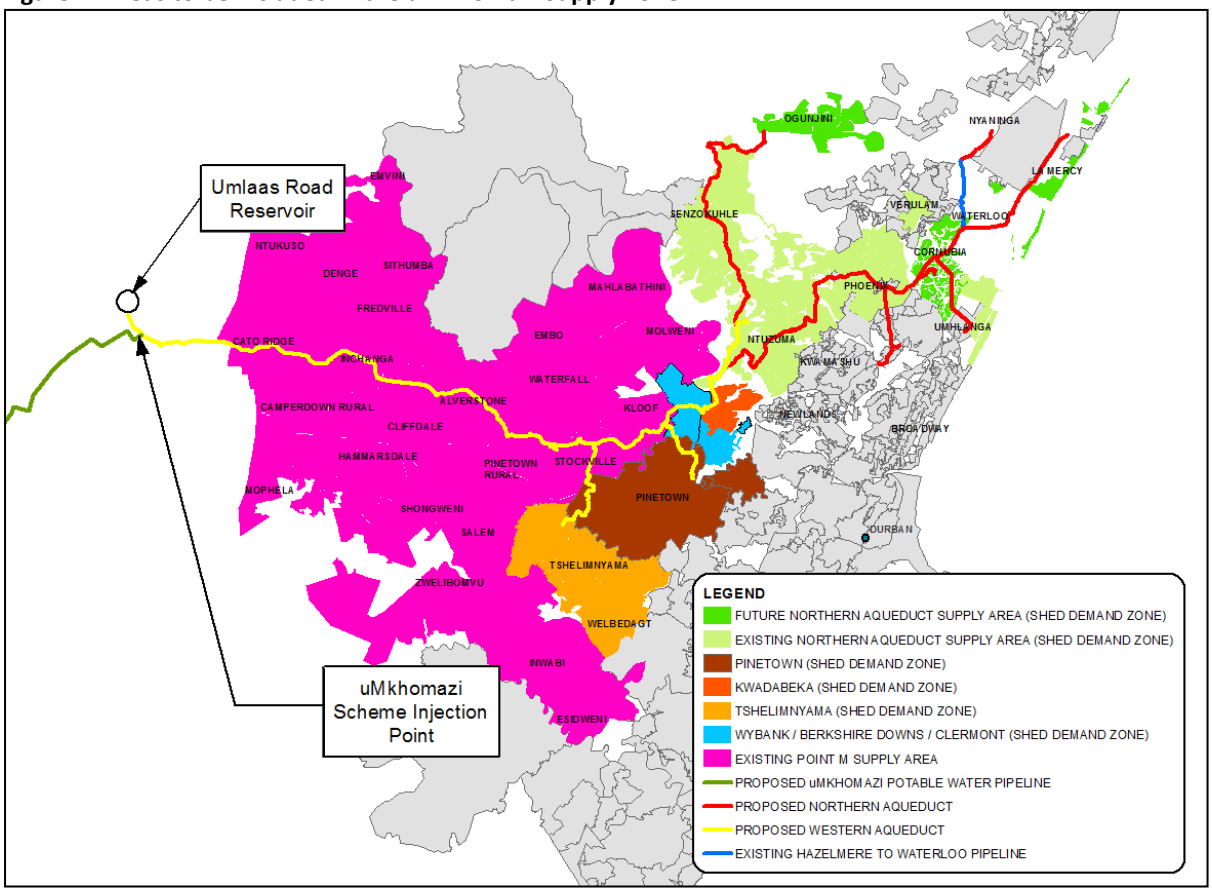
The primary purpose of this report is to estimate water demands over a 40-year analysis period between 2013 and 2053 for the proposed uMkhomazi Scheme. In addition, the report discusses the proposed phasing of potable water infrastructure.

2. Areas to be included in the uMkhomazi Supply Zone

The areas to be supplied through the uMkhomazi scheme via the Western Aqueduct can be broadly split into the existing area supplied from Point M and the shed demands which are presently supplied from Durban Heights Water Treatment Works (WTW) and Hazelmere WTW. This split has been introduced to create a distinction between existing demands and 'load shedding' to avoid pumping costs.

The areas that will contribute to the water demands from the uMkhomazi Scheme are depicted in **Figure 1** and listed under **items 2.1** and **2.2**.

Figure 1: Areas to be included in the uMkhomazi Supply Zone



2.1. Existing Supply Zone

The existing supply area lies between Point M in Cato Ridge and Abelia Road Reservoir in Kloof. This supply area is also known as the Western supply area comprising eThekwini Water and Sanitation's (EWS) Outer West region and part of the EWS Inner West region. The supply to this area presently comes from Midmar WTW.

This zone presently receives potable water from Umgeni Water's Midmar Mgeni System. The pipeline system that delivers water to this zone comprises Umgeni Water's '61 Pipeline and '57 Pipeline as well as Phase 1 of EWS's Western Aqueduct Pipeline. The inclusion of this zone as part of the proposed uMkhomazi supply zone is part of Umgeni Water's long term plan to reserve the water in the Upper Mgeni System for growth in demand in the greater Pietermaritzburg region, i.e. Midmar WTW will cease to supply this area once the proposed uMkhomazi Scheme is operational.

Phase 2 of EWS's Western Aqueduct Pipeline will have to be completed in order to transfer water to where it is required in this zone. This zone is depicted in **Figure 2**.

2.2. Shed Demand Zones

2.2.1. Shed Demand Zones Presently Supplied From Durban Heights Waterworks

The Durban Heights supply zones to be included as part of the uMkhomazi supply area are:

- The Pinetown supply zone which forms part of the Inner West region.
- The Tshelimnyama supply zone in the south.
- The KwaDabeka supply zone in the northwest.
- The Wyebank / Berkshire Downs / Clermont supply zone in the west.
- Part of the Northern Aqueduct supply zone in the north including Ntuzuma, Mzinyathi, Mgangeni, Senzokuhle, Kwa Silwane Ngonweni Phoenix and Umhlanga.

The supply to these zones from the uMkhomazi Scheme requires Phase 2 of the Western Aqueduct Pipeline to be constructed to deliver water to the Pinetown, Tshelimnyama, KwaDabeka, Wyebank and Ntuzuma zones. In addition, the new Northern Aqueduct Pipeline that will link to the Western Aqueduct will be required to supply water to a portion of the existing northern supply zone between Phoenix and Umhlanga as well as the Mzinyathi, Mgangeni, Senzokuhle, Kwa Silwane and Ngonweni areas.

These zones are depicted in **Figure 13**.

2.2.2. Shed Demand Zones Presently Supplied From Hazelmere Waterworks

The Hazelmere Waterworks supply zones to be included as part of the uMkhomazi supply area are Waterloo, iNyaninga, Zimbali South, Westbrook and La Mercy. Although Hazelmere Waterworks has sufficient capacity to meet the existing demands from these zones, it cannot meet the predicted future demands as a result of a limitation on the yield of the Hazelmere Dam.

The Waterloo, iNyaninga, Zimbali South, Westbrook and La Mercy zones can initially be supplied from Durban Heights WTW when Hazelmere WTW runs out of capacity, but these zones will ultimately become part of the uMkhomazi supply zone when Durban Heights no longer has the capacity to supply. Phase 2 of the Western Aqueduct Pipeline and the new Northern Aqueduct Pipeline will be required to supply water to the Waterloo and iNyaninga zones. In addition, the proposed Waterloo to La Mercy link will be required to deliver water to the Zimbali South, Westbrook and La Mercy zones.

These zones are depicted in **Figure 20**.

2.2.3. Shed Demand Areas presently supplied from Ogunjini Waterworks

A portion of the Ogunjini Waterworks supply zone is planned to be included as part of the uMkhomazi supply zone. A link has been proposed between the future Northern Aqueduct at Senzokuhle and Ogunjini 4 Reservoir to provide a nominal supply of water to Ogunjini.

Phase 2 of the Western Aqueduct as well as the proposed new Northern Aqueduct from Ntuzuma to Kwa Silwane and Ogunjini will be required to deliver water to Ogunjini.

This zone is depicted in **Figure 20**.

3. Methodology for Water Demand Projections

3.1. Existing Water Demands

The starting point for projecting demands for the uMkhomazi scheme was to understand the existing demands for the envisaged supply area. In order to improve the accuracy of the existing demands, where possible, individual reservoir zones were grouped into clusters whose summated demands could be verified by bulk meters that are read regularly or that are linked to telemetry. This removed the need to know the demands at each reservoir and increased the confidence in the existing demands by addressing the following problems:

- Individual reservoir zones that were not metered.
- Bi-directional metered zones where there was uncertainty regarding the water balance in the zone.
- Zones supplied from multiple reservoirs, where the contribution from each reservoir was uncertain.
- Lack of historical data as a result of flow logging on an intermittent and rotational basis.

The above methodology was applied wherever a bulk meter with a sufficient history of sales data was able to be linked to a group of reservoir supply zones identified to be supplied from the uMkhomazi Scheme. Where it was not possible to apply this methodology, the existing demands for a zone were estimated by summing up the individual reservoir demands making up the zone to be supplied.

Where a history of sales data was available, the 2013 demand was calculated as the 12 month moving average for monthly sales data as at June 2013.

3.2. Projected Water Demands

3.2.1. Demand Information Based on Spatial Development Framework

The projected water demands in this report are largely sourced from water demand estimates that have been based on eThekwini Municipality's Spatial Development Planning process. eThekwini Water and Sanitation has engaged the services of the engineering consultant Brendan Magill, who has developed a data set of ultimate water demands for the city. The methodology that has been used by Brendan Magill is as follows.

- Using eThekwini's Spatial Development Framework and Spatial Development Plans, all areas earmarked for new development, densification or infill development were identified.
- The extent of development allowed for was up to the ultimate developable potential (UDP) of the areas earmarked for development, i.e. once all these areas are fully developed, no further development can take place and these areas would be considered to have reached their UDP.
- It was assumed that UDP for the city as a whole would be reached in the year 2153, i.e. a 150 year planning horizon. Individual zones could reach their UDP before this date, depending on the urgency and funding available for the development.
- Water demands were allocated to new housing, commercial and industrial developments in accordance with the envisaged levels of service of the respective developments.
- Water demands were generated per reservoir supply zone. For each reservoir zone, an existing (2013) and ultimate (2153) water demand was provided. No data was provided on the timing of individual developments.

Based on eThekwini's published Spatial Development Framework, Knight Piésold identified the areas that had been targeted as high priority projects. A key element of information that is missing from both the Spatial Development Framework and the Spatial Development Plans, is the timing and sequence of the priority projects.

The Spatial Development Framework however lists the following as "Catalytic Projects". These were adopted as the highest priority for water demand projection purposes with the exception of the Port / Back of Port project which will not be supplied from the uMkhomazi Scheme.

- Cornubia
- Cato Ridge
- Tongaat/Dube Trade Port and Surrounds and
- Port / Back of Port projects

For the purposes of the demand projection exercise, two scenarios were considered, i.e. Low Road and High Road scenarios, representing respectively a moderate view and an optimistic view on the pace of development that can be expected in the region.

For the Low Road scenario:

- Catalytic projects were assumed to reach their UDP in a 40 year period (2053).
- Priority projects were assumed to reach their UDP in a 70 year period (2083).

For the High Road scenario:

- Catalytic projects were assumed to reach their UDP in a 30 year period (2043).
- Priority projects were assumed to reach their UDP in a 60 year period (2073).

It is therefore implicitly assumed that areas in the north and west of Durban will generally be the highest priority for new development, while areas in the south will generally be the lowest priority. This implies that areas to the south could take between 70 and 150 years to reach their UDP in terms of new development. It is possible that non-priority projects in all areas could be developed concurrently with the priority projects, albeit with much longer development durations.

These assumptions generally tie in with the sentiments expressed in eThekwini's SDF.

3.2.2. Demand Information Provided by Tongaat Hulett Developments

For the developments planned north of Durban, the majority of the proposed property development projects are by private developers and in particular, Tongaat Hulett Developments (THD). THD engaged the services of SMEC Consulting Engineers to carry out town planning and engineering design services for the proposed developments. The SMEC brief included developing water demand projections for all the Tongaat Hulett developments in the north.

The water demand forecasts for the north were developed by allocating a per capita demand to the number of individuals estimated to occupy the planned housing developments. The per capita demand was allocated in accordance with income levels and the nature of the housing development. Water demand from commercial developments was estimated by allocating average consumption per unit of floor area to the total area of the commercial developments.

The water demands produced by SMEC were thought to be too optimistic by EWS, who then carried out an exercise to temper these projections by applying earliest dates for the provision of in particular, sanitation infrastructure to serve the developments. The bulk of the uMkhomazi water demands for the north are based on the 'tempered' SMEC water demands.

The future developments and related water demands for eThekwini's northern region are therefore known with a high degree of confidence as a result of extensive planning projects that have been undertaken by THD and EWS.

3.2.3. Demand Information Provided by eThekwini Water & Sanitation

In some instances, water demands have been included based on information supplied directly from EWS. These are developments that EWS felt were not covered adequately by the SDF. In particular these are:

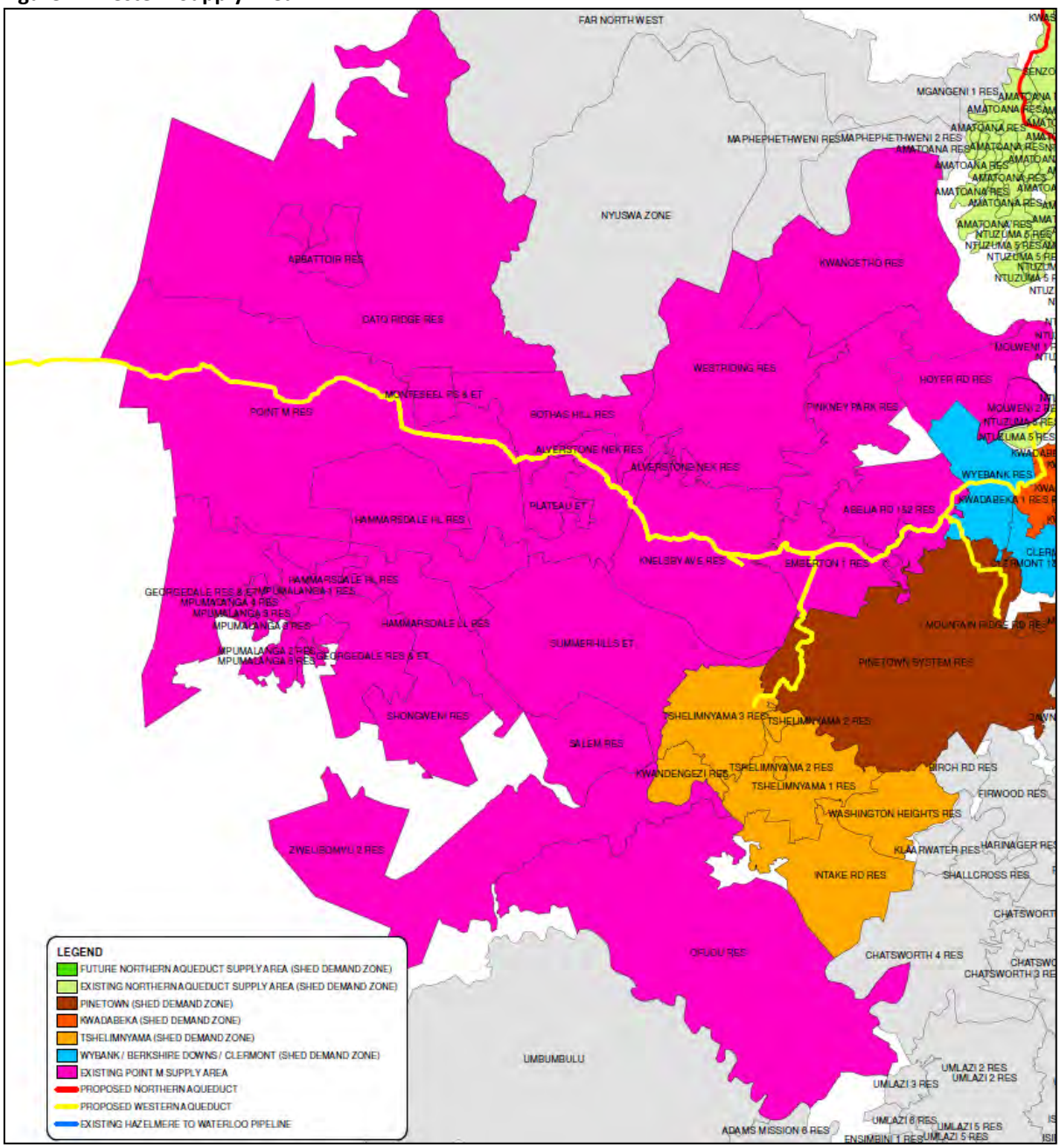
- The Mzinyathi to Ogunjini region, where water demand is expected to grow very quickly after the initial provision of water to the region. The reason for the expected 'stepped' growth is that the region is presently the lowest priority in the north and when the Northern Aqueduct water supply system cannot cope with the demand from Mzinyathi, the supply is turned off in order that the Ntuzuma region does not run out of water. When a new supply of water is provided from the uMkhomazi scheme via the Western Aqueduct, it is expected that the demand that is not presently being met by the existing system, will cause an apparent sharp increase in demand.
- Metro Housing developments in the north. These are low to middle income housing developments that may not be adequately catered for in the SDF.

4. Water Demand Projections

4.1. Western Area

The individual reservoir supply zones that make up the Western Area are Abelia Rd Reservoir, Alverstone Nek Reservoir, Bothas Hill Reservoir, Cato Ridge Abattoir, Cato Ridge Reservoir, Emberton Reservoir, Georgedale Reservoir & Et, Hammarsdale HL Reservoir, Hammarsdale LL Reservoir, Hoyer Reservoir (Ex Crestholme), Knelsby Park Reservoir, Kwanqetho Reservoir, Molweni 1 Reservoir, Molweni 2 Reservoir, Monteseel PS & ET, Mpumalanga 1 Reservoir, Mpumalanga 2 Reservoir, Mpumalanga 3 Reservoir, Mpumalanga 4 Reservoir, Mpumalanga 6 Reservoir, Ofudu Reservoir, Pinkney Park Reservoir, Plateau ET Reservoir, Point M Reservoir, Salem Reservoir, Shongweni Reservoir, Summerhills ET, Westriding Reservoir and Zwelibomvu 2 Reservoir. The Western area is depicted in **Figure 2**.

Figure 2: Western Supply Area

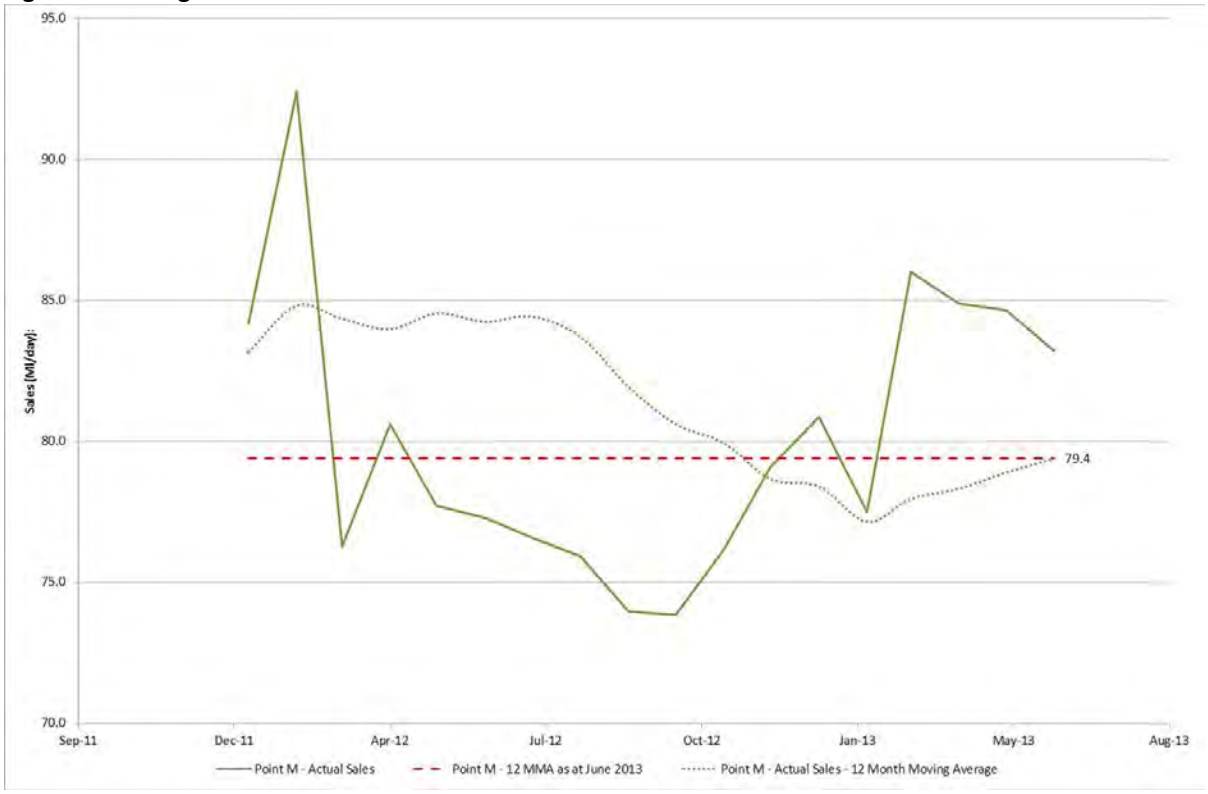


4.1.1. Existing Western Area Demands

EWS's Western Aqueduct Phase 1 was commissioned in 2011. This pipeline serves the entire Western area that was previously supplied from the old '57 Pipelines via "Point X". All flow passing through this pipeline is measured by electromagnetic flow meters installed at Point M. These meters became operational in December 2011. There is therefore an accurate measure of flow into the Western Aqueduct over a period of nineteen months. The existing demand for the EWS Western area is therefore known and there is a high degree of confidence in its accuracy. Sales data prior to December 2011 is available but has not been used as EWS believes it to be inaccurate.

The Average Annual Daily Demand (AADD) for the Western area up to June 2013 has been calculated to be 79.4 Ml/day as indicated in **Figure 3**.

Figure 3: Existing Demands – Western Area



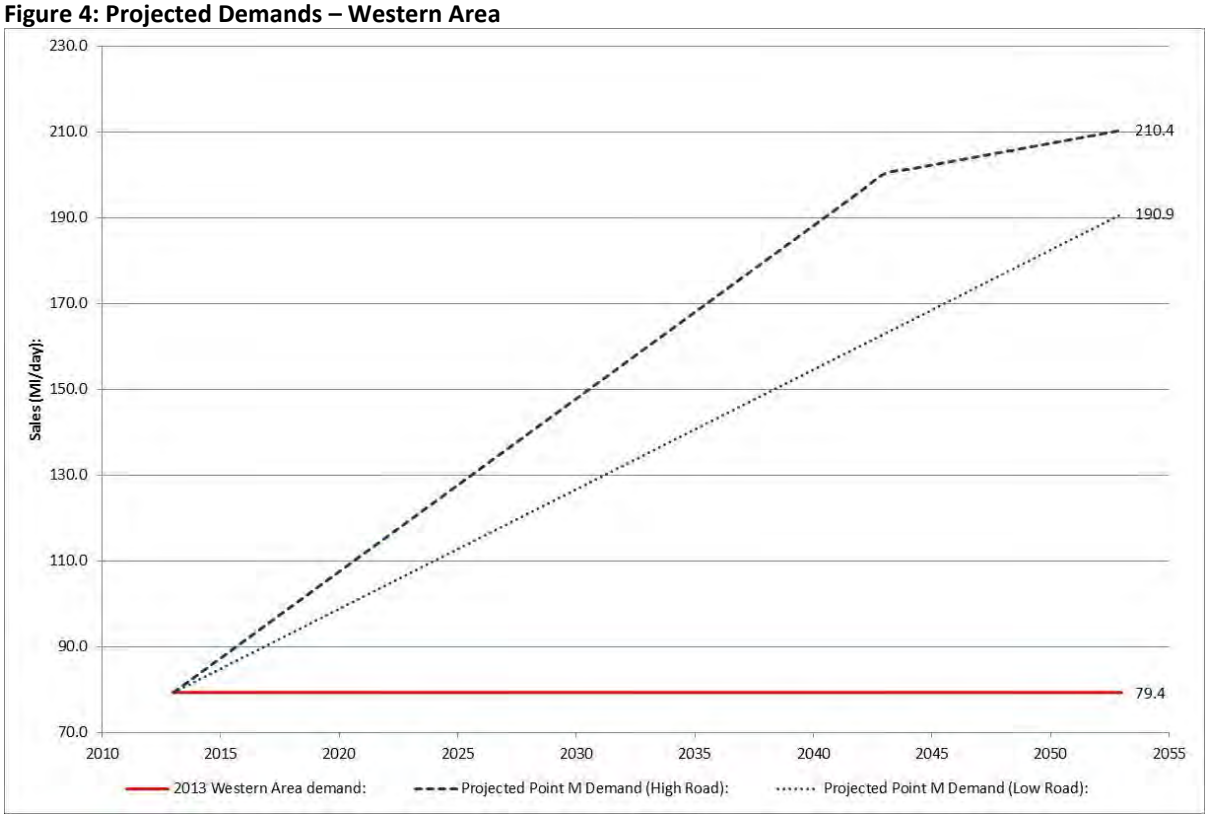
4.1.2. Future Western Demands

Future demands for the Western area are listed in **Table 1** and depicted in **Figure 4**.

		High Road:					Low Road:				
Reservoir Zone:	**2013**	**2023**	**2033**	**2043**	**2053**	**UDP in:**	**2023**	**2033**	**2043**	**2053**	**UDP in:**
ABELIA RES	0.0	0.1	0.2	0.3	0.4	2073	0.1	0.2	0.2	0.3	2083
ALVERSTONE NEK RES	0.0	0.6	1.2	1.8	2.4	2073	0.5	0.9	1.4	1.9	2083
BOTHAS HILL RES	0.0	0.3	0.5	0.8	1.0	2073	0.2	0.4	0.6	0.8	2083
CATO RIDGE ABBATTOIR	0.0	1.0	2.1	3.1	3.1	2043	0.7	1.4	2.1	2.8	2053
CATO RIDGE RES	0.0	4.4	8.9	13.3	13.3	2043	3.0	5.9	8.9	11.8	2053
EMBERTON RES	0.0	0.0	0.1	0.1	0.1	2073	0.0	0.1	0.1	0.1	2083
GEORGEDALE RES & ET	0.0	2.6	5.2	7.9	7.9	2043	1.7	3.5	5.2	7.0	2053
HAMMARSDALE HL RES	0.0	6.5	13.1	19.6	19.6	2043	4.4	8.7	13.1	17.5	2053
HAMMARSDALE_LL_RES	0.0	1.8	3.6	5.4	5.4	2043	1.2	2.4	3.6	4.8	2053
HOYER RES (EX CRESTHOLME)	0.0	0.2	0.4	0.6	0.8	2073	0.2	0.3	0.5	0.6	2083
KNLESBY PK RES	0.0	1.2	2.4	3.5	4.7	2073	0.9	1.8	2.7	3.6	2083
KWANQETHO RES	0.0	0.5	1.0	1.5	1.9	2073	0.4	0.7	1.1	1.5	2083
MOLWENI 1 RES	0.0	0.0	0.1	0.1	0.1	2073	0.0	0.0	0.1	0.1	2083
MOLWENI 2 RES	0.0	0.1	0.2	0.2	0.3	2073	0.1	0.2	0.3	0.4	2053
MONTESEEL PS & ET	0.0	0.0	0.0	0.0	0.1	2073	0.0	0.0	0.0	0.0	2083
MPUMALANGA 1 RES	0.0	0.4	0.8	1.2	1.2	2043	0.3	0.5	0.8	1.1	2053
MPUMALANGA 2 RES	0.0	0.5	1.0	1.5	1.5	2043	0.3	0.7	1.0	1.3	2053
MPUMALANGA 3 RES	0.0	0.0	0.0	0.0	0.0	2043	0.0	0.0	0.0	0.0	2053
MPUMALANGA 4 RES	0.0	0.0	0.0	0.1	0.1	2043	0.0	0.0	0.0	0.0	2053
MPUMALANGA 6 RES	0.0	0.1	0.2	0.3	0.3	2043	0.1	0.1	0.2	0.3	2053
OFUDU RES	0.0	1.1	2.3	3.4	4.6	2073	0.9	1.7	2.6	3.5	2083
PINKNEY PARK RES	0.0	0.1	0.2	0.3	0.5	2073	0.1	0.2	0.3	0.3	2083
PLATEAU ET RES	0.0	0.2	0.3	0.5	0.7	2073	0.1	0.3	0.4	0.5	2083
POINT M RES	0.0	12.7	25.5	38.2	38.2	2043	8.5	17.0	25.5	34.0	2053
SALEM RES	0.0	0.4	0.9	1.3	1.8	2073	0.3	0.7	1.0	1.4	2083
SHONGWENI RES	0.0	0.0	0.1	0.1	0.2	2073	0.0	0.1	0.1	0.1	2083
SUMMERHILLS ET	0.0	1.9	3.7	5.6	7.4	2073	1.4	2.8	4.2	5.7	2083
WESTRIDING RES	0.0	2.2	4.3	6.5	8.6	2073	1.6	3.3	4.9	6.6	2083
ZWELIBOMVU 2 RES	0.0	1.2	2.4	3.6	4.8	2073	0.9	1.8	2.8	3.7	2083
Future Western Area demand:	**0.0**	**40.3**	**80.6**	**120.9**	**131.1**	-	**27.9**	**55.8**	**83.6**	**111.5**	-
2013 Western Area demand:	**79.4**	**79.4**	**79.4**	**79.4**	**79.4**	-	**79.4**	**79.4**	**79.4**	**79.4**	-
Projected Western Area demand:	**79.4**	**119.7**	**160.0**	**200.3**	**210.4**	-	**107.3**	**135.1**	**163.0**	**190.9**	-

Table 1: Projected Water Demands Western Area

Figure 4: Projected Demands – Western Area



4.2. Pinetown and Wyebank-Berkshire Downs Supply Area:

The individual reservoir supply zones that make up the Pinetown-Wyebank-Berkshire Downs Supply Area are Mount Moriah, Haygarth Road, Jerome Drive, Wyebank, Berkshire Downs, Clermont 1, 2, 4 & 5 and KwaDabeka 5. The Pinetown-Wyebank-Berkshire Downs Supply Area is depicted in **Figure 5**.

4.2.1. Existing Pinetown and Wyebank-Berkshire Downs Demands

Potable water is presently pumped from Durban Heights Waterworks to the Pinetown, Wyebank and Berkshire Down systems via several rising mains. Umgeni Water sells water to EWS into this system at the fence of Durban Heights WTW. The sales into this system are therefore metered with a long historical record, thereby allowing a high level of confidence in the existing demands to this zone.

In the future envisaged configuration of the Western Aqueduct, the Pinetown and the Wyebank-Berkshire Downs zones will be supplied from separate offtakes. For the sake of accuracy for the demand projection exercise however, they have been grouped together to benefit from the historical sales data into the combined system.

Sales data indicates that the AADD for this system is 47.8 Ml/day as indicated in **Figure 6**.

Figure 5: Pinetown-Wyebank-Berkshire Downs Supply Area

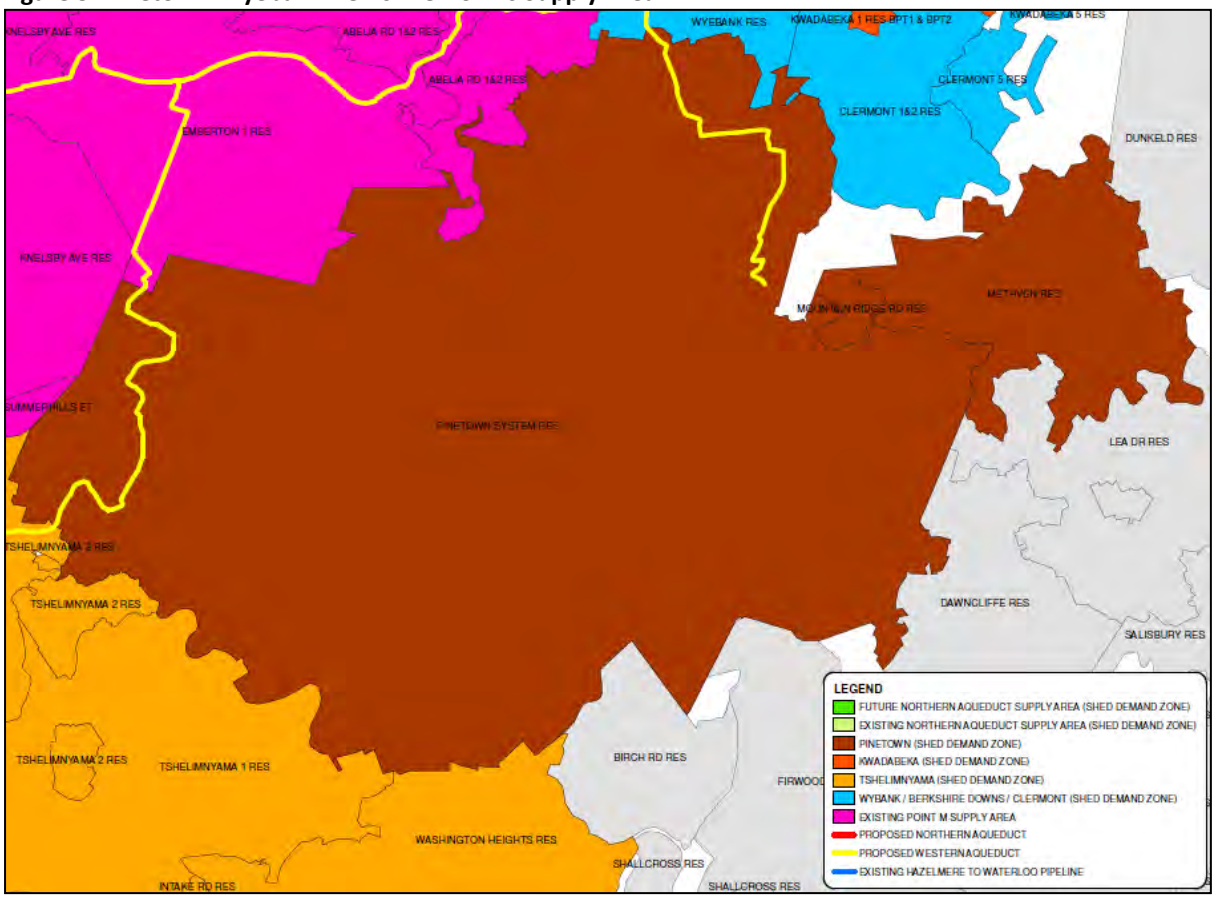
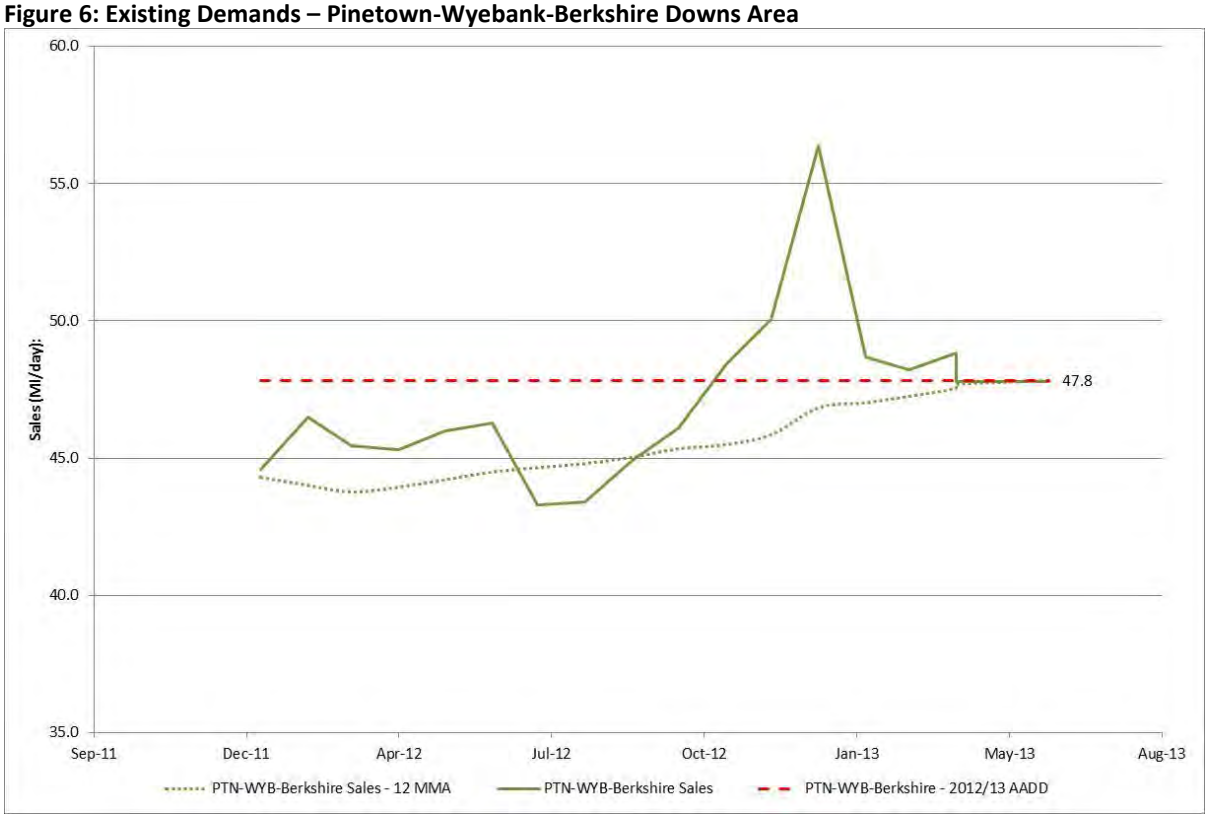


Figure 6: Existing Demands – Pinetown-Wyebank-Berkshire Downs Area



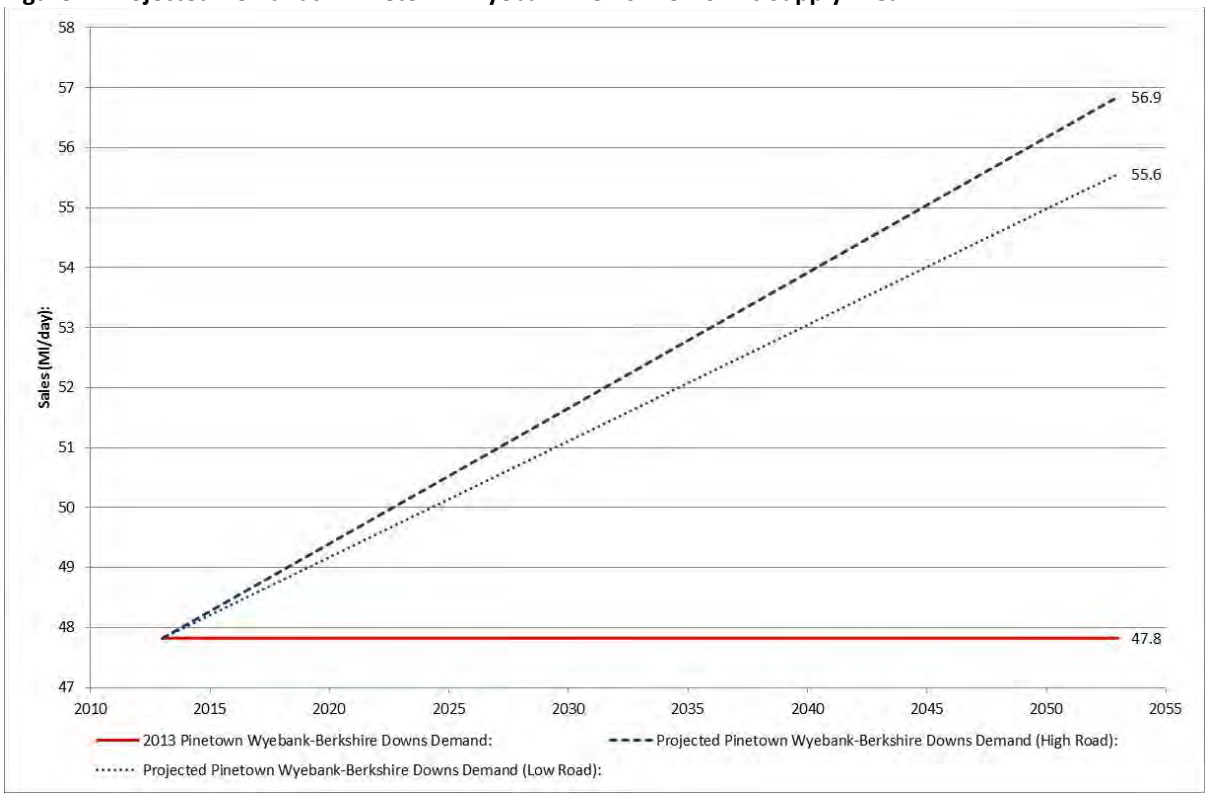
4.2.2. Future Pinetown and Wyebank-Berkshire Downs Demands

Future demands for the Pinetown-Wyebank-Berkshire Downs area are listed in **Table 2** and depicted in **Figure 7**.

		High Road:					Low Road:				
Reservoir Zone:	**2013**	**2023**	**2033**	**2043**	**2053**	**UDP in:**	**2023**	**2033**	**2043**	**2053**	**UDP in:**
BERKSHIRE DOWNS	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
CLERMONT 1, 2&4 RES	0.0	0.4	0.8	1.2	1.6	2073	0.3	0.7	1.0	1.3	2083
CLERMONT 5 RES	0.0	0.1	0.2	0.3	0.4	2073	0.1	0.2	0.3	0.3	2083
KWADABEKA 5 RES	0.0	0.0	0.1	0.1	0.2	2073	0.0	0.1	0.1	0.1	2083
CLUBHOUSE PLACE	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
HAYGARTH ROAD	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
HOCKING PLACE	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
METHVEN RES	0.0	0.1	0.1	0.2	0.3	2073	0.1	0.1	0.2	0.2	2083
MOUNTAIN RIDGE RES	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
PARADISE VALLEY	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
PINETOWN SYSTEM RES	0.0	1.4	2.8	4.2	5.6	2073	1.2	2.4	3.6	4.8	2083
WYBANK RES	0.0	0.3	0.5	0.8	1.0	2073	0.2	0.4	0.7	0.9	2083
Future PTN-WYB-Berkshire demand:	**0.0**	**2.3**	**4.5**	**6.8**	**9.0**	-	**1.9**	**3.9**	**5.8**	**7.7**	-
2013 PTN-WYB-Berkshire demand:	**47.8**	**47.8**	**47.8**	**47.8**	**47.8**	-	**47.8**	**47.8**	**47.8**	**47.8**	-
Projected PTN-WYB-Berkshire demand:	**47.8**	**50.1**	**52.3**	**54.6**	**56.9**	-	**49.8**	**51.7**	**53.6**	**55.6**	-

Table 2: Projected Water Demands - Pinetown, Wyebank-Berkshire Downs

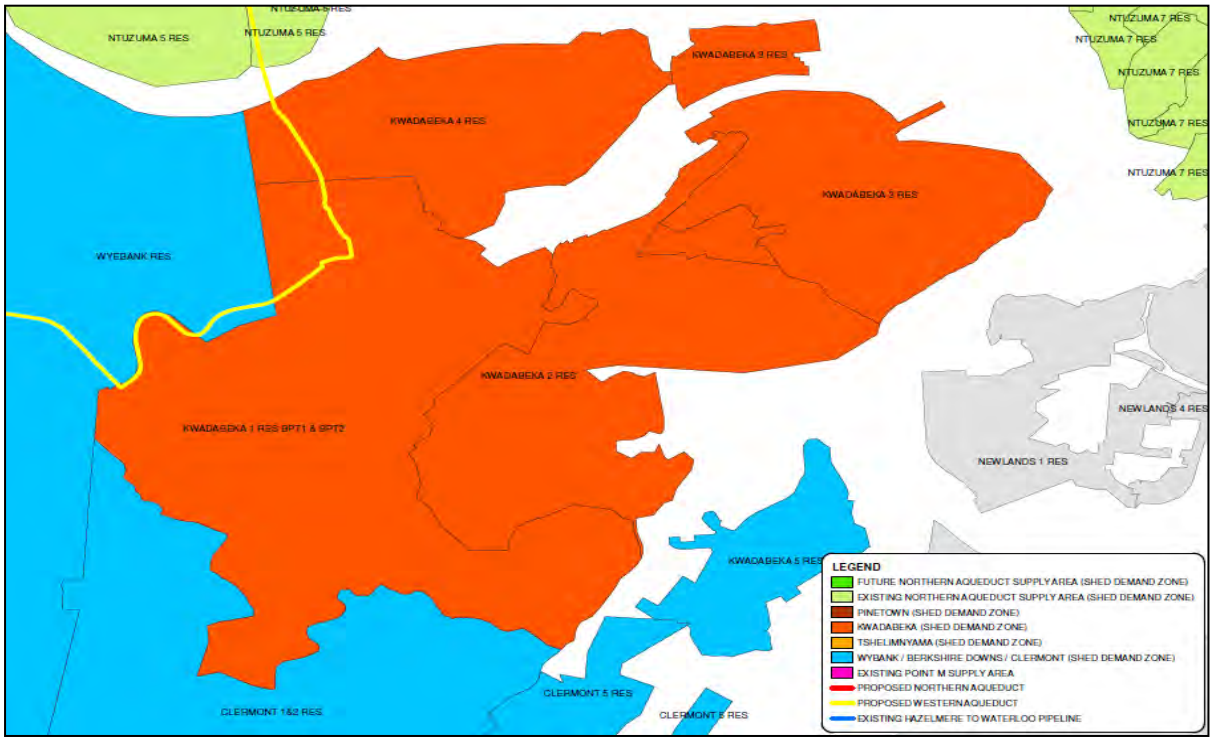
Figure 7: Projected Demands – Pinetown-Wyebank-Berkshire Downs Supply Area



4.3. KwaDabeka Supply Area

The individual reservoir supply zones that make up the KwaDabeka Supply Area are KwaDabeka 1, 2, 3 and 4. The KwaDabeka Supply Area is depicted in **Figure 8**.

Figure 8: KwaDabeka Supply Area

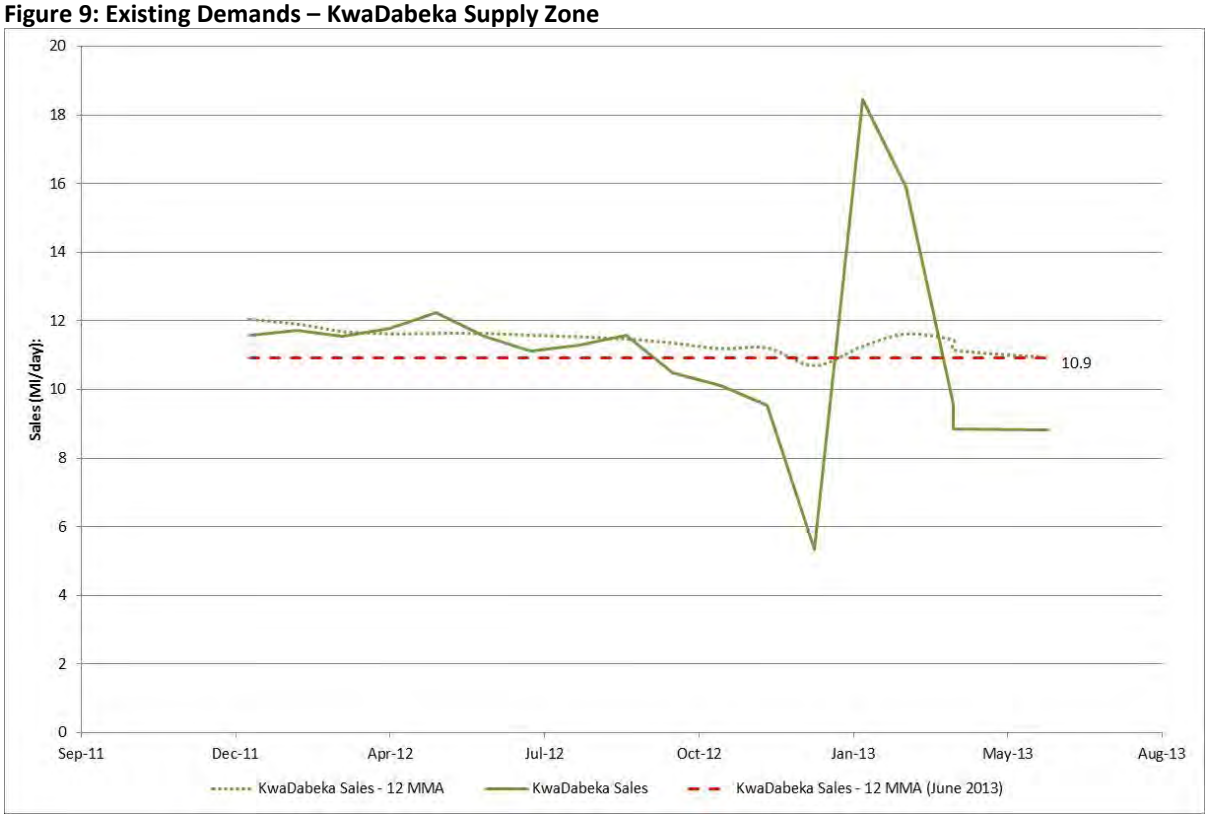


4.3.1. Existing KwaDabeka Demands

The KwaDabeka system is supplied via a ring-fenced pump and rising main system from Durban Heights Waterworks. Umgeni Water sells water into this system at the fence of the Durban Heights WTW. There is a long historical record of sales into this system, enabling a high confidence in the existing demands.

Based on Umgeni Water's sales figures, the AADD for this system has been estimated at 10.9 Ml/day as depicted in **Figure 9**.

Figure 9: Existing Demands – KwaDabeka Supply Zone



4.3.2. Future KwaDabeka Demands:

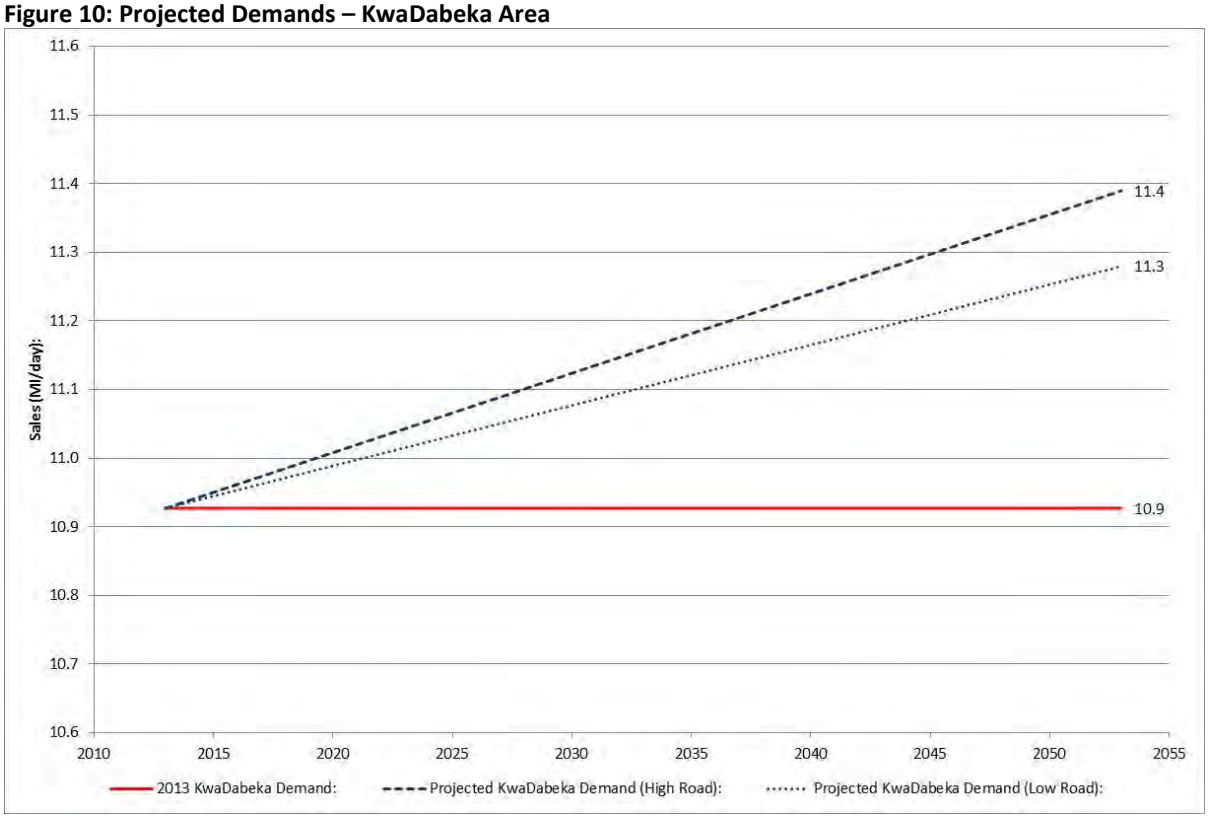
Future demands for KwaDabeka are listed in **Table 3** and depicted in **Figure 10**.

		High Road:					Low Road:				
Reservoir Zone:	**2013**	**2023**	**2033**	**2043**	**2053**	**UDP in:**	**2023**	**2033**	**2043**	**2053**	**UDP in:**
KWADABEKA 1 RES BPT1 & BPT2 **	0.0	-0.1	-0.2	-0.4	-0.5	2073	-0.1	-0.2	-0.3	-0.4	2083
KWADABEKA 2 RES	0.0	0.2	0.3	0.5	0.6	2073	0.1	0.2	0.4	0.5	2083
KWADABEKA 3 RES	0.0	0.0	0.1	0.1	0.2	2073	0.0	0.1	0.1	0.1	2083
KWADABEKA 4 RES	0.0	0.0	0.1	0.1	0.2	2073	0.0	0.1	0.1	0.1	2083
Future KwaDabeka demand:	**0.0**	**0.1**	**0.2**	**0.3**	**0.5**	-	**0.1**	**0.2**	**0.3**	**0.4**	-
2013 KwaDabeka demand:	**10.9**	**10.9**	**10.9**	**10.9**	**10.9**	-	**10.9**	**10.9**	**10.9**	**10.9**	-
Projected KwaDabeka demand:	**10.9**	**11.0**	**11.2**	**11.3**	**11.4**	-	**11.0**	**11.1**	**11.2**	**11.3**	-

Table 3: Projected Water Demands - KwaDabeka System

**** Negative figures denote de-densification of developed areas where residents of informal settlements are moved into formal housing.**

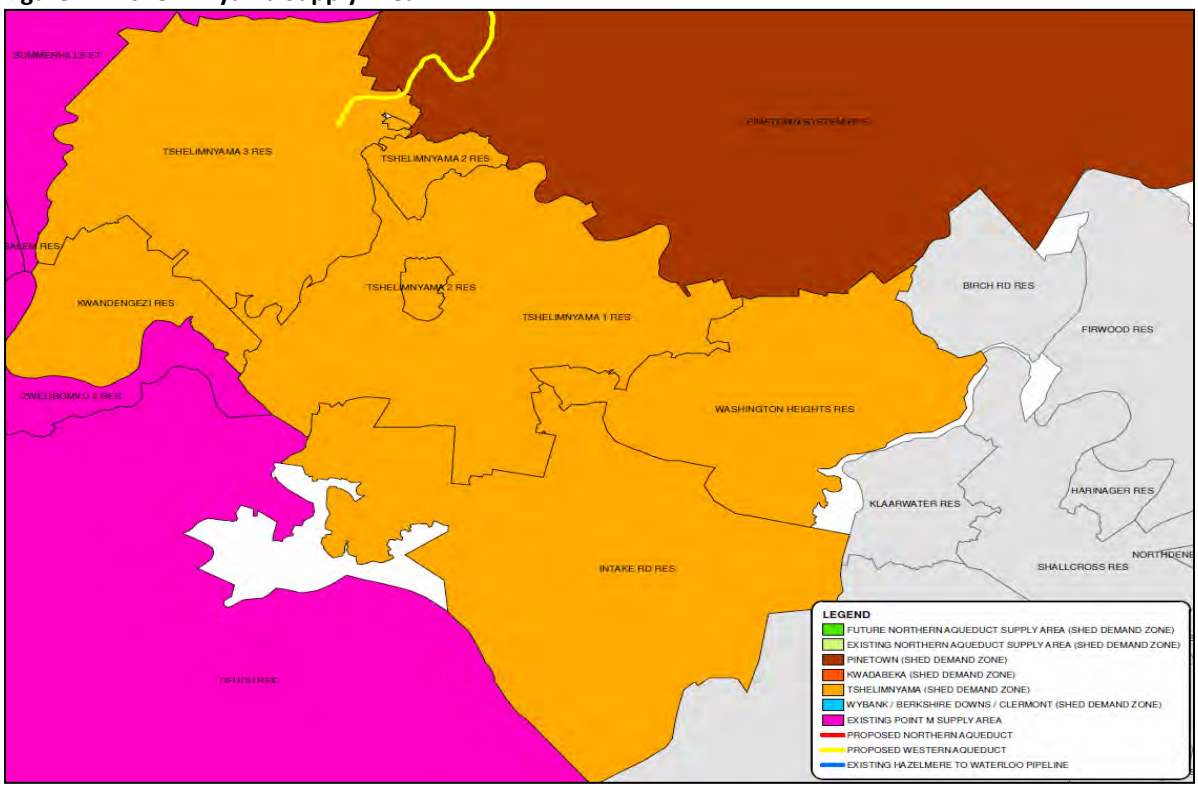
Figure 10: Projected Demands – KwaDabeka Area



4.4. Tshelimnyama Supply Area

The individual reservoir zones that make up the Tshelimnyama Supply Area are Tshelimnyama 1, 2 and 3, KwaNdengezi, Washington Heights and Intake Road. The Tshelimnyama Supply Area is depicted in **Figure 11**.

Figure 11: Tshelimnyama Supply Area



4.4.1. Existing Tshelimnyama Demands

The Tshelimnyama subsystem is presently supplied from Durban Heights WTW via the Southern Aqueduct, a trunk main that generally supplies part of the EWS southern area demands. Tshelimnyama 1 Reservoir receives a water supply via a pumped system from Northdene and Shallcross reservoirs. Tshelimnyama 1 Reservoir in turn supplies a series of other reservoirs via a system of pump stations and trunk mains. Tshelimnyama can also be supplied via the Pinetown system.

It is planned that the Tshelimnyama subsystem will ultimately receive water via a branch pipeline from the Western Aqueduct.

Since the Tshelimnyama system is a subsystem of the larger Southern Aqueduct system, it is not metered separately and there is no record of historical sales. EWS's Non-Revenue Water Division did however carry out a flow logging exercise in 2010 and estimated the water demand in this subsystem at 18.8 Ml/day. A nominal growth factor of 0.5% per annum has been applied to escalate this figure to 2013. The existing demand for the Tshelimnyama system has therefore been estimated as 19.0 Ml/day with a low level of confidence. The reason for the low confidence level is that the area can receive a supplementary supply via the Pinetown system but it is not known whether it is in fact receiving this water and what the volume is.

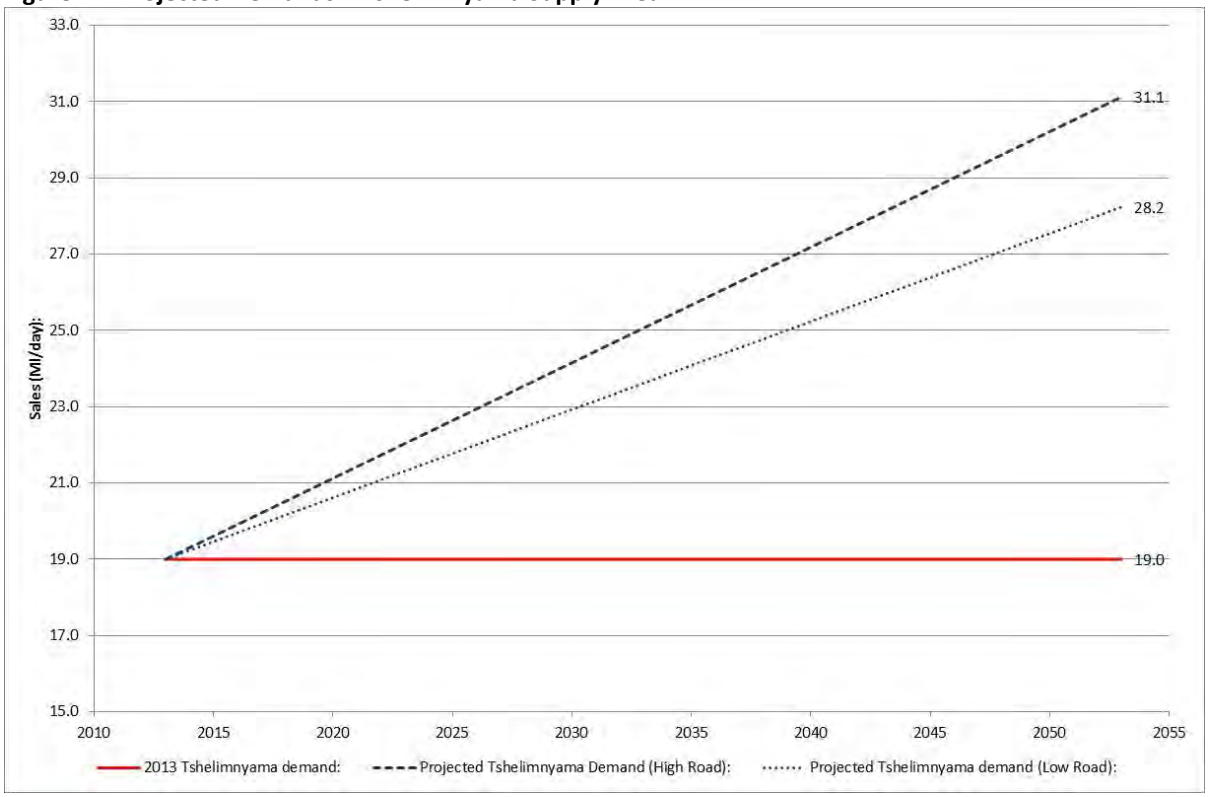
4.4.2. Future Tshelimnyama Demands

Future demands for Tshelimnyama are listed in **Table 4** and depicted in **Figure 12**.

		High Road:					Low Road:				
Reservoir Zone:	**2013**	**2023**	**2033**	**2043**	**2053**	**UDP in:**	**2023**	**2033**	**2043**	**2053**	**UDP in:**
INTAKE ROAD RES	0.0	0.4	0.7	1.1	1.4	2073	0.3	0.5	0.8	1.1	2083
KWADENGEZI RES	0.0	0.2	0.3	0.5	0.6	2073	0.1	0.2	0.4	0.5	2083
TSHELIMNYAMA 1 RES	0.0	0.5	1.0	1.6	2.1	2073	0.4	0.8	1.2	1.6	2083
TSHELIMNYAMA 2 RES	0.0	0.1	0.1	0.2	0.3	2073	0.1	0.1	0.2	0.2	2083
TSHELIMNYAMA 3 RES	0.0	1.5	3.1	4.6	6.2	2073	1.2	2.3	3.5	4.7	2083
WASHINGTON HTS RES	0.0	0.4	0.8	1.2	1.6	2073	0.3	0.6	0.9	1.2	2083
Future Tshelimnyama demand:	**0.0**	**3.0**	**6.1**	**9.1**	**12.1**	-	**2.3**	**4.6**	**6.9**	**9.2**	-
2013 Tshelimnyama demand:	**19.0**	**19.0**	**19.0**	**19.0**	**19.0**	-	**19.0**	**19.0**	**19.0**	**19.0**	-
Projected Tshelimnyama demand:	**19.0**	**22.0**	**25.1**	**28.1**	**31.1**	-	**21.3**	**23.6**	**25.9**	**28.2**	-

Table 4: Projected Water Demands - Tshelimnyama Supply Area

Figure 12: Projected Demands – Tshelimnyama Supply Area



4.5. Northern Aqueduct

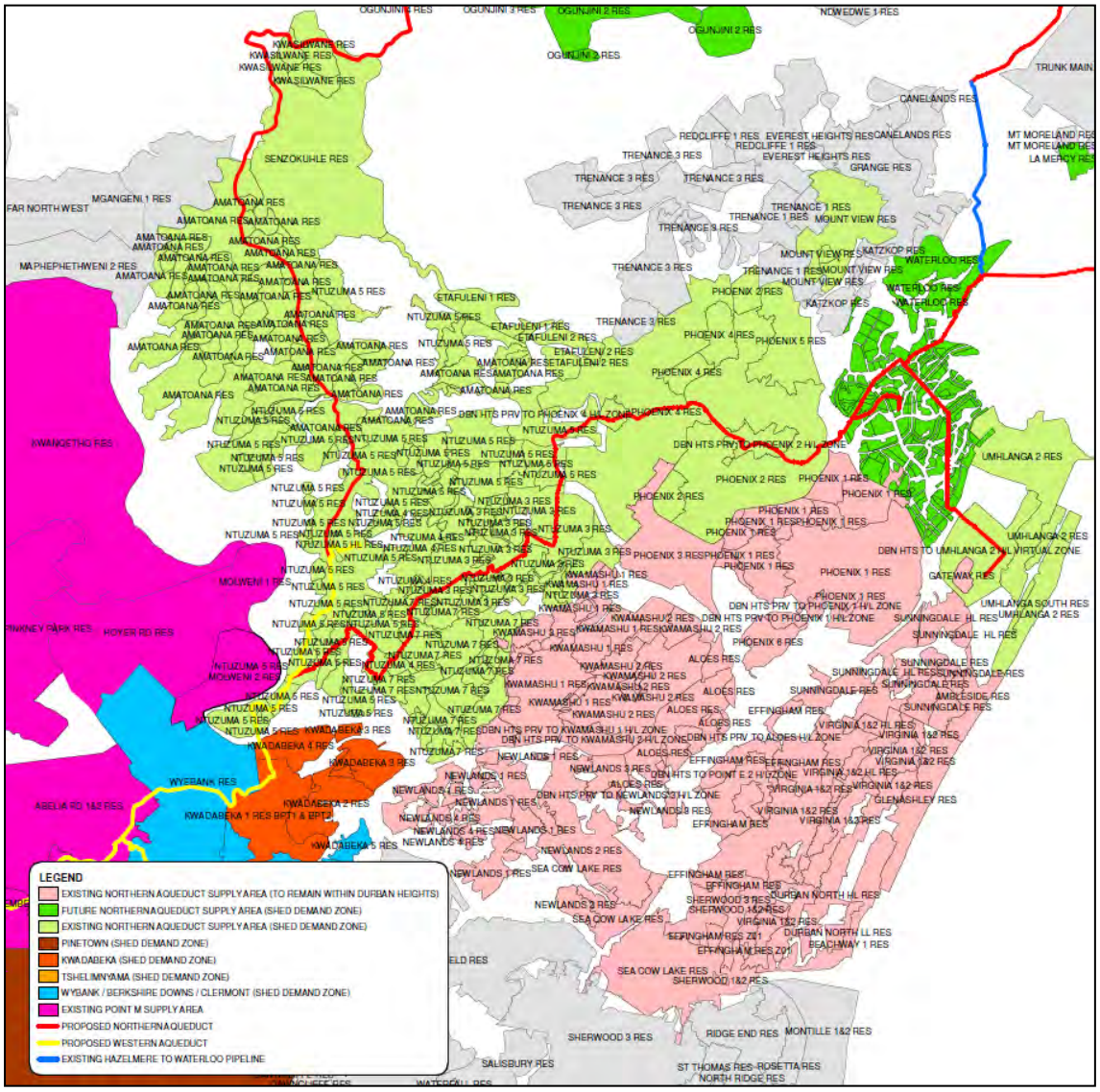
The Northern Aqueduct (NA) receives its water from Durban Heights Waterworks. The intention is to shed part of the present NA supply area to the uMkhomazi Scheme. All future developments that will result in an increase in water demand will then be supplied from the uMkhomazi Scheme along with the partial shed zone. The existing NA supply zones that are to be transferred to the uMkhomazi Scheme are Ntuzuma Reservoirs 3, 4, 5 and 7, Shembe Village, Amaotane, Etafuleni, Mzinyathi, Mgangeni, Ngonweni, Phoenix Reservoirs 2, 4 and 5, Senzokuhle, Kwa Silwane, Mgangeni and Umhlanga. These zones were selected as a result of the close proximity to the proposed new

Northern Aqueduct pipeline that is scheduled for construction in 2013-2014. The balance of the existing NA supply areas will continue to be supplied from Durban Heights Waterworks.

Once the construction of the new Northern Aqueduct is completed, additional zones will be included in its supply area. These zones that are not presently supplied from the NA and will ultimately form part of the uMkhomazi demand are Blackburn (proposed new reservoir) and the Hazelmere Waterworks supply zones of Waterloo, iNyaninga, Zimbali South, Westbrook and La Mercy. In addition, part of the Ogunjini system which is presently supplied from the Ogunjini Waterworks is be included. These areas are discussed under separate headings.

The Northern Aqueduct Supply Area is depicted in **Figure 13**.

Figure 13: Northern Aqueduct Supply Area



4.5.1. Existing Northern Aqueduct Demands

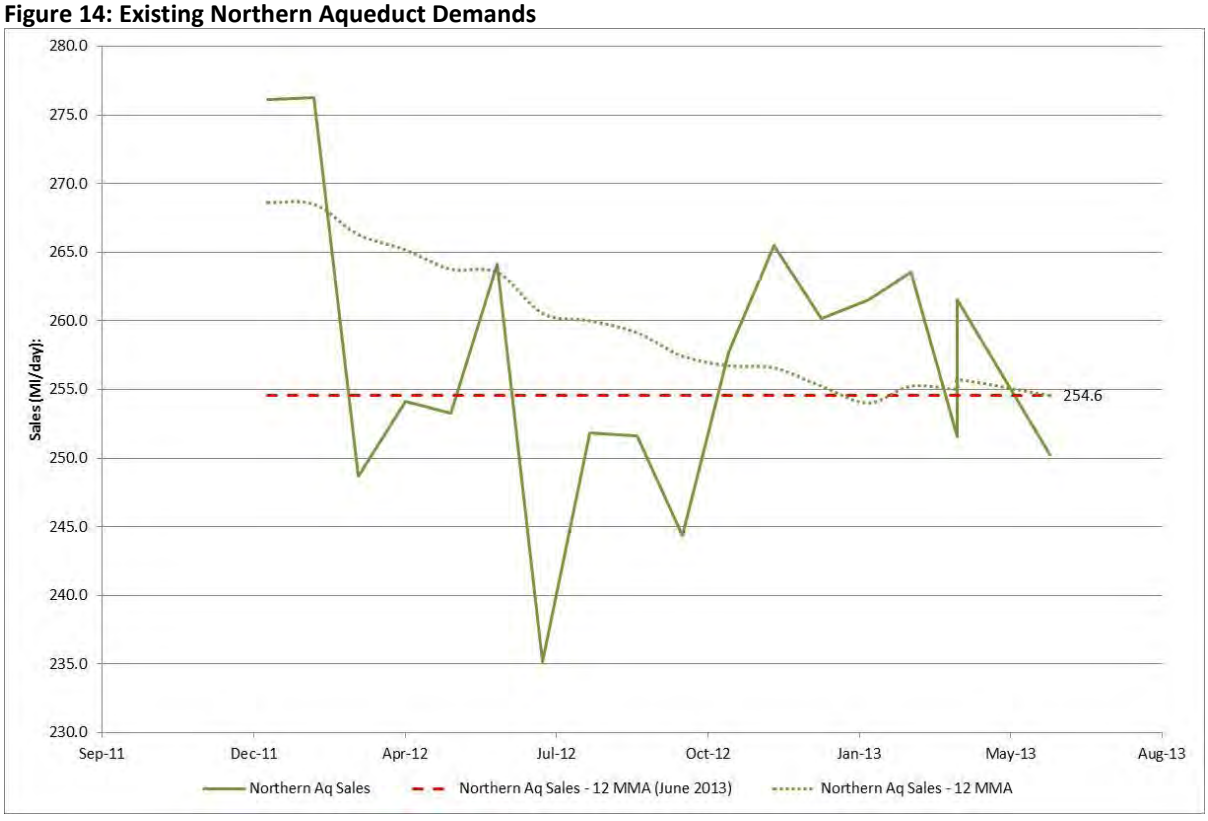
The Northern Aqueduct is supplied from Durban Heights WTW. UW sells water to EWS at the fence of the WTW and historical sales figures are available. These sales figures however take into account both sales into the Northern Aqueduct and the Central Aqueduct via Grace Avenue (the Ridge demand). It was necessary therefore to distinguish between Central and Northern Aqueduct demands.

The operation of the EWS system is such that the Ridge area, a demand zone in Central Durban, is able to be supplied either by gravity from Durban Heights WTW via the Central Aqueduct or by pumping from Wiggins WTW. Automated valves on the Central Aqueduct at Grace Avenue ensure that only one WTW can supply the Ridge zone at any given time.

UW and EWS's standard operating rule is that the Ridge receives its water via pumping from Wiggins. Discussions with EWS personnel confirmed that this mode of operation has not changed between April 2012 and June 2013. The metered sales data for this period was therefore taken as representative of the total sales into the Northern Aqueduct, i.e. no water was supplied into the Central Aqueduct during this period.

The average annual daily demand (AADD) over this period was calculated to be 254.6 Ml/day with a high level of confidence. The 2012/13 sales are depicted in **Figure 14**.

Figure 14: Existing Northern Aqueduct Demands



For the purposes of the demand projection exercise, it was necessary to split the existing Northern Aqueduct demands. The reason for this is that once the uMkhomazi Project is operational, a portion

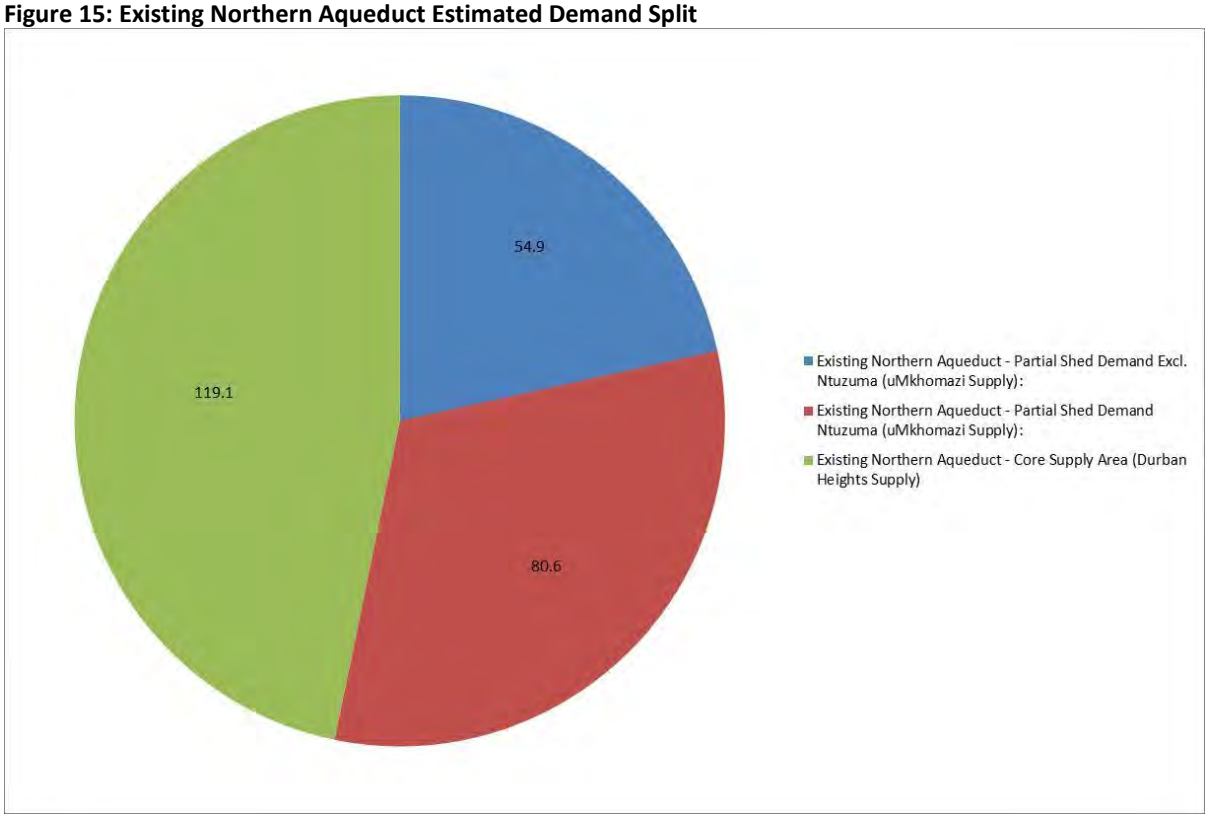
of the Northern Aqueduct demand will be shifted to the uMkhomazi Scheme while the remaining 'core' portion will continue to be supplied from the Durban Heights Waterworks.

No up to date information was available on the demands from individual reservoir zones. Older data therefore had to be used to proportion the existing demand presented in **Figure 14**. The following split was determined:

- Ntuzuma: The total demand for the various Ntuzuma reservoir supply zones was estimated to be 80.6 Ml/day.
- Mzinyathi: This region is supplied from Ntuzuma 5 Reservoir. Supply is not metered and the region presently has its water turned off on a daily basis in order not to compromise the Ntuzuma system which is regarded as a higher priority. As a result of these factors, it was not possible to estimate the Mzinyathi demand. The present demand was therefore taken to be zero and assumed to be part of the present Ntuzuma demand.
- Northern Aqueduct: The sum of the individual Northern Aqueduct reservoir supply zone demands for the areas that are intended to be transferred to the uMkhomazi Scheme was estimated at 54.9 Ml/day.

The estimated demand split is depicted in **Figure 15**. It should be noted that while there is a high level of confidence in the total Northern Aqueduct demands, there is a low level of confidence in the various split demands.

Figure 15: Existing Northern Aqueduct Estimated Demand Split



4.5.2. Projected Northern Aqueduct Demands

4.5.2.1. Projected Partial Northern Aqueduct Demands

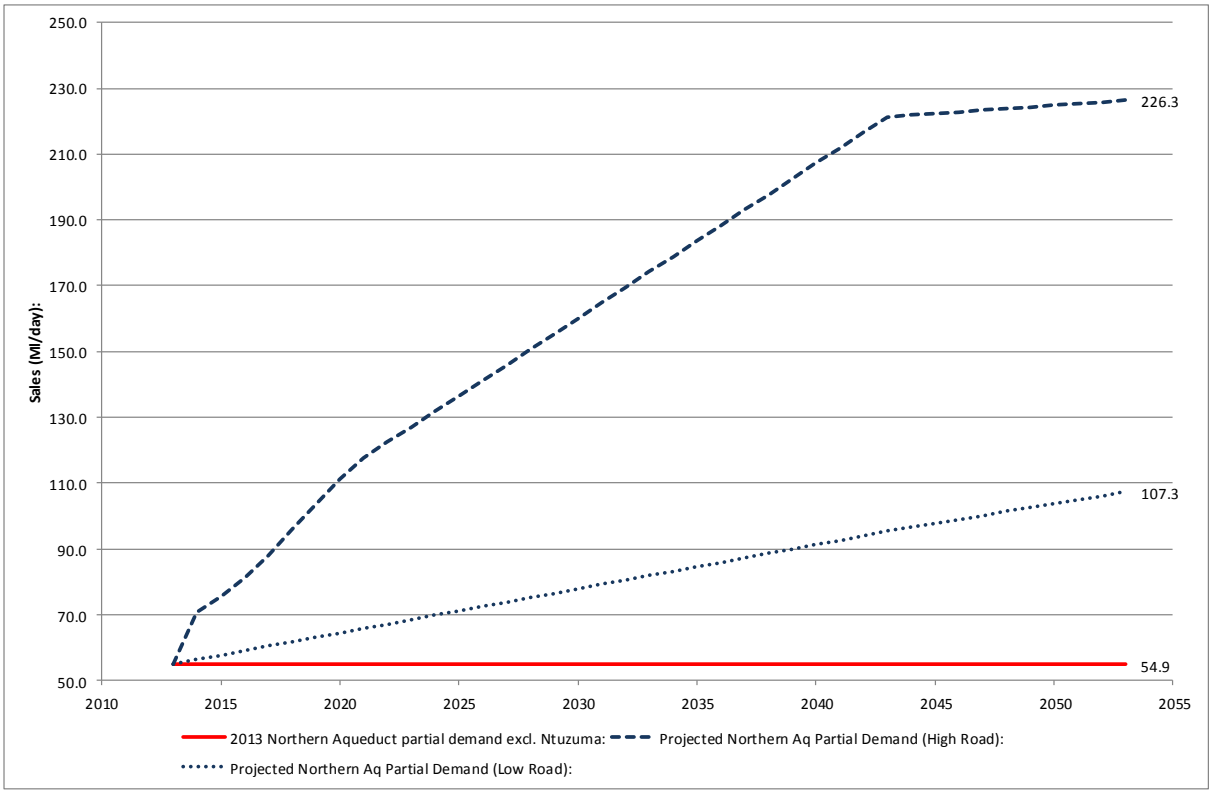
Projected demands for the Partial Northern Aqueduct Supply Area are listed in **Table 5** and depicted in **Figure 16**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
CORNUBIA	0.0	37.4	49.6	61.8	61.8	2043	8.3	16.6	24.9	33.2	2053
MOUNT VIEW RES	0.0	0.1	0.3	0.4	0.5	2073	0.2	0.4	0.5	0.7	2053
PHOENIX 2 RES	0.0	0.2	0.4	0.5	0.7	2073	0.2	0.5	0.7	0.9	2053
PHOENIX 4 RES	0.0	1.1	2.2	3.3	4.4	2073	1.5	2.9	4.4	5.9	2053
PHOENIX 5 RES **	0.0	0.0	0.0	0.0	-0.1	2073	0.0	0.0	-0.1	-0.1	2053
UMHLANGA	0.0	6.7	17.9	29.2	29.2	2043	1.6	3.2	4.9	6.5	2053
METRO HOUSING NORTH EXCL. MZINYATHI	0.0	26.7	49.0	71.3	74.9	2073	1.8	3.5	5.1	5.4	2083
Future Northern Aq partial demand:	0.0	72.2	119.3	166.4	171.5	-	13.6	27.0	40.4	52.5	-
2013 Northern Aq partial demand:	54.9	54.9	54.9	54.9	54.9	-	54.9	54.9	54.9	54.9	-
Projected Northern Aq part. demand:	54.9	127.1	174.2	221.3	226.3	-	68.5	81.9	95.3	107.3	-

Table 5: Projected Water Demands - Northern Aqueduct Partial Demand

** Represents de-densification projects.

Figure 16: Projected Northern Aqueduct Partial Demand



4.5.2.2. Projected Ntuzuma Demands

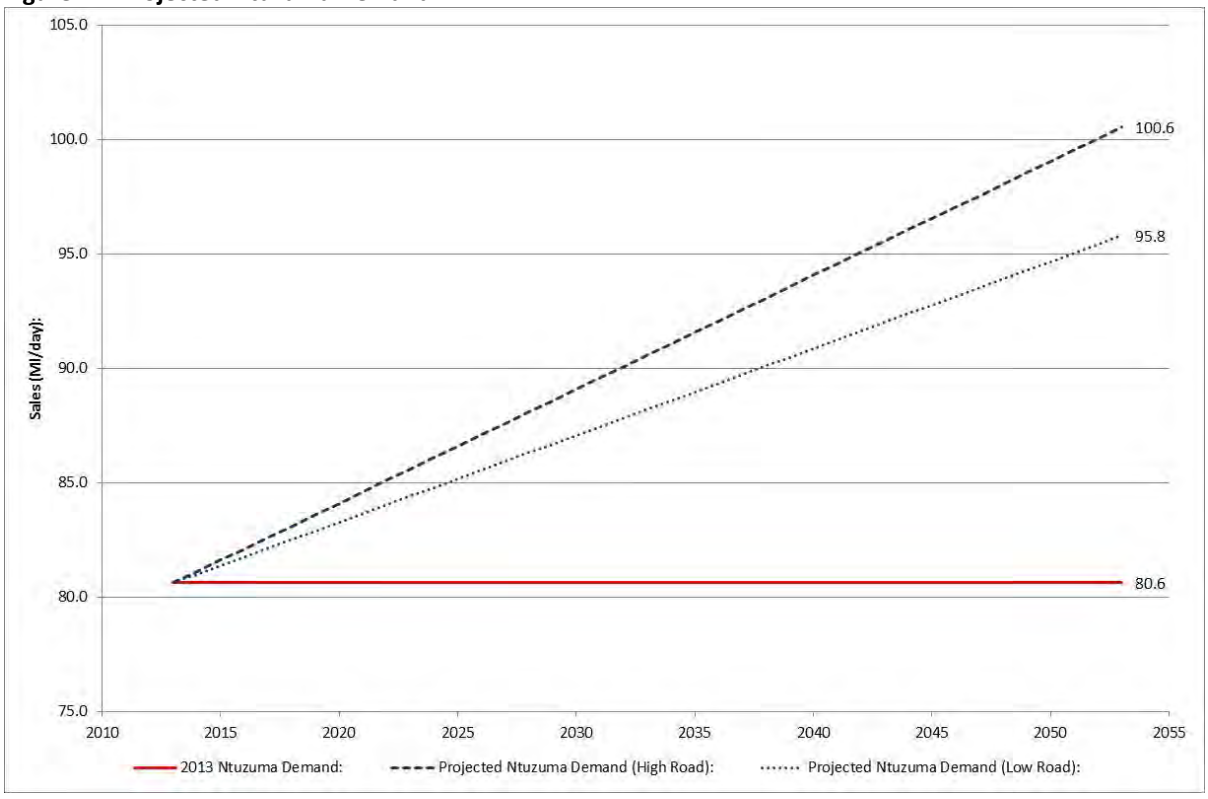
Projected demands for Ntuzuma are listed in **Table 6** and depicted in **Figure 17**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
AMAOTANA RES	0.0	0.7	1.4	2.2	2.9	2073	0.5	1.1	1.6	2.2	2083
ETAFULENI RES	0.0	0.2	0.5	0.7	1.0	2073	0.2	0.4	0.5	0.7	2083
KWASILWANE RES	0.0	0.0	0.0	0.0	0.0	2073	0.0	0.0	0.0	0.0	2083
NR 5 ELEVATED TANK	0.0	0.0	0.1	0.1	0.1	2073	0.0	0.0	0.1	0.1	2083
NTUZUMA 3 RES	0.0	0.3	0.6	0.9	1.3	2073	0.2	0.5	0.7	1.0	2083
NTUZUMA 4 RES	0.0	-0.1	-0.1	-0.2	-0.3	2073	-0.1	-0.1	-0.2	-0.2	2083
NTUZUMA 5 RES	0.0	1.4	2.8	4.1	5.5	2073	1.1	2.1	3.2	4.2	2083
NTUZUMA 7 RES	0.0	0.8	1.6	2.5	3.3	2073	0.6	1.2	1.9	2.5	2083
RURAL NORTH WEST	0.0	1.4	2.8	4.2	5.6	2073	1.1	2.1	3.2	4.2	2083
SENSOKUHLE RES	0.0	0.2	0.3	0.5	0.6	2073	0.1	0.2	0.3	0.5	2083
Future Ntuzuma demand:	0.0	5.0	10.0	14.9	19.9	-	3.8	7.6	11.4	15.2	-
2013 Ntuzuma Demand:	80.6	80.6	80.6	80.6	80.6	-	80.6	80.6	80.6	80.6	-
Projected Ntuzuma demand:	80.6	85.6	90.6	95.6	100.6	-	84.4	88.2	92.0	95.8	-

Table 6: Projected Water Demands - Ntuzuma

** Represents de-densification projects.

Figure 17: Projected Ntuzuma Demand



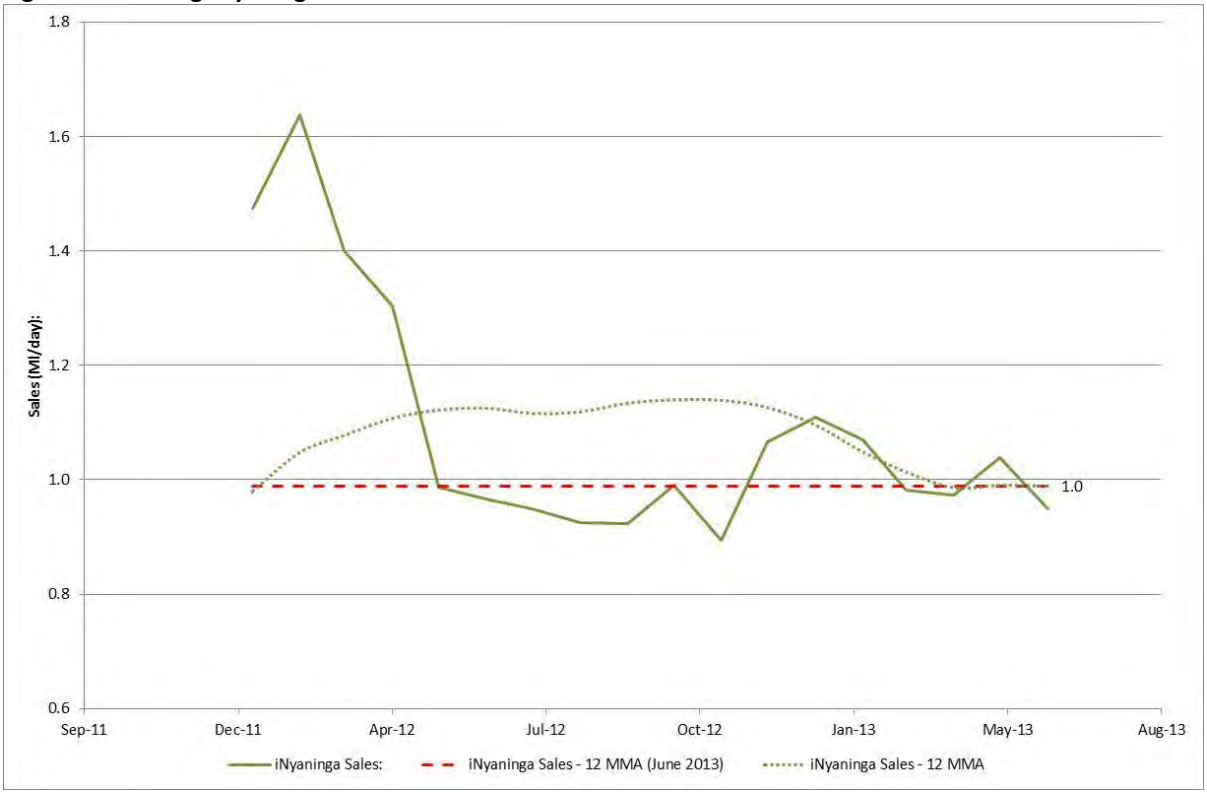
4.6. iNyaninga

The iNyaninga supply zone is a relatively new zone that is presently supplied from Hazelmere WTW. It receives its supply as an offtake from the La Mercy Pipeline. This zone supplies the King Shaka Airport and Dube Trade Port areas as well as the iNyaninga area itself. It is planned that the iNyaninga zone will in future receive water via a branch pipeline from the Northern Aqueduct and will ultimately be supplied from the uMkhomazi scheme.

4.6.1. Existing iNyaninga Demands

The iNyaninga Reservoir demand has been metered since it was commissioned and there is therefore a history of accurate sales data available. The existing iNyaninga demand has been estimated at 1.0 Ml/day with a high degree of confidence. Historical sales data is depicted in **Figure 18**.

Figure 18: Existing iNyaninga Demand



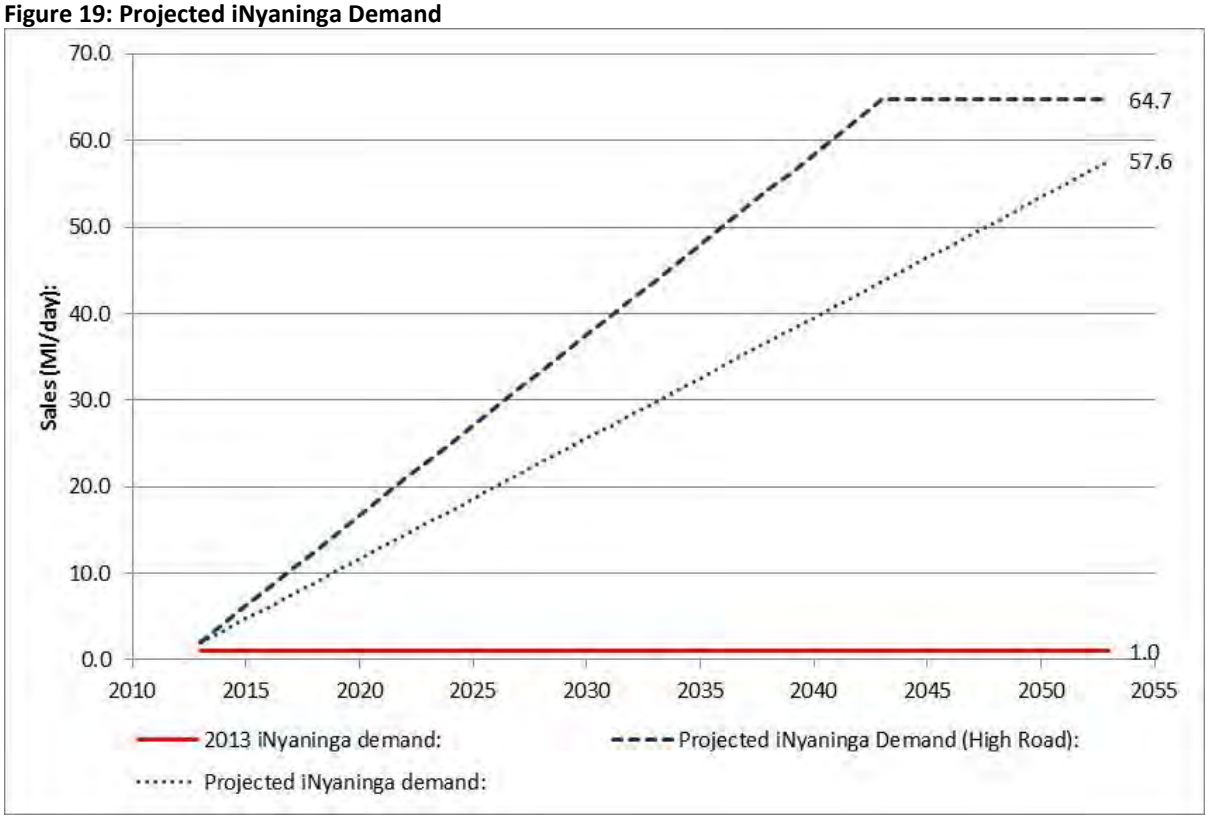
4.6.2. Projected iNyaninga Demands

Projected demands for iNyaninga are listed in **Table 7** and depicted in **Figure 19**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
KSIA & Dube Tradeport	1.1	11.3	21.4	31.6	31.6	2043	7.7	14.5	21.3	28.1	2053
iNyaninga	0.0	10.7	21.4	32.1	32.1	2043	7.1	14.3	21.4	28.6	2053
Future iNyaninga demand:	1.1	22.0	42.8	63.7	63.7	-	14.9	28.8	42.7	56.6	-
2013 iNyaninga demand:	1.0	1.0	1.0	1.0	1.0	-	1.0	1.0	1.0	1.0	-
Projected iNyaninga demand:	2.1	23.0	43.8	64.7	64.7	-	15.9	29.8	43.7	57.6	-

Table 7: Projected Water Demands - iNyaninga Supply Area

Figure 19: Projected iNyaninga Demand



4.7. Waterloo Demands

The Waterloo subsystem is presently supplied from Hazelmere WTW. It receives its supply via a dedicated pumping main from Hazelmere Waterworks to Waterloo Reservoir. This system presently supplies water to Waterloo township but is positioned to provide a supply to new development the Sibaya, Umdloti North, and Mount Moreland areas.

It is planned that the Waterloo zone will in future receive water via a branch pipeline from the Northern Aqueduct and will ultimately become part of the uMkhomazi supply zone.

4.7.1. Existing Waterloo Demands

The supply into the Waterloo rising main is metered and has a long history of sales data. The 2013 Waterloo sales volume has been estimated at 5.0 Ml/day with a high degree of accuracy. The existing Waterloo demand is depicted in **Figure 21**.

Figure 20: Waterloo and La Mercy Supply Zones

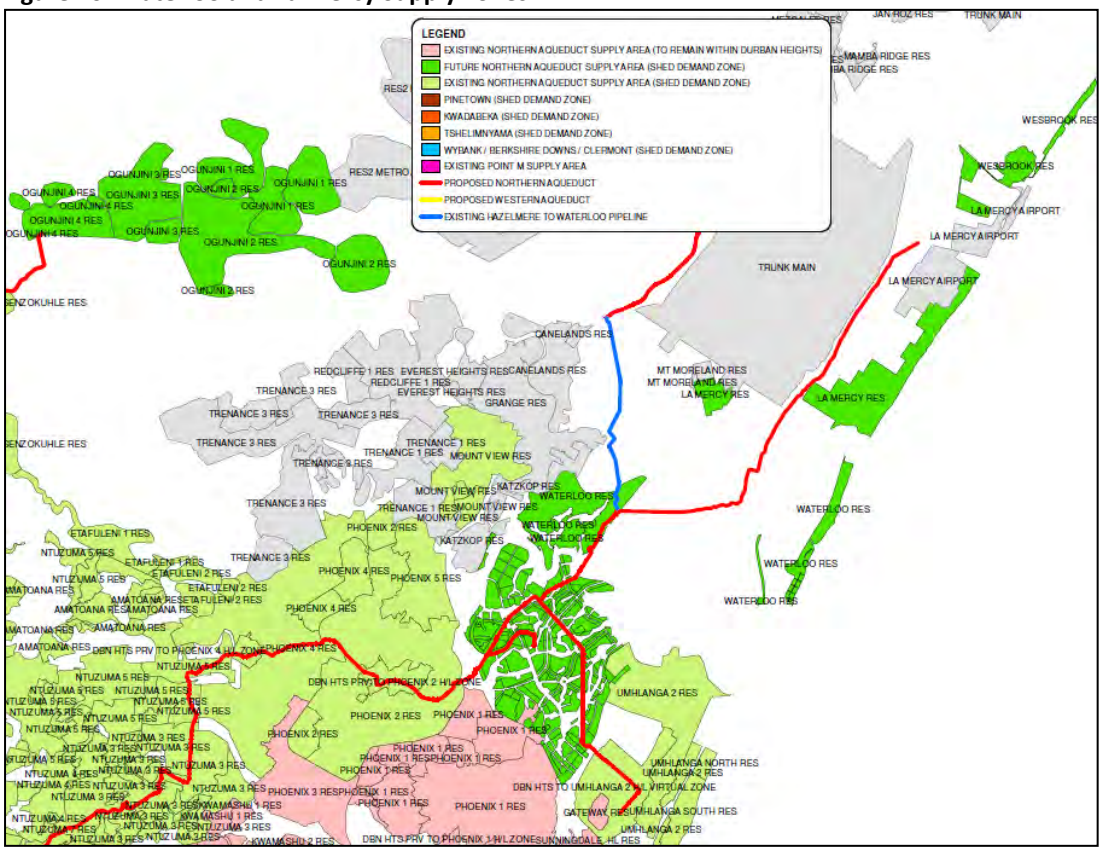
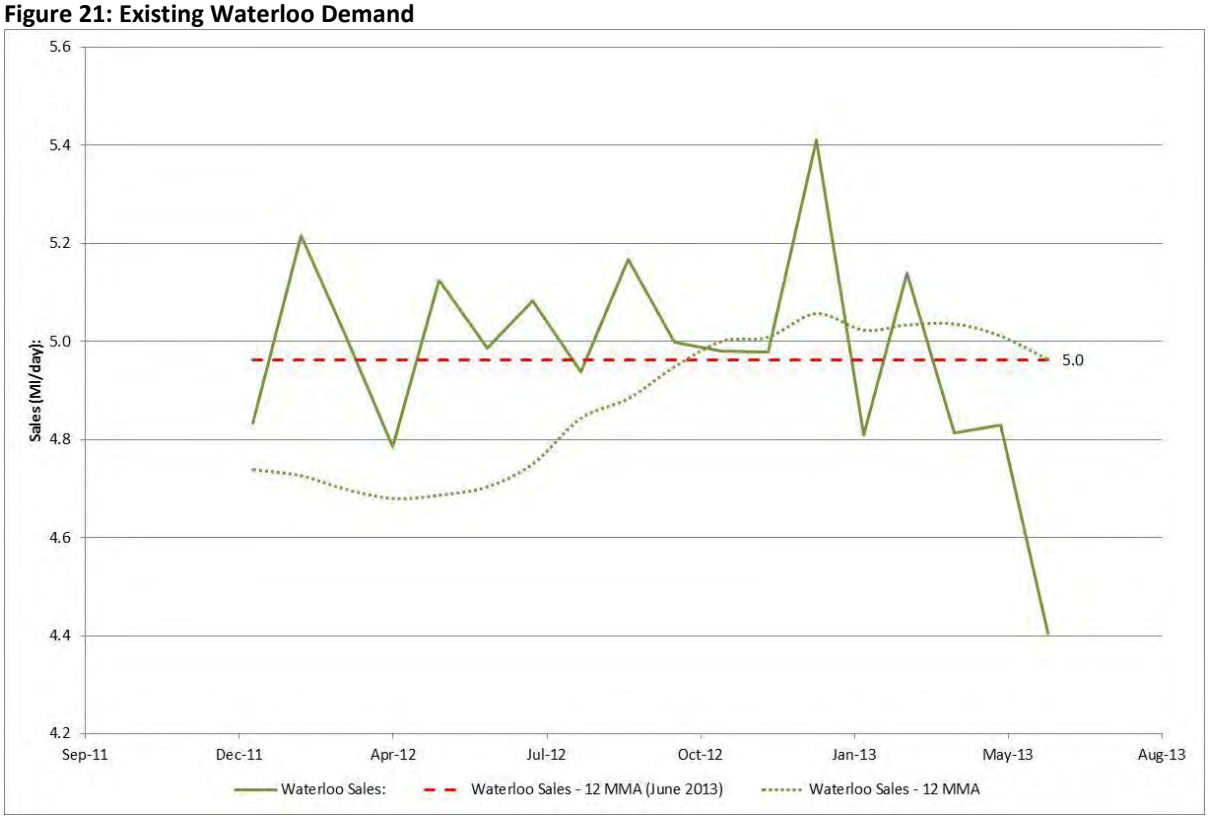


Figure 21: Existing Waterloo Demand



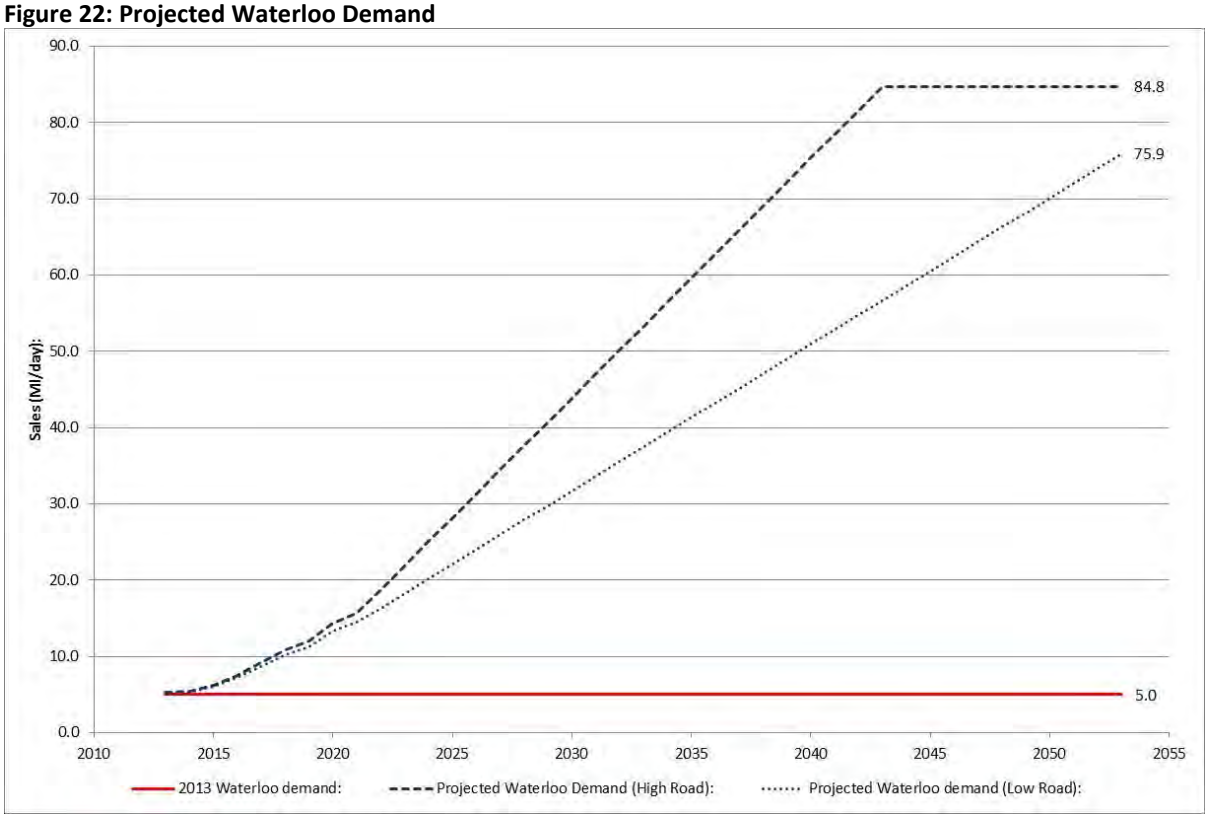
4.7.2. Projected Waterloo Demands

Projected demands for Waterloo are listed in **Table 8** and depicted in **Figure 22**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
Sibaya Nodes 1-5	0.3	3.7	8.6	13.4	13.4	2043	3.0	6.0	9.0	11.9	2053
Sibaya West	0.0	2.3	14.0	25.7	25.7	2043	1.4	8.6	15.7	22.9	2053
Umdloti North	0.0	1.0	6.1	11.2	11.2	2043	0.6	3.7	6.8	9.9	2053
Mt Moreland Township	0.0	1.3	2.2	3.2	3.2	2043	1.1	1.7	2.3	2.9	2053
Mt Moreland South	0.0	4.0	7.9	11.7	11.7	2043	3.4	5.7	8.0	10.4	2053
Mt Moreland North	0.0	4.5	9.5	14.6	14.6	2043	3.7	6.8	9.9	13.0	2053
Future Waterloo demand:	0.3	16.9	48.3	79.8	79.8	-	13.3	32.5	51.7	70.9	-
2013 Waterloo demand:	5.0	5.0	5.0	5.0	5.0	-	5.0	5.0	5.0	5.0	-
Projected Waterloo demand:	5.3	21.9	53.3	84.8	84.8	-	18.3	37.5	56.7	75.9	-

Table 8: Projected Water Demands - Waterloo Supply Area

Figure 22: Projected Waterloo Demand



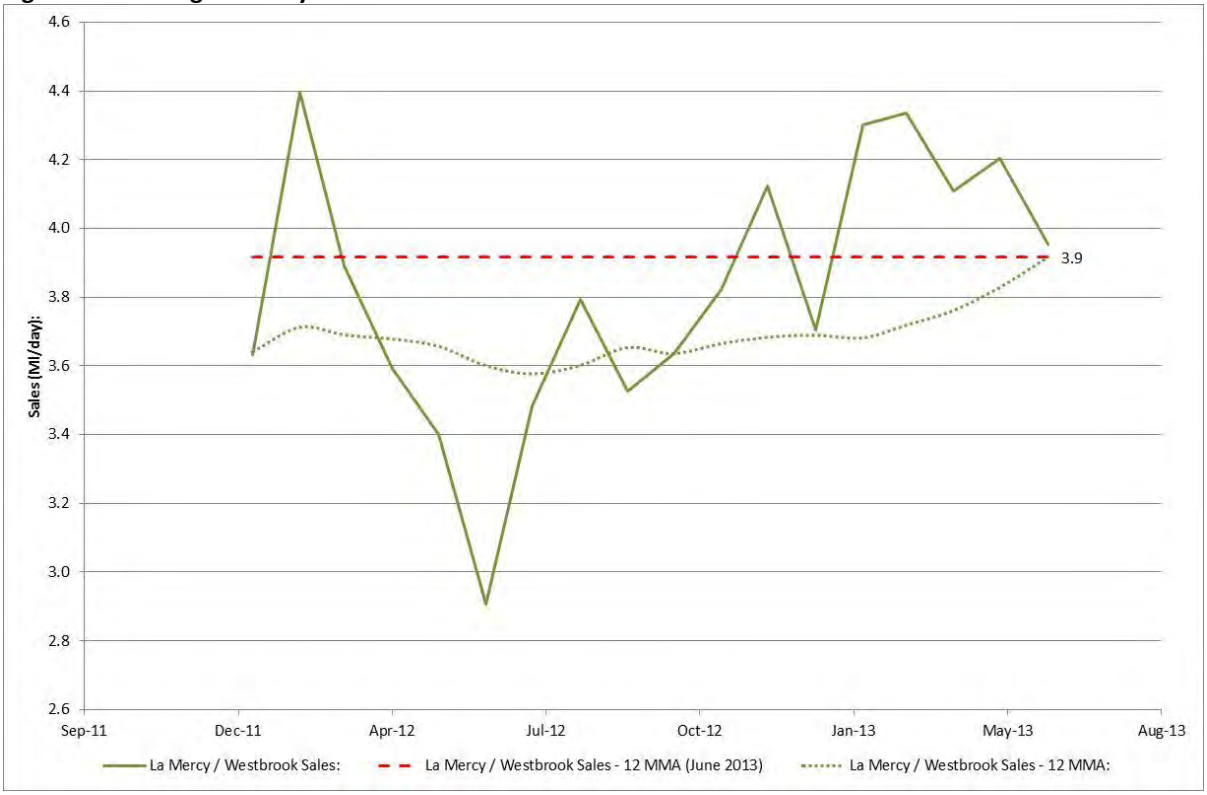
4.8. La Mercy-Westbrook & Zimbali South Demands

La Mercy and Westbrook are presently supplied from Hazelmere Waterworks. Zimbali South is a new zone that will eventually be grouped with La Mercy and Westbrook as a result of its location. EWS has future plans to link the La Mercy area to the Northern Aqueduct via the proposed Waterloo to La Mercy pipeline. These areas will ultimately be incorporated into the uMkhomazi supply zone.

4.8.1. Existing La Mercy-Westbrook & Zimbali South Demands

There is a history of metered flows to the La Mercy and Westbrook areas. The existing demand to these zones has been estimated at 3.9 Ml/day with a high degree of confidence. The existing La Mercy and Westbrook demands are depicted in **Figure 23**.

Figure 23: Existing La Mercy Demand



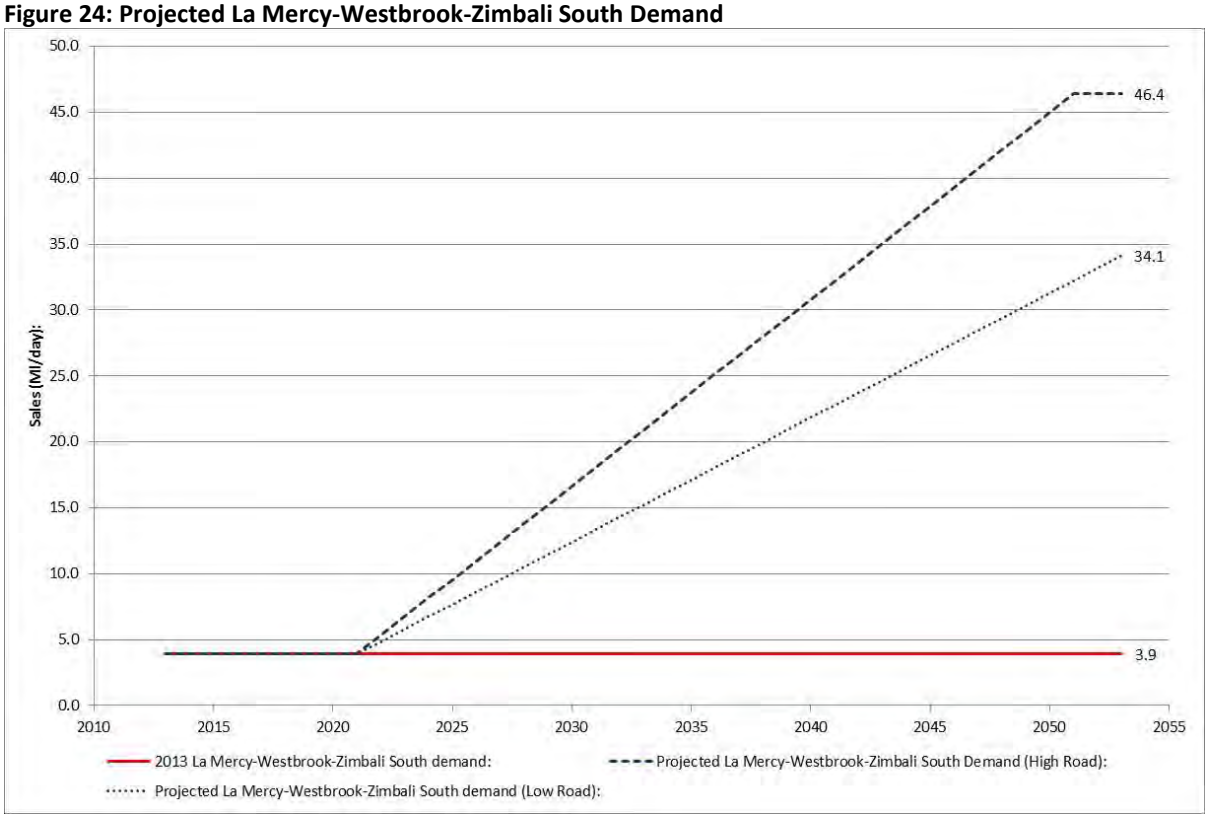
4.8.2. Projected La Mercy-Westbrook & Zimbali South Demands

The projected La Mercy-Westbrook & Zimbali South demands are listed in **Table 9** and depicted in **Figure 24**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
La Mercy Beach	0.0	1.5	9.0	16.6	22.6	2053	1.0	6.0	11.0	16.1	2053
Zimbali South Banks / Westbrook	0.0	1.3	8.0	14.6	19.9	2053	0.9	5.3	9.7	14.2	2053
Future La Mercy & Surrounds demand:	0.0	2.8	17.0	31.2	42.5	-	1.9	11.3	20.8	30.2	-
2013 La Mercy & Surrounds demand:	3.9	3.9	3.9	3.9	3.9	-	3.9	3.9	3.9	3.9	-
Projected La Mercy & Surrounds demand:	3.9	6.7	20.9	35.1	46.4	-	5.8	15.2	24.7	34.1	-

Table 9: Projected Water Demands - La Mercy, Westbrook & Zimbali Area

Figure 24: Projected La Mercy-Westbrook-Zimbali South Demand



4.9. Projected Mzinyathi-Ogunjini Demands

The Mzinyathi region presently receives its water supply from Durban Heights Waterworks via the Ntuzuma system, while the Ogunjini area is supplied from its own water treatment works in the Ogunjini area. It is planned that Mzinyathi as well as a portion of the Ogunjini demand will become a combined supply zone that will ultimately be supplied from the uMkhomazi Scheme.

Although it has been stated earlier that the Mzinyathi demands are included in the Ntuzuma demands, there is an anomaly in that the supply to this area is manually turned off on a daily basis when it starts to draw down Ntuzuma Reservoir 5 from which it is fed. This indicates that the existing Ntuzuma demand tabled earlier may not fully cater for the existing Mzinyathi demand.

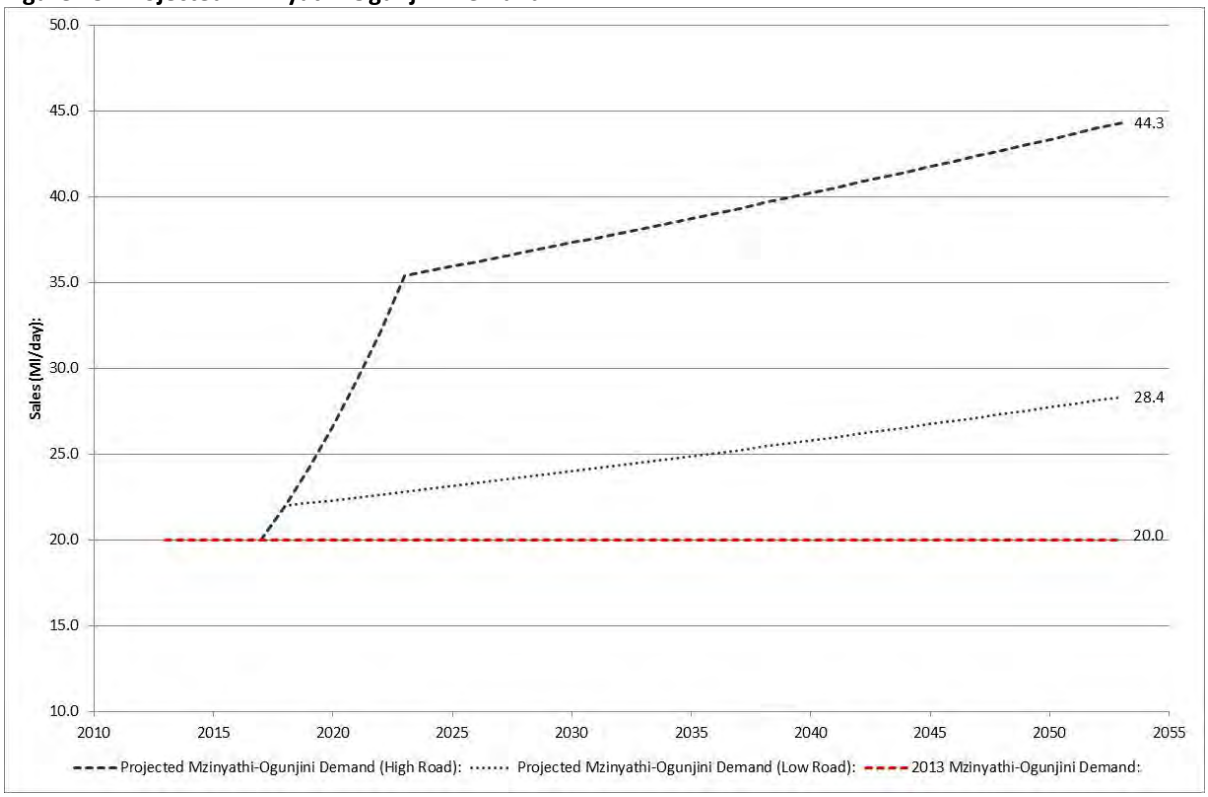
This problem has been addressed by allowing an additional 20.0 Ml/day to cover the shortfall in the existing Ntuzuma to Mzinyathi supply. The value of 20.0 Ml/day was estimated in discussions held with EWS Operations who are responsible for water supply to the Mzinyathi area.

Projected demands for the Mzinyathi-Ogunjini zone are listed in **Table 10** and depicted in **Figure 25**.

		High Road:					Low Road:				
Reservoir Zone:	2013	2023	2033	2043	2053	UDP:	2023	2033	2043	2053	UDP:
NR5 to Mzinyathi	0.0	12.2	14.7	17.4	20.3	2053	0.8	2.4	4.1	6.0	2053
Ogunjini Waterworks demand:	0.0	3.2	3.5	3.7	4.0	2053	2.1	2.2	2.3	2.4	2053
Future Mzinyathi demand:	0.0	15.4	18.2	21.1	24.3	-	2.8	4.5	6.4	8.4	-
2013 Mzinyathi demand:	20.0	20.0	20.0	20.0	20.0	-	20.0	20.0	20.0	20.0	-
Projected Mzinyathi demand:	20.0	35.4	38.2	41.1	44.3	-	22.8	24.5	26.4	28.4	-

Table 10: Projected Water Demands - Mzinyathi-Ogunjini Supply Area

Figure 25: Projected Mzinyathi-Ogunjini Demand



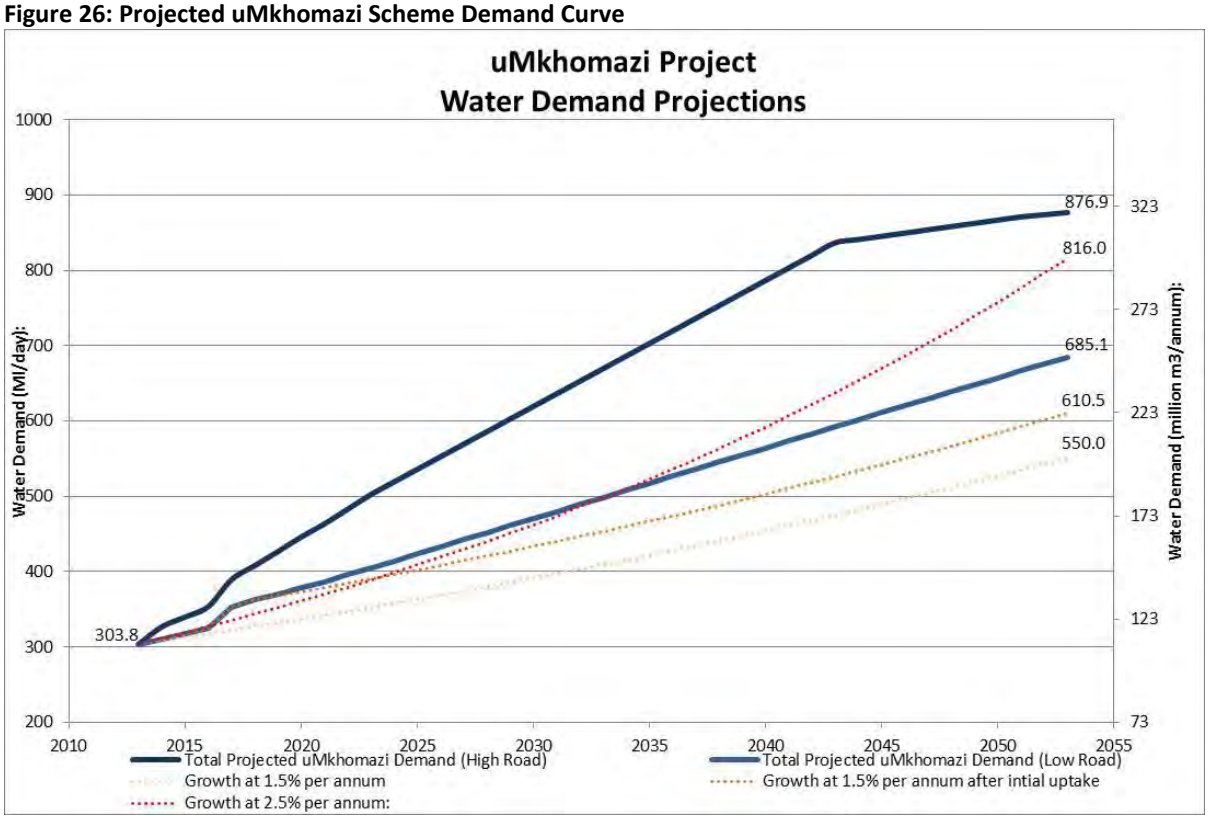
5. Total uMkhomazi Scheme Water Demands

The total uMkhomazi scheme demands are summarised in **Table 11** and depicted in **Figure 26**. It should be noted that these demand projections do not consider phasing of demands and maximising the utilisation of existing WTWs, which is the subject of Section 6 of this report.

		High Road:				Low Road:			
SUPPLY AREA:	**2013**	**2023**	**2033**	**2043**	**2053**	**2023**	**2033**	**2043**	**2053**
Projected Western Area demand:	79.4	119.7	160.0	200.3	210.4	107.3	135.1	163.0	190.9
Projected PTN WyeB-Berkshire demand:	47.8	50.1	52.3	54.6	56.9	49.8	51.7	53.6	55.6
Projected KwaDabeka demand:	10.9	11.0	11.2	11.3	11.4	11.0	11.1	11.2	11.3
Projected Tshelimnyama demand:	19.0	22.0	25.1	28.1	31.1	21.3	23.6	25.9	28.2
Projected Ntuzuma demand:	80.6	85.6	90.6	95.6	100.6	84.4	88.2	92.0	95.8
Projected Northern Aq part. demand:	54.9	127.1	174.2	221.3	226.3	68.5	81.9	95.3	107.3
Projected iNyaninga demand:	2.1	23.0	43.8	64.7	64.7	15.9	29.8	43.7	57.6
Projected Waterloo demand:	5.3	21.9	53.3	84.8	84.8	18.3	37.5	56.7	75.9
Projected La Mercy & Surrounds demand:	3.9	6.7	20.9	35.1	46.4	5.8	15.2	24.7	34.1
Projected Mzinyathi demand:	20.0	35.4	38.2	41.1	44.3	22.8	24.5	26.4	28.4
TOTAL PROJECTED UMKHOMAZI DEMAND:	**323.9**	**502.6**	**669.6**	**836.8**	**876.9**	**405.0**	**498.7**	**592.5**	**685.1**

Table 11: Projected Water Demands Summary

Figure 26: Projected uMkhomazi Scheme Demand Curve



5.1. Discussion on Water Demands

Low Road and High Road projected water demand scenarios have been developed for the uMkhomazi project as depicted in **Figure 25**. The Low Road scenario shows demand increasing from 303.8 Ml/day in 2013 to 685.1 Ml/day in 2053. The High Road scenario shows demand increasing to 876.9 Ml/day in 2053.

The 192 Ml/day difference in demand between the Low and High Road scenarios can be mostly attributed to an earlier uptake in demand in the High Road scenario, where development has been assumed to take place at a faster pace than in the Low Road scenario. This is also evident from the kink in the High Road scenario demand curve in the year 2043, which indicates that several supply zones have reached their ultimate developable potential. The assumptions regarding the pace of development are noted in the Methodology section of this report.

The Low and High Road scenarios result in average annual growth rates of 2.05% and 2.69% respectively, sustained over the 40-year analysis period.

An analysis was carried out to determine the sustained average annual growth rate for the entire eThekwini region based on historical sales data between 2001 and 2013. While the year-on-year growth fluctuates dramatically from one year to the next, the historical data shows that the sustained average annual growth in water demand for the eThekwini region was 2.5% between 2001 and 2013.

A scenario depicting projected annual growth at 2.5% over the analysis period has been included in **Figure 25**. This curve indicates that if the water demand increased at 2.5% for every year between 2013 and 2053, the 2053 demand would be 816.0 Ml/day. The 2.5% growth curve very closely mirrors the Low Road scenario until 2034, after which its exponential nature predictably causes it to veer away from the linear Low Road demand curve.

There is therefore a strong correlation between the historic growth in water demand in the eThekwini region and the projected growth in demands based on the Low Road scenario between the years 2013 and 2034. This gives confidence in the credibility of the Low Road demand scenario. The fact that the Low Road scenario does not track the 2.5% growth curve after 2034 is not seen as significant, given that development cannot continue exponentially within a defined region over an indefinite period of time.

At the request of the Department of Water Affairs, two additional scenarios have also been depicted in **Figure 25** for comparison purposes. One of these depicts a projected growth in demand at 1.5% per annum from 2013 while the other depicts a growth in demand at 1.5% per annum after initially tracking the Low Road scenario until the year 2018. A percentage of 1.5% per annum is often used as a typical growth rate in developing regions where no in-depth analysis of developments has been carried out. These curves provide a useful comparison to the projected demand curves.

Based on the analysis above, it is recommended that the sizing of infrastructure for the uMkhomazi project be based on the Low Road scenario.

6. Phasing of uMkhomazi Potable Water Infrastructure

The initial sections of this report develop and analyse the maximum demands that could become part of the uMkhomazi scheme after it is commissioned. The curves developed assume that the demands for all reservoir zones will simultaneously become part of the uMkhomazi supply zone after the scheme becomes operational. If this were true, it would leave both Durban Heights and Hazelmere WTWs with significant redundant capacity. In reality, Umgeni Water plans to construct only those phases of the uMkhomazi scheme infrastructure that are necessary to meet the shortfall in demand in the present system. All subsequent phases will be constructed only when needed.

While it is reasonable to allow for some spare capacity, any additional capacity built into the uMkhomazi scheme that creates redundancy at Durban Heights and Hazelmere WTWs could be considered to be wasted expenditure, if it is assumed both these WTWs are in good condition and are economical to operate.

This section of the report is therefore concerned with determining the latest possible timing of waterworks and pipeline infrastructure in order to defer capital expenditure on these items to the latest possible date. No Net Present Value analysis has been carried out to weigh the savings in pumping costs of the various eThekwini pumped schemes against the capital costs attributable to building spare capacity in the uMkhomazi scheme to replace these pumped scheme demands. It has simply been assumed that the greenfield uMkhomazi scheme infrastructure would be less economical to operate than the freehold or sunk-cost infrastructure at the existing treatment plants.

6.1. Assumptions and Methodology Used in the Phasing Exercise

In order to accurately determine the phasing of the uMkhomazi infrastructure, the capacities of the existing WTWs as well as the individual subsystems in the WTW supply zones needed to be known. This data was provided by Umgeni and EWS and is listed in **Table 12**.

Item:	Capacity (Ml/day):
Durban Heights WTW	550
Pinetown Pumped System	62
KwaDabeka Subsystem	47
Tshelimnyama Subsystem **	25
Ntuzuma Subsystem	60
Hazelmere WTW	79
iNyaninga – La Mercy Subsystem	33
Waterloo Subsystem	12

Table 12: Water Treatment Works and Subsystem Capacities

** Assumed capacity.

In calculating the phased capacity of the uMkhomazi scheme, it was assumed that the various subsystem demands allocated to the scheme would be shifted from their existing WTW to the uMkhomazi scheme in the year that the subsystem demand exceeded its capacity. Where the overall

WTW works capacity was exceeded in any given year, at least one of its subsystems was shifted to the uMkhomazi scheme.

It should be noted that this exercise implicitly assumes that at no time will any portion of Durban Heights or Hazelmere WTW be taken off line for any reason. Any spare capacity allowed for such eventualities will be the outcome of a strategic decision taken by Umgeni Water.

The Low Road water demand scenario was used as the basis for carrying out this phasing exercise.

6.2. Results of Phasing Exercise

The results of the phasing exercise are illustrated in **Figure 27**, **Figure 28** and **Figure 29**. These figures show how different subsystems can be transferred between Hazelmere WTW, Durban Heights WTW and the uMkhomazi scheme in a phased manner.

Figure 27: Phasing of Demands to and from Durban Heights WTW

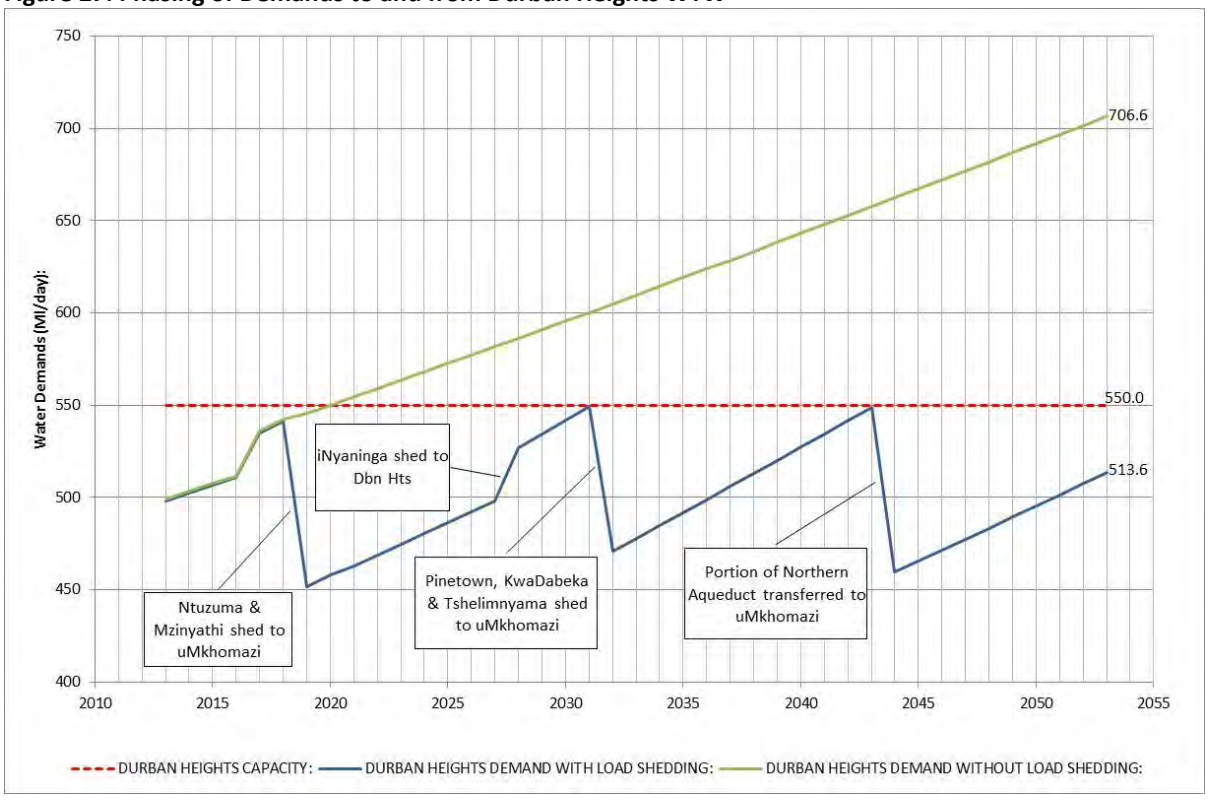
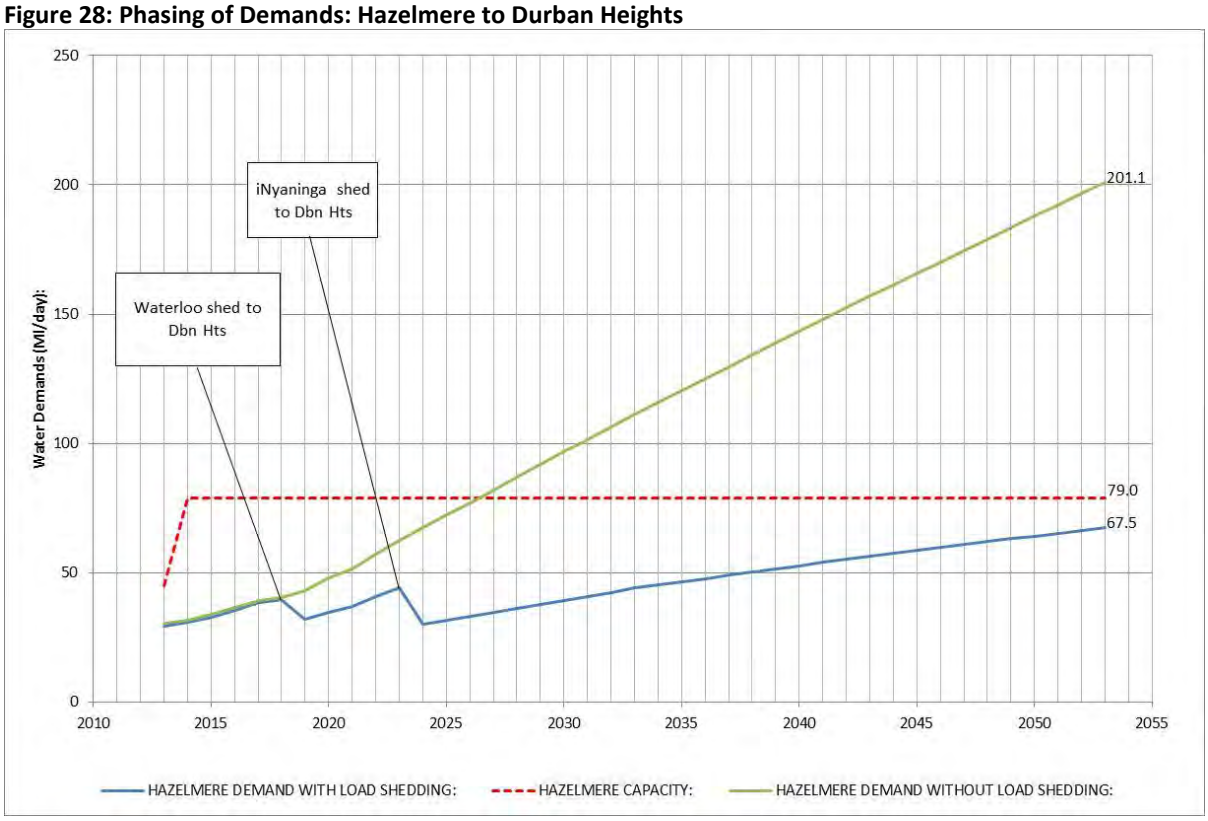


Figure 27 shows that Durban Heights WTW is presently operating very close to the limits of its treatment capacity. As soon as the Western Aqueduct is commissioned in 2018, the Ntuzuma and Mzinyathi demands will be shed to the Western Aqueduct, freeing up treatment capacity at Durban Heights. The Durban Heights demand will thereafter increase linearly and in 2028 will experience a sharp increase when iNyaninga becomes part of the Durban Heights supply.

In 2031 it is necessary to shed transfer the Pinetown KwaDabeka and Tshelimnyama systems to the uMkhomazi scheme followed by the partial Northern Aqueduct system in 2043.

Figure 28: Phasing of Demands: Hazelmere to Durban Heights

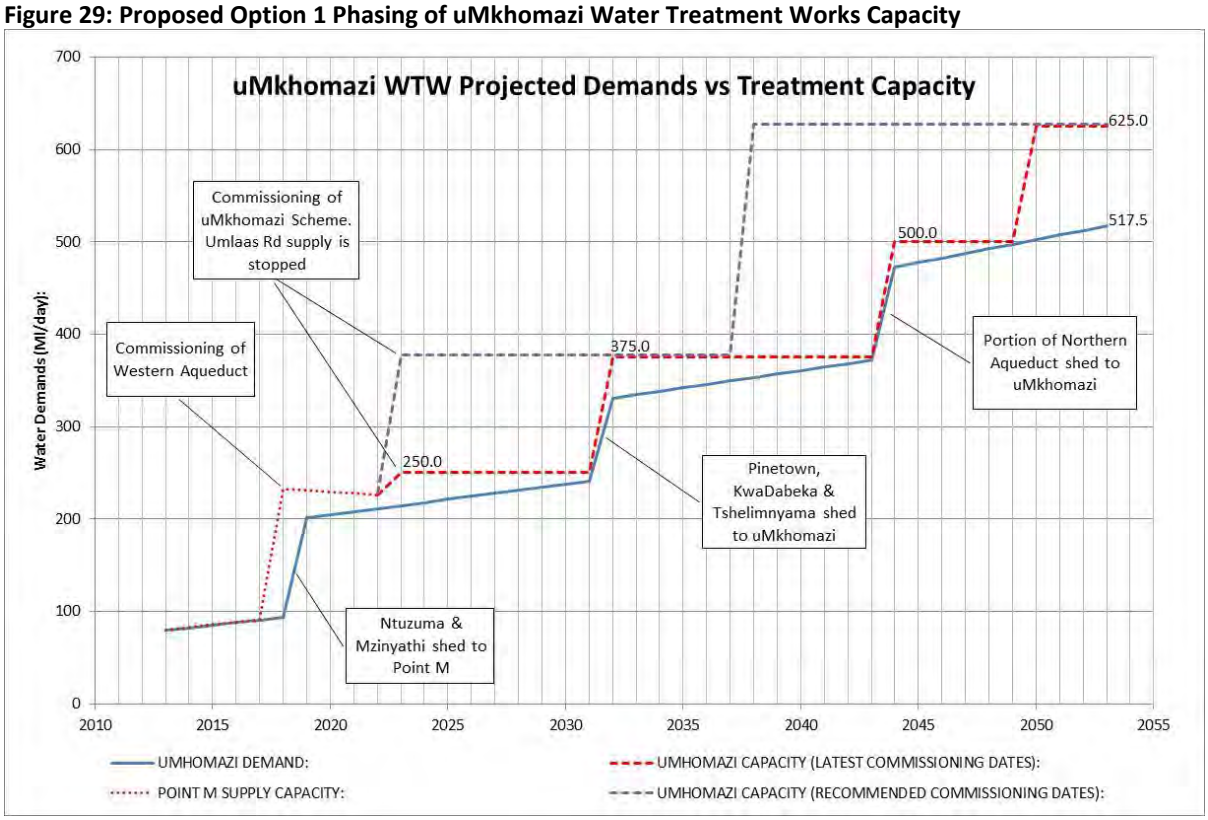


Hazelmere WTW presently supplies water to Ballito, Stanger and surrounds via the Ballito Pipeline. When Umgeni Water's Lower Thukela Bulk Water Supply Scheme is commissioned in 2014, it will take over the Ballito water demand, freeing up significant capacity at Hazelmere WTW. The curves in **Figure 28** already reflect this shift, given that it is a forgone conclusion.

It is not obvious from **Figure 28** that although Hazelmere WTW appears to have spare capacity up to 2026, the subsystems of Waterloo and iNyaninga run out of capacity in the years 2018 and 2023 respectively. Unless the pumps and / or pipelines within these subsystems are upgraded, these demands will need to be transferred to Durban Heights in 2018 and 2023.

Between 2024 and 2053, Hazelmere WTW and its remaining subsystems have sufficient capacity to meet the predicted growth in demands.

Figure 29: Proposed Option 1 Phasing of uMkhomazi Water Treatment Works Capacity



6.2.1. Conclusions: Water Treatment Works Phasing

6.2.1.1. WTW Phasing Option 1

Figure 29 shows how the phasing of demands away from Durban Heights and Hazelmere results in a phased increase in water demands on the uMkhomazi scheme. The uMkhomazi water treatment works has been planned such that it can be constructed in modules of 125 Ml/day. Phasing depicting the latest possible commissioning dates as well as a recommended alternative showing earlier commissioning dates are indicated in **Figure 29**.

It is evident from **Figure 29** that the minimum size of treatment plant required upon commissioning of the scheme is 250 Ml/day. This will provide sufficient capacity between commissioning and the year 2031 when the Pinetown, KwaDabeka and Tshelimnyama subsystems are transferred to the uMkhomazi scheme. A further 125 Ml/day module will therefore be required in 2031. It is however recommended that a 375 Ml/day module be constructed initially so as to allow spare capacity for outages that may occur on the aged pumped systems from Durban Heights Waterworks. Should this recommendation be accepted, the Pinetown, KwaDabeka and Tshelimnyama subsystems can be transferred to the uMkhomazi scheme immediately after commissioning of the 375 Ml/day capacity WTW in the year 2023.

A further 125 Ml/day module will be required in 2043 when a portion of the Northern Aqueduct demand is shed to the uMkhomazi scheme. This will however, quickly run out of capacity by 2049

and it is therefore recommended that a 250 Ml/day module be constructed instead in 2039, taking the total WTW capacity to 625 Ml/day in that year.

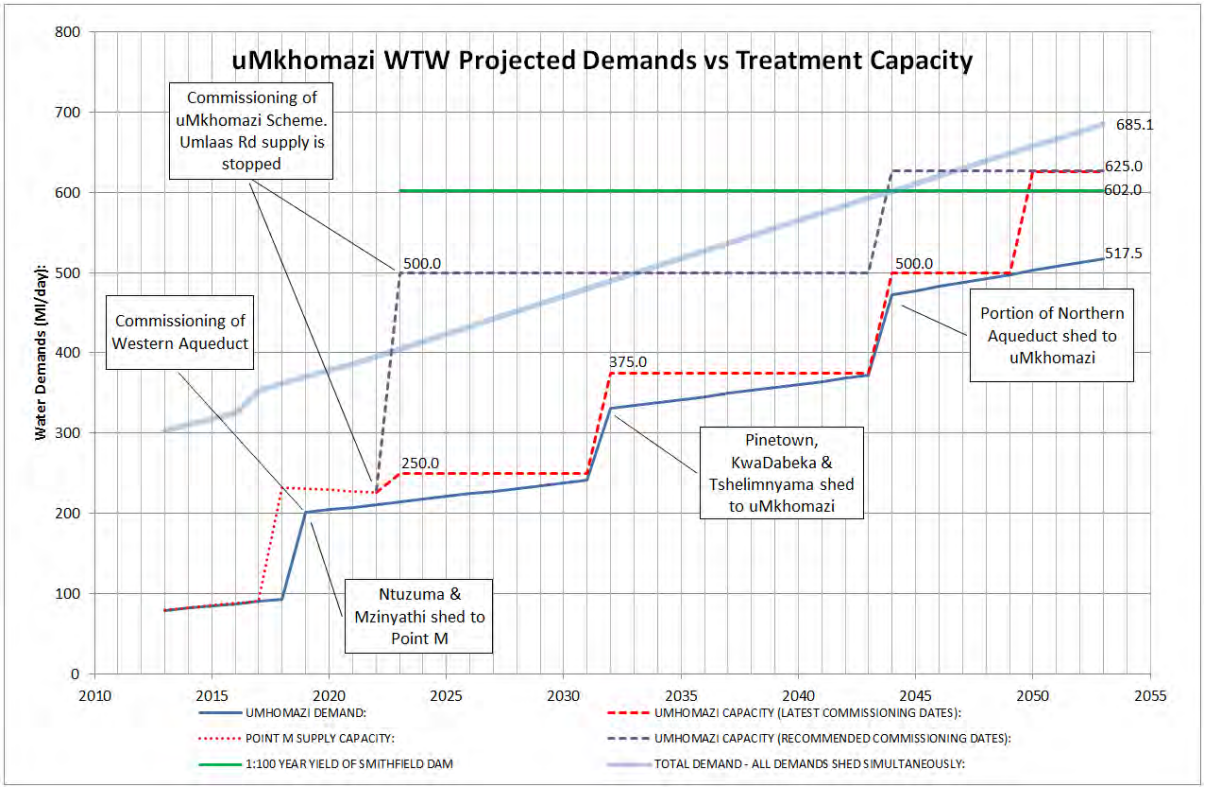
6.2.1.2. WTW Phasing Option 2

The initial WTW in Option 1 above was determined based on the projected uptake in demand in accordance with the projected water demand curve. The Option 1 phasing proposed that the first phase have a capacity of 375 Ml/day upon commissioning in 2023, with an augmentation in 2038 of 250 Ml/day, taking the capacity to a total of 625 Ml/day. As the WTW is designed in 125 Ml/day modules, this would require four modules to be built in 2023 with a further two in 2038.

As the outcome of a separate study, DWA have recommended to UW, based on factors that do not form part of the uMkhomazi study, that the first phase of the WTW be increased to 500 Ml/day upon commissioning in 2023, with a 125 Ml/day increase to 625 Ml/day in 2044. UW accepted this recommendation and this phasing was adopted. Five WTW modules will be required in 2023, with a sixth in 2044.

The revised phasing of the WTW is attached as **Figure 30**.

Figure 30: Proposed Option 2 Phasing of uMkhomazi Water Treatment Works Capacity



6.2.2. Conclusions: Potable Water Pipeline Phasing

The factors considered in determining the design capacity of the pipeline are listed below.

- Projected 2053 water demands (685 Ml/day, see **Figure 29)**
- Capacity of the WTW phase up to the year 2053 based on projected water demands (625 Ml/day, see **Figure 30**)
- Capacity of the Western Aqueduct (approximately 490 Ml/day)
- 1:100 year yield of Smithfield Dam (602 Ml/day, see **Figure 30**)
- 1:100 year combined yield of Smithfield and Impendle dams (1020 Ml/day)

It was agreed with Umgeni Water that the potable water pipeline should be sized to cater for the 1:100 year yield of Smithfield Dam excluding any contribution from Impendle Dam, i.e. 602 Ml/day.

The reasoning behind this decision is as follows:

- At 602 Ml/day the pipeline capacity caters for a 30 year project period from the planned commissioning date of the scheme in 2023. This results in a capacity that caters for all expected growth in demand in the supply region, without building in too much of spare capacity that may result in wasteful expenditure. The infrastructure will be neither undersized, i.e. running out of capacity too quickly, nor oversized, i.e. having excess spare capacity over a large part of the project planning period.
- The capacity of the receiving infrastructure, i.e. the Western Aqueduct pipeline, is limited to a peak flow of 490 Ml/day. Whilst having the option of constructing infrastructure with the full 602 Ml/day capacity, the WTW, potable water storage and pipeline can be built in modules or phases to suit the Western Aqueduct capacity.
- When Impendle Dam is built, the combined 1:100 year yield of Smithfield and Impendle dams will be 1020 Ml/day. The final planning for the water conveyance infrastructure from Impendle Dam may however result in raw water being transferred to Midmar Dam instead of Baynesfield. Should this scenario materialise, any potable water treatment, storage and conveyance capacity in excess of 602 Ml/day at Baynesfield would be wasted.

The uMkhomazi Potable Water Pipeline will be a large diameter steel pipeline. It will be cathodically protected against corrosion and will have a useful life well in excess of thirty years. Construction of a pipeline of this diameter and with a length of 25 kilometres is costly and is very disruptive to the environment, residences, businesses and farming operations.

It is therefore considered unwise to phase the construction of the pipeline over the analysis period by building a number of smaller diameter pipelines; i.e. one initially, followed by a second one in parallel some years later. The initial pipeline capacity constructed should therefore be sufficient to supply an AADD of 602 Ml/day.

Further details in relation to the pipeline are contained in Report No. **108/114/12/R4 – Pipeline Design Report.**

7. References

7.1. Reports

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