Water Administration System (WAS) Close out report Monitoring & Evaluation †

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Contents

Chapter 1

Introduction

1.1 Introduction

NB Systems cc has been tasked by the Strategic Water Partners Network (SWPN) to implement the water release module of the Water Adminstration System (WAS) at the following irrigation schemes:

- Orange Riet Water User Association (WUA)
- Impala Water WUA
- Loskop Irrigation Board (Left & Right bank)
- Lower Olifants River WUA
- Hartbeespoort Irrigation Board (East canal)
- Nzhelele Goverment Water Scheme (GWS)

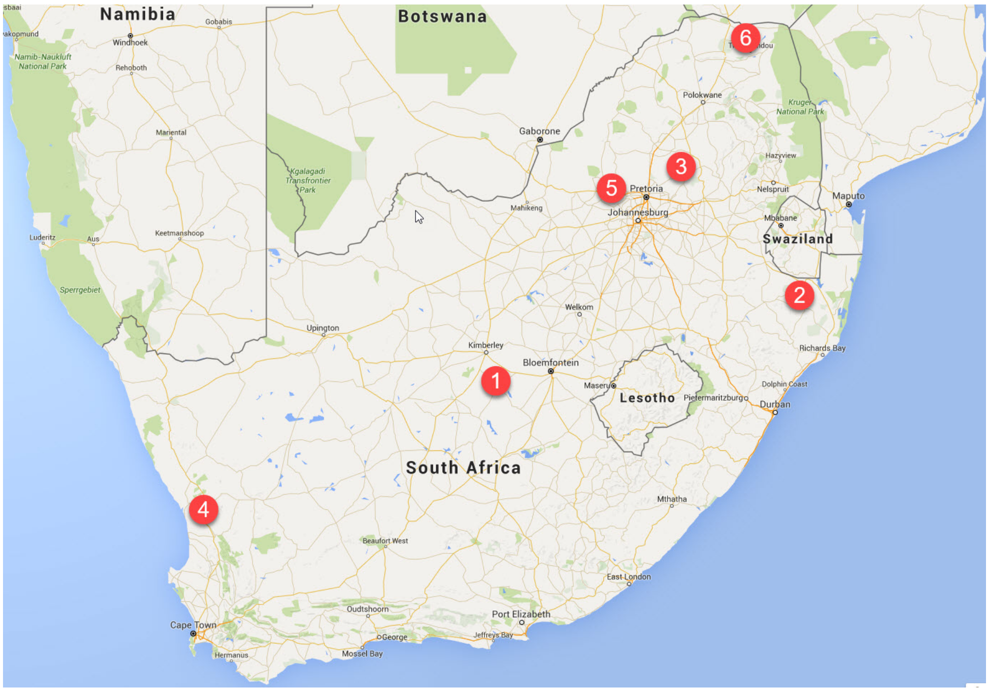

Figure 1.1: Locality map

The WAS makes use of nine modules and it is the choice of the specific scheme to decide which modules to implement depending on their specific needs. This project focuses on the implementation of the water release module with the main aim of reducing water losses. The main function of the

	Irrigation scheme	Province	Area (ha)	Quota (m^3/ha)	Full quota (m^3)	Abstractions
1	Orange Riet WUA	Northern Cape/Free State	15 941	11 000	175 351 000	679
2	Impala WUA	KZN	17 012	10 000	170 120 000	423
3	Loskop Irrigation Board: Left bank canal	Mpumalanga	14 398	7 700	110 864 600	586
3	Loskop Irrigation Board: Right bank canal	Mpumalanga	1 776	7 700	13 675 200	72
4	Lower Olifants River WUA	Western Cape	9 510	12 200	116 022 000	1 206
5	Hartbeespoort Irrigation Board (East canal)	North West	6 828	6 200	42 333 600	892
6	Njelele GWS	Limpopo	2 914	8 400	24 477 600	86
			68 379		652 844 000	3 944

Figure 1.2: Irrigation scheme data

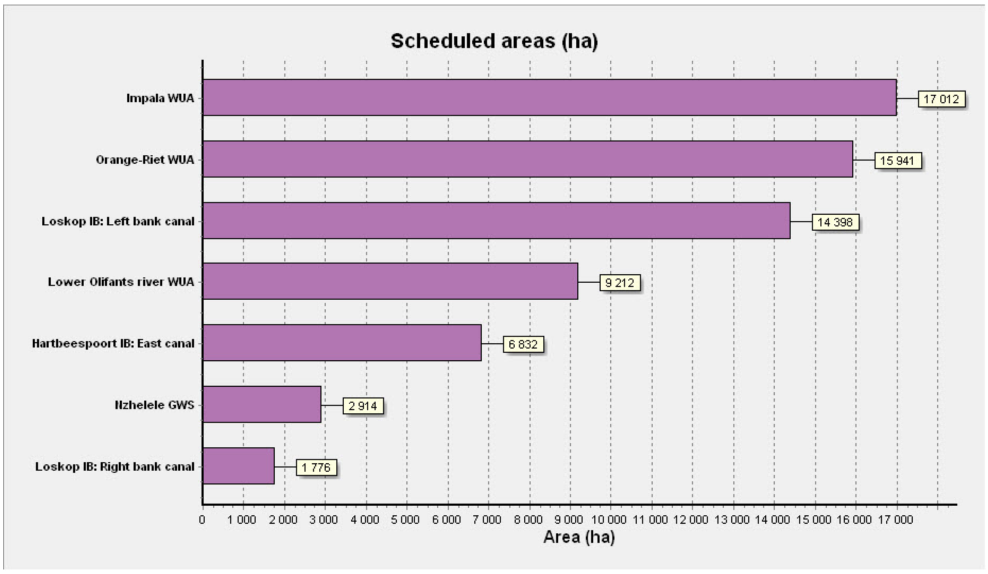

Figure 1.3: Scheduled areas (ha)

water release module is to minimise water losses and to simplify the water release calculations.

The stated water loss percentages at all of the schemes that are using the WAS were never validated independently. The implementation of the water release module, however requires an independent determination of the base line water loss. The base line water loss is needed to determine the extent of the success of the implementation of the water release module.

The determination of the base line water loss depends on:

- Accurate historical release data which means that there must be a reliable measuring station at the inflow into the scheme.

- A complete set of water ordered data for the corresponding period under investigation.

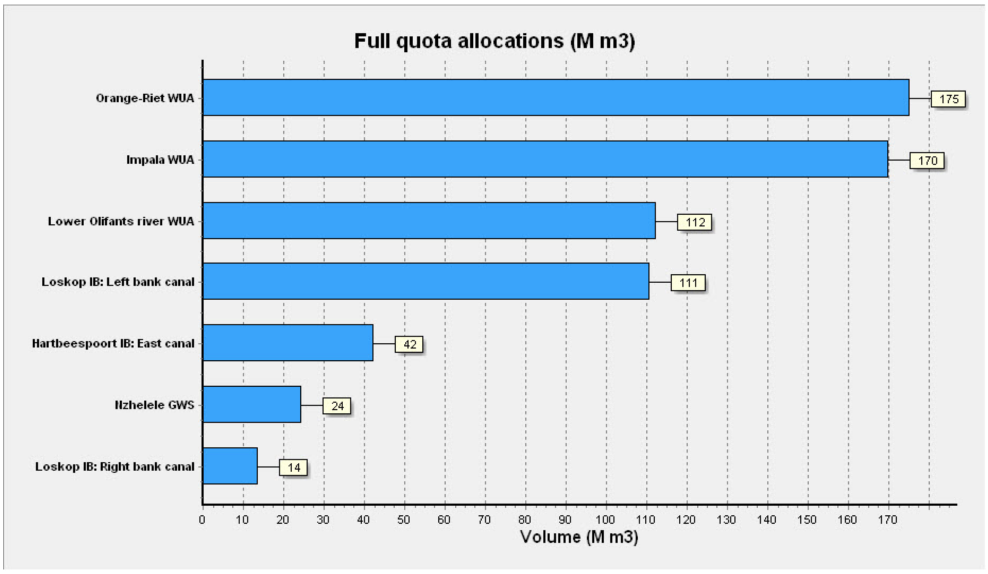

Figure 1.4: Full quota allocations (M m^3)

The global water loss volume is calculated by taking the difference between the total of water released and the total of water ordered. The percentage water loss is calculated using the following equation.

$$Water\ loss(\%) = \frac{(A - B)}{A} \times 100$$

where
A = Released volume (m^3)
B = Ordered volume (m^3)

1.2 Project objectives

The primary objective of the project is to reduce water losses and the overall water demand of selected schemes through the implementation of the Water Administration System water release module. The specific Objectives are:

1. To reduce water losses and the overall water demand of selected irrigation schemes in order to progressively close the water gap at the local and catchment level.

2. To improve scheme financial management and productivity through more efficient water use.

3. To train and capacitate scheme personnel to utilise the WAS in order to sustain and build on the efficiency gains realised through the system.

4. To develop a public platform for access to WAS information as a means of promoting peer regulation and incentive based monitoring in the agricultural sector related to water use.

5. To scope the water saving benefits and costs for further roll out of the water release module in irrigation schemes where the WAS has already been implemented.

1.3 Project scope

The water release module of WAS must be installed at five irrigation schemes that have been selected in consultation with the SWPN ASC using pre-set criteria. The schemes selected are: Impala, Hartbeespoort (East Canal), Loskop, Lower Olifants, and Nzhelele irrigation schemes. In addition, measurement activities will be undertaken on the Orange Riet Irrigation scheme which was supported in the previous phase of the WAS project roll out.

The implementation of the WAS water release module will contain the following components:

1. Using data available, quantify the water saving benefits and costs (time and money) for further roll out of the water release module in the irrigation schemes where WAS has already been implemented.

2. Installation of good quality measuring stations at appropriate locations for the calculation of baseline water losses.

3. Hosting of measurement information on a real time monitoring system to enable external validation of baseline information.

4. Development of an appropriate training programme to capacitate scheme management and operational personnel on the use of the WAS system. This may include scheme personnel outside the 5 selected schemes who may benefit from the training proposed. Furthermore, the training programme must incorporate schemes supported in the first phase of the WAS deployment which included Sand-Vet, Hartbeespoort (West Canal), Vaalharts and Orange Riet irrigation schemes.

5. Development of an appropriate public platform for access to WAS information generated during the course of this assignment

6. Monthly monitoring of all participating schemes as well as schemes supported in the first phase of the WAS implementation for the generation of Water Use Efficiency Accounting Reports, which must be submitted to the Department of Water and Sanitation. In addition, the monitoring component must include the development of a credible business case for the universal (throughout South Africa) roll out of the WAS system to motivate both private and public sector role players to invest and adopt the system. This will be done to ensure future sustainability of the savings achieved through this seed investment into the WAS deployment provided by the SWPN.

The six irrigation schemes that were selected for this project already used the WAS for a couple of years except for the Nzhelele GWS. They did use the WAS for a number of years but had to stop because NB Systems Cc was not on the list of preferred service providers for the DWS.

Chapter 2

Orange-Riet WUA

2.1 Background

The Orange-Riet Water User Association (ORWUA) is situated in the Upper Orange River catchment in South Africa. Water is released from the Van der Kloof Dam on the Orange river, travels through a 13,6 km canal to the Scheiding Pumping Station where it is pumped 47 m up before being released into the 112 km long Orange-Riet canal.

Orange-Riet WUA includes a total of 15 941 ha and 679 abstraction points. Their full quota is 11 000 m^3/ha per year which means that 175 351 000 m^3 is available for distribution each water year under normal conditions.

The water year of Orange-Riet WUA starts in April. The Water Administration System (WAS) was implemented in 2001 and they have been using it successfully ever since. The canal network data has been captured and the release module has been implemented successfully.

2.2 Inception meeting

An inception meeting was held on the 4th of May 2016 that was attended by:

- Dr N Benadé - Project leader
- Mr H Du Toit - CEO ORWUA
- Mr J Fourie - DWS head office
- Mrs R Malan - ORWUA
- Mr I Masike - DWS head office

2.3 Canal network data

The data for the Orange-Riet canal network has been captured and verified. The calibration of and training on the use of the release module have been completed during phase 1 of the project.

2.4 Water orders

The water orders and meter readings at ORWUA are up to date. This information is captured weekly in an ongoing basis and is required to keep track of individual water balances and to generate monthly invoices. An irrigation scheme cannot operate successfully without this information being up to date.

A volume of 5 million m^3 is included as a water use which is allowed to lower the salt concentration in the Lower Riet river down stream of the scheme. This volume is distributed evenly over the water year under consideration.

2.5 Measuring station

A new Cello logger has been installed at the Scheiding measuring station during the first week of July 2016. The Cello logger has been linked to the Zednet Internet platform and it can be seen in Figure 2.1. Data can now be downloaded and processed automatically. This simplifies the processing of water use reports which, in turn, saves a lot of time and money in the process.

Figure 2.1: Scheiding measuring station with Cello logger

2.6 Results

Figure 2.2 and 2.3 shows the water use and water loss summary results from 2014 until 2017. From the results it is evdident that their is a downward trend in water losses from year to year. It is important to note that the year 2017 only includes data up to October which was the latest data available.

Water Use Efficiency Accounting Report History (2014 to 2017)
Orange-Riet WUA

Year	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)
2014	144 341	2 165	647	456	0	4 169	151 773	264 304	112 532	42.6
2015	194 641	2 084	799	414	0	1 698	199 637	302 674	103 036	34.0
2016	186 062	2 677	834	400	0	4 039	194 017	292 413	98 397	33.6
2017	98 479	2 595	658	326	1 252	5 166	108 476	184 655	76 182	41.3

Figure 2.2: Orange Riet WUA: Water loss summary table

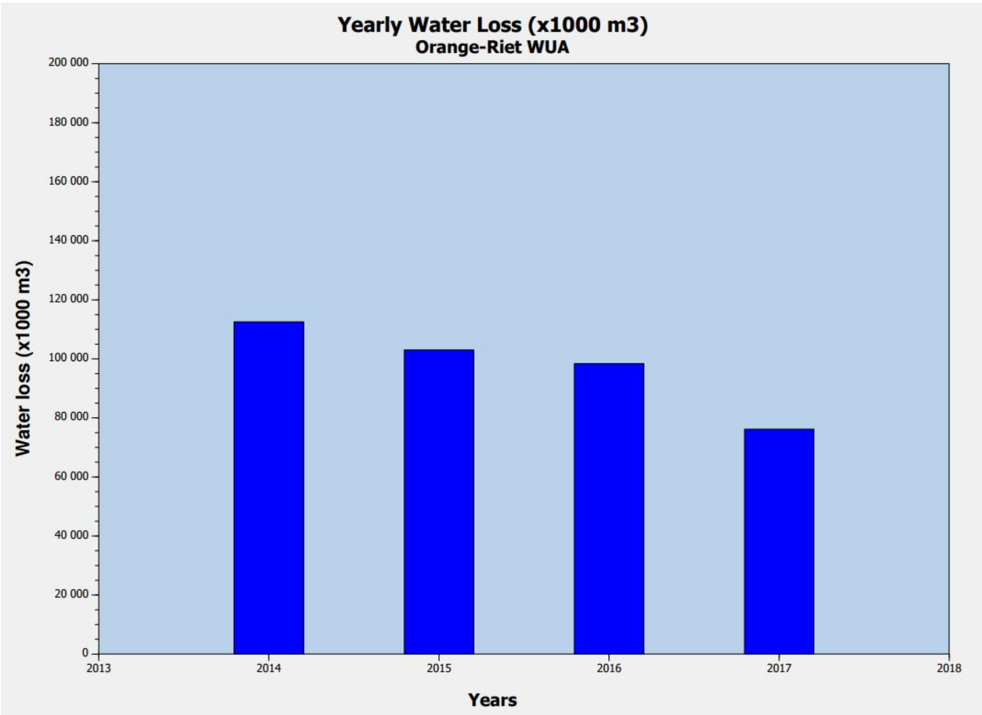

Figure 2.3: Orange Riet WUA: Water loss summary graph

Chapter 3

Impala WUA

3.1 Background

The main water source at Impala WUA is the Bivane dam which was built on the Bivane river and completed in the year 2000.

Conceptualised, planned and built by the Impala Water Users Association, the dam was conceived as a sustainable water supply for the local irrigation scheme, and to secure primary water for the town of Pongola and surrounding communities. Its waters are collected from a catchment area of 1 600 square kilometers, and have a surface area of 700 ha.

Besides supplying potable water to 2 500 people, the dam also supplies irrigation water for 16 200 ha of Pongola farmland.

Impala WUA has a complete measuring system in place which monitors and records flow records at the inflow into the scheme and at all the main diversion points and canal tail ends.

The water year of Impala WUA starts in May. They have been using the WAS since 1997 which is 20 years.

3.2 Inception meeting

An inception meeting was held on the 17$^{\text{th}}$ of May 2016 at the offices of Impala WUA and it was attended by:

- Nico Benadé - Project leader
- Johan Boonzaaier - CEO
- Fanie Cronjé - Head water control officer
- Andries Padi - DWS head office

3.3 Distribution sheet data

Impala WUA prefers the twelve hourly water distribution sheet method to calculate their water releases. The data has been captured and verified. Their main reason for not using it at the moment has been resolved. They are currently using an Excel spreadsheet to calculate their water releases but they are positive to implement the new method.

3.4 Water orders

The water orders and meter readings at Impala WUA are up to date. This information is captured weekly in an ongoing basis and is required to keep track of individual water balances and to generate monthly invoices.

3.5 Measuring stations

The main inflow measuring station into their canal network is shown in Figure 3.1. Impala WUA has already installed Cello loggers at a number of measuring stations that covers all their important water distribution sites. They are using SMS-communication to transmit all the data to a base station in their offices.

As part of this project, the inflow (see Figure 3.1) and the main return flow to the river was connected to the Zednet platform. They have also connected all of their other measuring stations to the Zednet platform as shown in Figure 3.2. This enables them to generate water use efficiency reports on sub-areas as well.

Figure 3.1: Grootdraai inflow measuring station

Id	Scheme	Description
5785	ImpalaWUA	Groot Draai water (river level upstream)
5786	ImpalaWUA	Weggooi Water Level Transvaal verdeling (river level upstr)
5787	ImpalaWUA	Nochane Water Level Transvaal verdeling (river level upstr)
5947	ImpalaWUA	Nqumile Water level Mbega eindpunt (river level upstream)
5985	ImpalaWUA	Mhlati weir (river level upstream)
5986	ImpalaWUA	Notchane eindpunt (canal level)
6011	ImpalaWUA	Wonderfontein Hk water level Natal verdeling (canal level)
6035	ImpalaWUA	Sitilo Hk dorpsverdeling (canal level)
6044	ImpalaWUA	Drein Sitilo weggooi (canal level)
6045	ImpalaWUA	Tvl Hk verdeling (canal level)
6046	ImpalaWUA	D9 Hk water level: Dorpsverdeling (canal level)
6047	ImpalaWUA	Weggooi Water Sitilo Eindpunt (canal level)
6048	ImpalaWUA	Natal Hk verdeling (canal level)
6049	ImpalaWUA	Mbega water level Natal verdeling (canal level)
6050	ImpalaWUA	Mbega weggooi Naltal verdeling (canal level)
6051	ImpalaWUA	Privaat kanaal Mbega (canal level)
6075	ImpalaWUA	Upper Pongola (river level upstream
6076	ImpalaWUA	Bivane Dam Weir (river level upstream)
6104	ImpalaWUA	Tlc (canal level)
6105	ImpalaWUA	Wonderfontein Weggooi Kanaal (canal level)
6106	ImpalaWUA	Wonderfontein Weggooi (canal level)
6107	ImpalaWUA	Wonderfontein Eindpunt (canal level)
6387	ImpalaWUA	Bivane Dam (dam level)
6402	ImpalaWUA	Tk 11 eindpunt (canal level)

Figure 3.2: Impala WUA: list of Cello measuring stations

3.6 Results

The water loss results of Impala WUA are shown in Figure 3.3 and 3.4. The results are pretty good although it needs to be put into perspective.

Their current water loss results (2016 & 2017) are produced under severe water restrictions and abnormal circumstances. It is expected that the results will change once the Bivane dams fills up enough so that they can return to normal operating conditions.

The year 2017 is up to date until October but it already shows an increase in the total volume that was release compared to the previous year.

Water Use Efficiency Accounting Report History (2014 to 2017)
Impala WUA

Year	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)
2014	95 206	1 004	2 352	162	27 717	0	126 445	192 310	65 865	34.2
2015	95 659	757	2 302	192	23 079	0	121 994	180 453	58 460	32.4
2016	88 978	1 136	1 640	196	26 932	0	118 884	137 004	18 121	13.2
2017	93 697	735	1 990	148	27 938	0	124 511	148 719	24 209	16.3

Figure 3.3: Impala WUA: Water loss history table

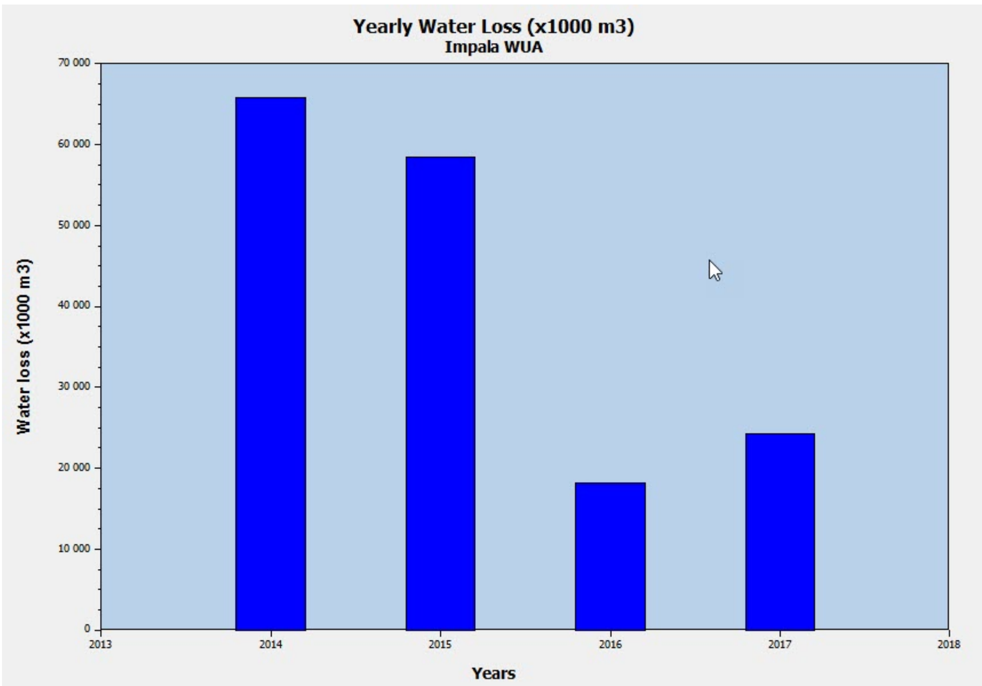

Figure 3.4: Impala WUA: Water loss history chart

Chapter 4

Loskop WUA

4.1 Background

Loskop dam has been constructed more than 70 years ago and it is situated across a gorge on the Olifants River about 32 km south of Groblersdal in Mpumalanga. The Loskop Irrigation Board provides irrigation water to 16 174 hectares of agricultural land by means of irrigation canals with a total length of more than 550 kilometers.

At present, the Loskop irrigation scheme consists of 658 properties with an average scheduled area of 25,7 ha each. Wheat, grapes, vegetables, tobacco, peanuts, cotton, and citrus fruit are cultivated. Furthermore, water from the dam supplies the Hereford Irrigation Board, the Olifants River Irrigation Board, as well as the Groblersdal and Marble Hall municipalities.

Loskop was the first irrigation scheme in South Africa to make use of the Water Administration System (WAS) which was installed in 1986. All the research and testing to develop WAS was done at the then Loskop GWS.

4.2 Inception meeting

An inception meeting was held on the 21st of April 2016 that was attended by:

- Dr N Benadé - Project leader - NB Systems
- Mr M Padi - DWS head office
- Mrs L Sithole - DWS head office
- Mr J van Stryp - CEO Loskop IB
- Mr P Pretorius - Loskop IB

4.3 Distribution sheet data

Loskop Irrigation Board opted to use the twelve hourly distribution sheet method to calculate their water releases for its ease of use and practical approach.

The twelve hourly distribution sheet data has been captured and training to use it has been given. They are now in the process of changing their operational procedures to cater for the new way of water release calculation.

4.4 Water orders

Loskop IB has eight water wards and it is the only irrigation scheme where all the water ward managers have their own computers with the WAS installed. They capture the water orders on a weekly basis and then make printouts of all their distribution sheets and sluice water balances.

This information is then re-captured and verified at the boards offices on a weekly basis. Their water releases for the left and right bank canals are then calculated manually.

4.5 Measuring stations

4.5.1 Right bank canal (B3H016)

A new Cello logger was installed at the right bank canal on the 21st of June 2016. The reference measuring plate reading was 150mm at 11:47. The signal at this station was weak and an antenna had to be installed to solve the problem. The logger is connected to the Zednet network and everything seems to work fine.

Figure 4.1: Measuring station at Loskop IB right bank canal

4.5.2 Results: Right bank canal

The current average water loss in m^3 per week for the 2017/2018 water year is 64 231 m ^{3} and it is shown in Figure 4.2.

The current average % water loss per week for the 2017/2018 water year stabilised at 23% and it is shown in Figure 4.3.

There is currently not enough results (the time period is too short) to make any real conclusions on the performance of the right bank main canal. The initial data before the new Cello logger was installed cannot be verified at the moment. There is however a decrease in the average water loss per week compared to the previous year.

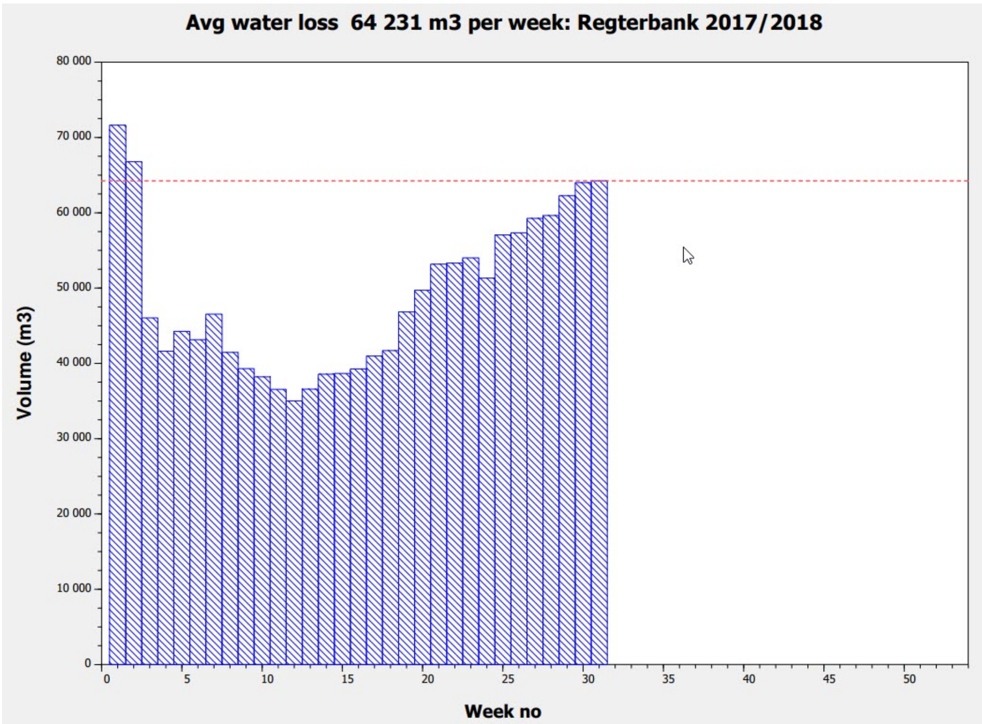

Figure 4.2: Loskop IB right bank canal: Average weekly water loss (m^3)

4.5.3 Left bank canal (B3H015)

A new Cello logger was installed at the left bank canal on the 21st of June 2016. The reference measuring plate reading was 643mm at 12:50. A 200mm difference on the measuring plate was picked up and corrected during the installation. This means that their water losses are currently much higher than they are used to.

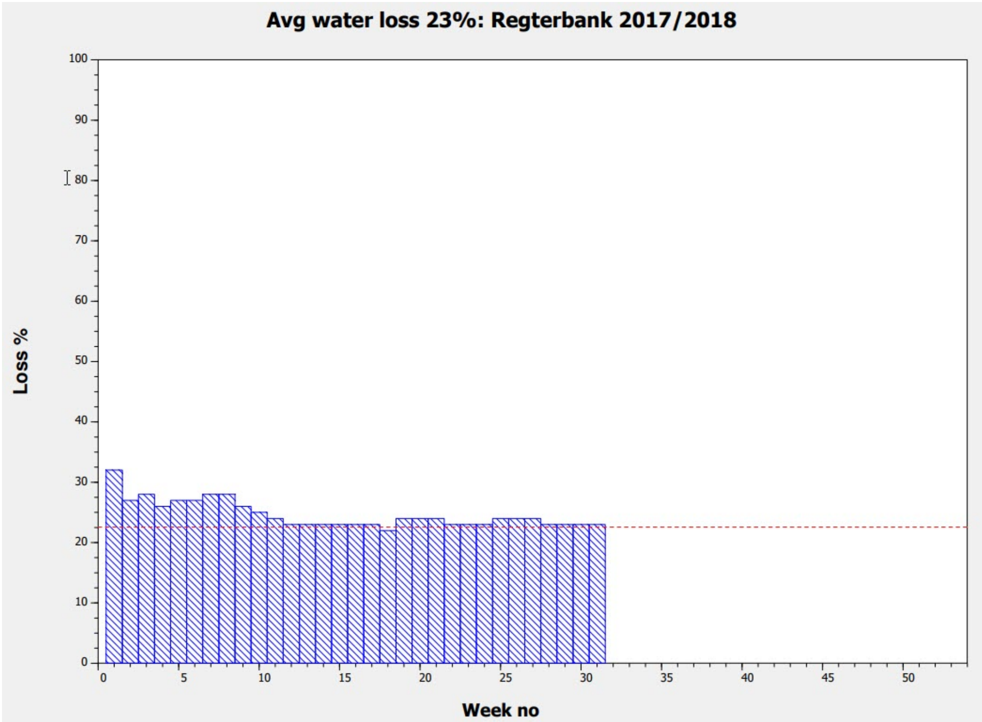

Figure 4.3: Loskop IB right bank canal: Average weekly water loss (%)

No problem was experienced with the communication. The logger is connected to the Zednet network and everything is working fine.

4.5.4 Results: Left bank canal

The current average water loss in m^3 per week for the 2017/2018 water year is 655 238 m ^{3} and it is shown in Figure 4.5. This is lower compared to the previous year.

The current average % water loss per week of the 2017/2018 water year stabilised at 25% and it is shown in Figure 4.6. This percentage is lower compared to the 34% previously. The initial difference on measuring plate has been re-checked and there is currently a difference of 20mm that will be investigated as soon as possible.

There is currently not enough results (the time period is too short) to make any real conclusions on the performance of the left bank main canal.

Figure 4.4: Measuring station at Loskop IB left bank canal

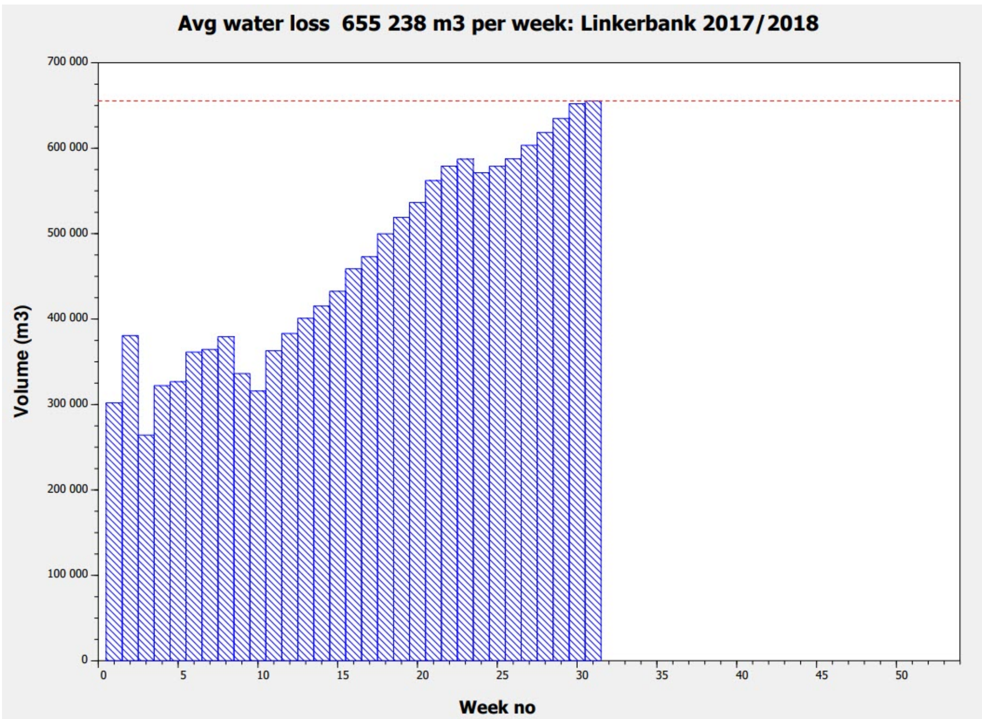

Figure 4.5: Loskop IB left bank canal: Average weekly water loss (m^3)

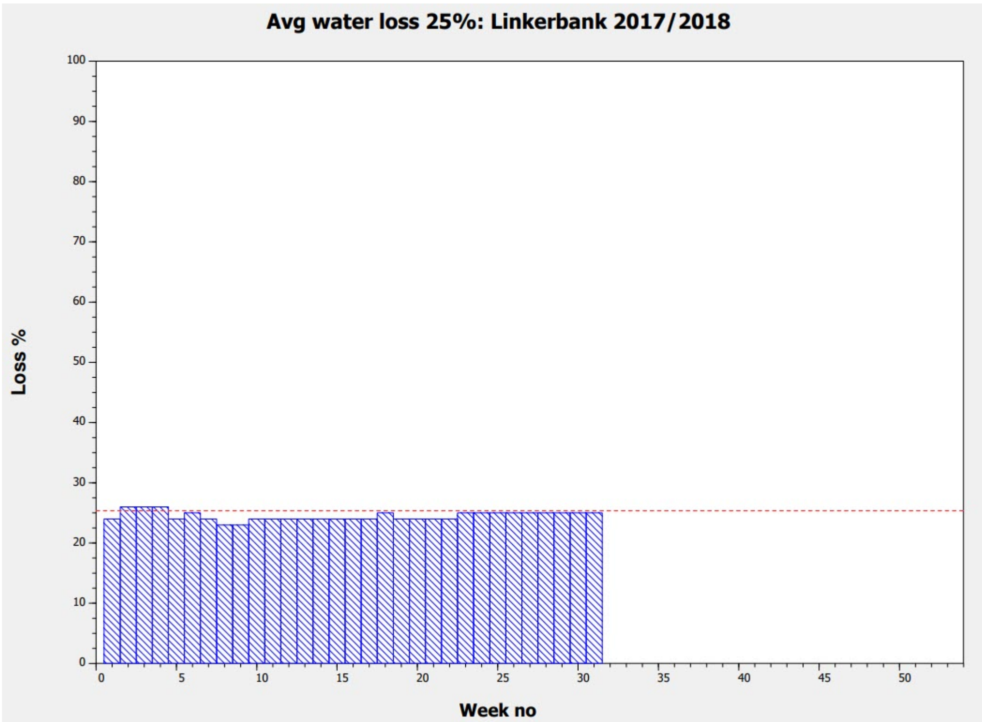

Figure 4.6: Loskop IB left bank canal: Average weekly water loss (%)

Chapter 5

Lower Olifants River WUA

5.1 Background

The Lower Olifants River Water User Association (LORWUA) was the first Water User Association (WUA) to be established in South Africa. LORWUA is one of the largest irrigation farming enterprises in South Africa that delivers water on demand to over 1 000 abstraction points. Their total irrigated area is 9 510 ha.

Water is ordered on a weekly basis from the Clanwilliam dam into the Bulshoek dam and then into a 90 km main canal with secondary canals for distribution. LORWUA is situated in the Vredendal area, Western Province and the main sources for providing water to the irrigation scheme are the Bulshoek- and Clanwilliam dams.

The irrigation scheme is divided into nine wards. The main canal splits into two branch canals namely the left bank, which is 136 km long and the right bank canal which is 123 km long. The scheme has a total of 1 052 sluices to provide water to a scheduled quota of 12 200 m^3/ha per year. This translates to a volume of 116 million m^3 per year.

5.2 Inception meeting

An inception meeting was held on the 9$^{\text{th}}$ of July 2016 that was attended by:

- Dr N Benadé - Project leader - NB Systems
- Mr J Fourie - DWS head office
- Mr J Matthee - CEO LORWUA
- Mr M James - LORWUA
- Mr C Visagie - LORWUA
- Mr C Smith - LORWUA
- Mr K Wiese - LORWUA

5.3 Distribution sheet data

LORWUA is the only irrigation scheme in South Africa that make use of a six hourly distribution sheet which they call a "bokvel". A decision was made at the inception meeting to add the same functionality of the twelve hourly distribution sheet to the six hourly one. LORWUA has been using the water distribution sheet method to calculate their releases from Bulshoek dam with great success.

5.4 Water orders

LORWUA has nine water wards and the ward managers capture all the water orders once a week. LORWUA was the first irrigation scheme that introduced the WAS-client software to their farmers. They are also the first where their water managers make use of the WAS-client to capture water orders on a water ward basis.

The WAS-client software is specifically developed to be used by farmers to manage their water ordering and water usage information per abstraction point on a weekly basis. There is no limit on the number of abstraction points and water years that can be handled. The setup of the WAS-client software has been fully automated which makes the roll-out to the farmers and the water ward managers very easy.

The water orders and meter readings at LORWUA are up to date.

5.5 Measuring stations

An existing Cello, that is connected to the Zednet network, is installed in the main canal at Bulshoek dam (see Figure 5.1). This measuring station is working fine and reliable historical data is available to calculate a base line water loss.

Their is however a challenge in terms of the uploading of the data to the Zednet database. It seems that DWS has terminated the SIM-card on the logger since the end of July 2017. This problem will be addressed as soon as possible.

5.6 Results

The yearly water loss history for the past four years is shown in Table 5.1. It shows that the yearly water loss has a consistent downwards trend. It is important to note that the results of year 2017 has been produced under severe water restrictions which explains the much lower total loss compared to the other years. The same results is shown as a bar chart in Figure 5.2.

What was interesting is the fact that their release volumes which were calculated manually were virtual identical compared to the volumes calcu-

Figure 5.1: Measuring station at Bulshoek dam main canal

lated using the measured values. This is an indication of excellent control of their releases from the Bulshoek dam.

The results are excellent and it seems like they have their water losses perfectly under control.

Water Use Efficiency Accounting Report History (2014 to 2017)
Lower Olifants river WUA

Year	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)
2014	94 191	10 201	0	1 979	0	0	106 374	137 665	31 290	22.7
2015	80 111	9 922	0	1 982	0	0	92 013	119 784	27 769	23.2
2016	73 433	8 137	0	1 931	0	0	83 505	108 596	25 092	23.1
2017	45 618	6 491	0	1 529	0	0	53 636	68 574	14 939	21.8

Table 5.1: Lower Olifants River WUA: Yearly water loss history table

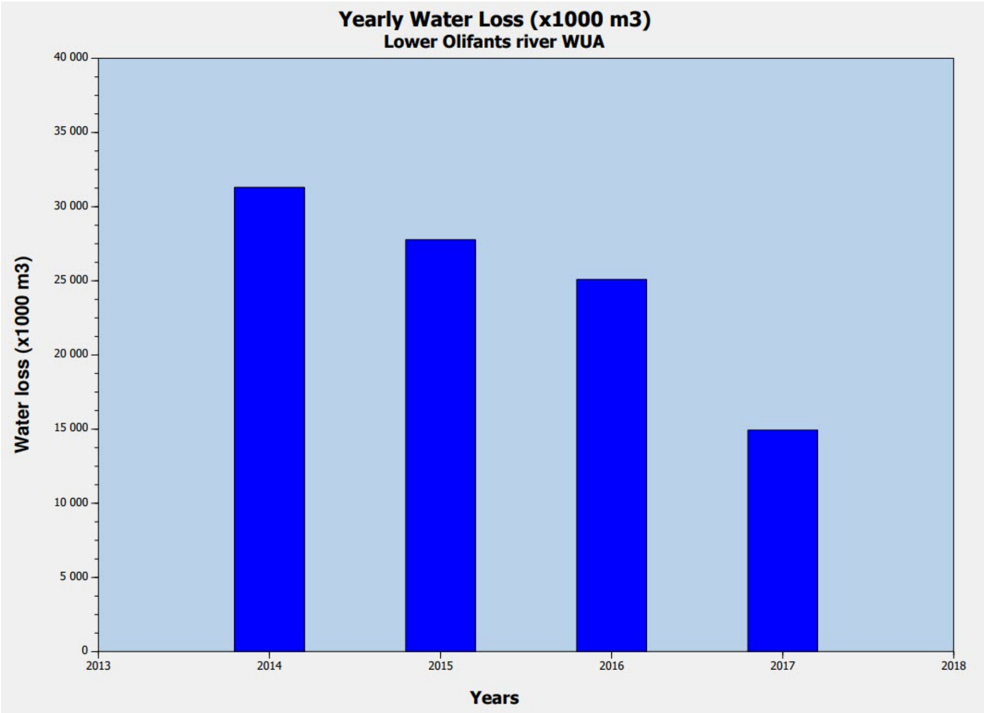

Figure 5.2: Lower Olifants River WUA: Yearly water loss history graph

Chapter 6

Nzhelele WUA

6.1 Background

Nzhelele GWS is the only government operated scheme that is part of this project. The WAS was in use at Nzhelele until 2010 where after they went back to using an Excel spreadsheet based system. The WAS database is fortunately still available with all the farmer and sluice details intact.

The scheme gets its water from the Nzhelele dam which is located on the Nzhelele River in Limpopo Province. The dam has a capacity of 55.3 million m^3. The scheme delivers water on demand to 86 abstraction points. Their total irrigated area is 2 914 ha and water is ordered on a weekly basis from the Nzhelele dam.

6.2 Inception meeting

An inception meeting was held on the 23rd of May 2016 that was attended by:

- Dr N Benadé - Project leader - NB Systems
- Mr A Padie - DWS head office
- Mr S Chauke - DWS Nzhelele
- Mr C Lusenga - DWS Tzaneen

6.3 Distribution sheet data

Nzhelele GWS has opted to use the twelve hourly distribution sheet to calculate their water releases. The distribution sheet data has been captured and training has been given in the use of it. Follow up training is however needed to ensure that the WAS operator at Nzhelele is proficient in using it.

6.4 Water orders

Their water orders are captured on an Excel spread sheet since they have stopped using the WAS in 2010. We have upgraded their WAS database to the latest version and also captured the water orders of the previous water year (2015/2016) to be able to calculate the baseline water loss.

We used their current Excel spread sheets to capture the historical data. Numerous errors were found including missing data and errors in the spread sheet equations.

On-site training has been given to the water distribution officer (Mr S Chauke) to be able to capture the water orders in WAS on a weekly basis. Since the initial training the officer has proven to be able to capture the water orders in WAS successfully. Mr Chauke has also completed a two day WAS training course in Pretoria since the initial training.

6.5 Measuring station

The measuring station at the inflow of the main canal is shown in Figure 6.1. The original plan was to install a Cello logger and link it to the Zednet network. This was however not possible due to the lack of a cellphone signal at the site.

The only alternative solution was to request the data from Hydro at the DWS Tzaneen offices on a monthly basis. The logger at the inflow of the main canal was replaced on request by DWS with a new one funded by the project. Data is now supplied by DWS Tzaneen office on request.

Figure 6.1: Measuring station at Nzhelele main canal

6.6 Results

The baseline water loss has been captured using the data from the previous water year. Measuring station data was however only available until January

2016 due to a battery failure on the DWS logger. The missing data could not be recovered and the current continuous data set starts on the 10th of January 2017.

The monthly water loss in x1000 m^3 and % for Feb, Mar and Apr is shown in Table 6.1. The water losses are fairly constant from month to month but there is not enough data to come to any conclusion.

Year	Mnth	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)
2017	Feb	871	0	0	0	0	0	871	1 144	273	23.9
2017	Mar	1 224	0	0	0	0	0	1 224	1 580	355	22.5
2017	Apr	1 071	34	0	0	0	0	1 105	1 434	329	22.9
		3 166	**34**	**0**	**0**	**0**	**0**	**3 200**	**4 158**	**957**	**23.0**

Table 6.1: Nzhelele GWS: Monthly water loss (x 1000 m^3)

Chapter 7

Hartbeespoort IB

7.1 Background

Hartbeespoort Dam is one of the most significant dams within the economic hub of the North West Province and of the Crocodile (West) Marico water management area. Hartbeespoort Dam is a vital resource that provides water to 1440 properties in the area.

The release of water from Hartbeespoort Dam into the canal system is controlled by the DWS and distributed by the irrigation board to users on request.

7.2 Inception meeting

An inception meeting was held on the 19$^{\text{th}}$ of April 2016 that was attended by:

- Dr N Benadé - Project leader - NB Systems
- Mr M Padi - DWS head office
- Mrs L Sithole - DWS head office
- Mrs A de Villiers - HBP
- Mr A Swanepoel - HBP
- Mr NL Fourie - HBP
- Mr G Brown - HBP

7.3 Canal network data

Hartbeespoort IB is the only scheme that is using the WAS with a dual user identification system, one for accounting purposes and another for water distribution management. User-id's are used for their account numbers and Alias-id's are used for their sluice numbers. The fact that there is not a one-to-one relationship between the two numbers complicates the implementation of the release module.

Hartbeespoort IB investigated both water release calculation methods which included the canal network approach and the twelve hourly distribution sheet method. They have decided to use the twelve hourly distribution sheet method to calculate their releases for its ease of use and it mimics their current release calculation procedures.

7.4 Water orders

The water orders and meter readings at Hartbeespoort IB are captured on a daily basis and are up to date. The successful implementation of the release module will however require that they change their current water order capturing procedures. Their current water release calculation depends on distribution sheets that are compiled manually by the water bailiffs on the different water wards and the water orders that are only captured afterwards in the WAS.

This procedure will have to be changed where the water orders are captured on the WAS and the distribution sheets are then generated automatically including predefined water losses. Although the water release module has been implemented and training given, Hartbeespoort IB currently still uses their old method of water release calculation.

They are however positive to move to the new method of release calculation which will take some time to change. Experience from other schemes in similar situations have proven that once they have made the change they don't go back due to the time savings, productivity improvements and ease of use.

7.5 Measuring stations

7.5.1 East canal (A2H117)

A Cello logger was installed at the inflow of the East canal on the 20^{th} of June 2016. The measuring structure is a rated section which means that it is not as accurate compared to a standard Parshall flume or Crump weir. It is however the best that can be done under the circumstances.

Hartbeespoort Irrigation Board has, since the installation of the new measuring station, used the Zednet Internet platform extensively for their water distribution management.

7.6 Results

Since the Cello logger was only installed in June 2016, the base line water loss was calculated using data supplied by the Head water control officer for the first part of the water year and measured values using the Cello logger for the latter part of the year.

The yearly water loss in x1000 m^3 for 2015, 2016 and 2017 calendar years is shown in Table 7.1. The yearly water loss graph for the same period is

Figure 7.1: Measuring station at Hartbeespoort IB East canal

shown in Figure 7.2. There is a notable decrease in the actual volume lost although the last year runs only up to the end of November 2017.

Water Use Efficiency Accounting Report History (2015 to 2017)
Hartbeespoort IB: East canal

Year	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)
2015	38 990	2 139	0	114	0	0	41 238	92 675	51 439	55.5
2016	31 757	1 989	0	115	0	0	33 858	76 975	43 115	56.0
2017	25 173	1 798	0	94	0	0	27 067	60 750	33 682	55.4

Table 7.1: Hartbeespoort IB East canal: Yearly water loss history

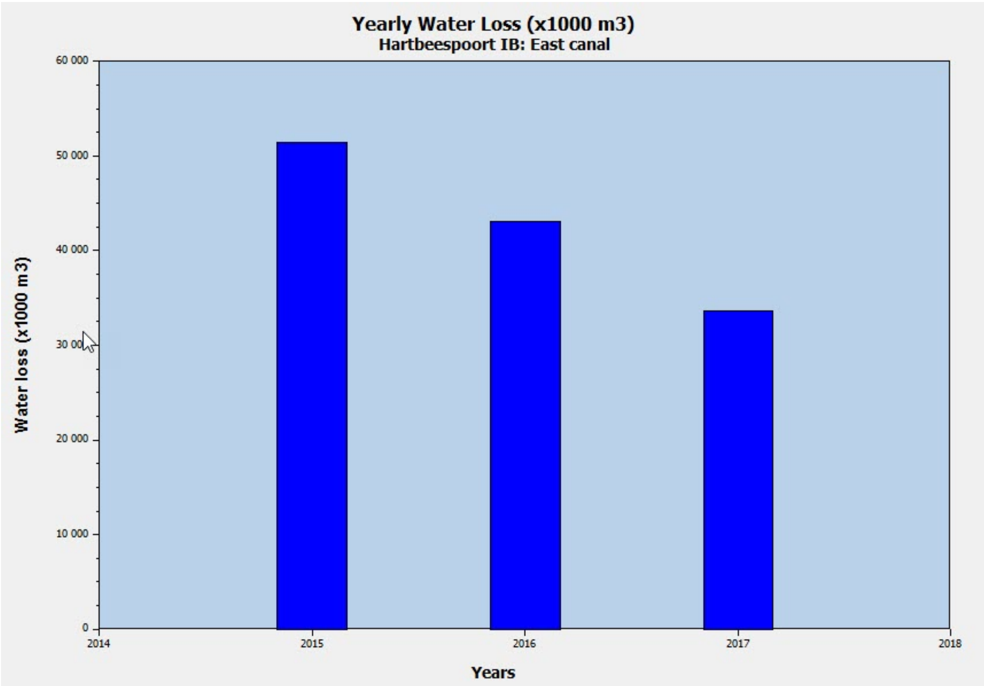

Figure 7.2: Hartbeespoort IB East canal: Yearly water loss (x1000 m^3)

Chapter 8

WAS Business case

8.1 Business case

The WAS is an integrated information management system for irrigation schemes that deliver water on demand through canal networks and rivers.

WAS is used for water distribution management and for the calculation of canal and dam operating procedures for a given downstream demand. WAS improves service delivery to farmers and saves:

- Time,
- Money and
- Water

8.1.1 WAS data flow

The WAS data flow diagram, as shown in Figure 8.1, displays the different components that is available for a complete roll-out of the WAS on an irrigation scheme that delivers water on demand.

The description of each component is as follows:

1. The WAS-client is a stand-alone application that is used by individual farmers to capture and maintain their own water orders. The software can upload and download water orders to and from the WAS database. This allows farmers to capture and keep a record of their own water orders for multiple sluices and synchronise it with the WAS database remotely through the internet.

   The WAS-client application can be downloaded by a farmer from the ***wateradmin*** website.

2. The WAS is a SQL relational database that is used at scheme level for water distribution and debit accounting management.

3. The ***www.wateradmin.co.za*** (Site map, Appendix A.1, page 66) website is a multi purpose website that is used for the following:

   - Save water orders that was uploaded by farmers using the WAS-client application.
   - Save water orders that was uploaded by the WAS.
   - Download WAS-client water orders into the WAS.
   - Display water orders, water reports and graphs that was uploaded using the WAS.

- Display water summary reports that was uploaded using the iScheme software.

4. The iScheme software is a database that is developed and used by NB Systems Cc to retrieve all the water use information that was uploaded to the ***wateradmin*** website using the WAS.

   iScheme then generates a water use history summary of all the schemes into a single report and upload it to the ***wateradmin*** website to be displayed.

5. Zednet is an Internet platform that is used to archive and display measuring station data on the Internet.

   The WAS makes use of the Zednet Application Programming Interface (API) to import measuring station data directly into the WAS database. This functionality makes it possible to generate water use reports automatically in the WAS which in turn are uploaded to the ***wateradmin*** website.

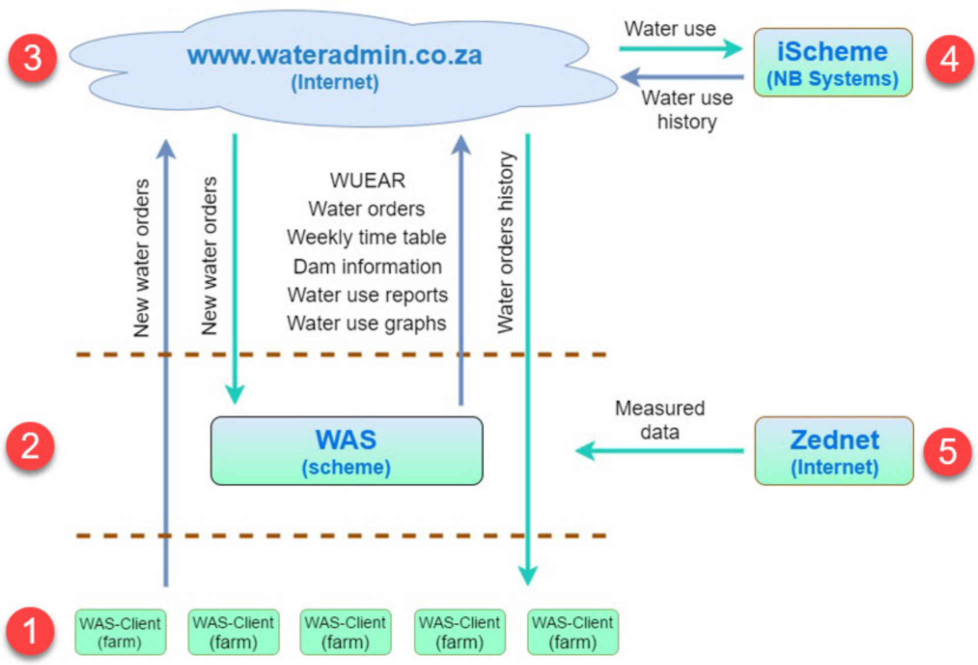

Figure 8.1: WAS data flow diagram

8.1.2 Saving time, money & water

The following paragraphs describe a list of functions in the WAS that saves an enormous amount of time compared to the manual work that had to be done previously. Not to mention the possible human errors that are eliminated in the process. Time saved this way automatically increases productivity which in turn has a cost savings benefit.

In the past water bailiffs spent a lot of time on administrative tasks which meant that the operation and maintenance of the canals were neglected. The implementation of the WAS made it possible for them to have more time to focus on actual water distribution management tasks and deliver a better service to the farmers. This in turn tend to minimise their water distribution losses.

- **Automated download of measuring station data**

  With reference to Chapter 9 that describes the working of the Zednet measuring station network in detail it is estimated that there is a time saving of at least 80% compared to the manual capturing of measuring station data. Not to mention the possible human errors that can occur while capturing data.

  The automatic import procedure that was created in the WAS using the Zednet application programming interface (API) enables a WAS operator to import the data from an unlimited number of measuring stations automatically. It is now virtually impossible to import data into a wrong measuring station.

- **Generation of the water use efficiency accounting reports**

  Compiling a monthly Water Use Efficiency Accounting Report (WUEAR) manually use to take at least two days. The WAS generates a more detailed report in a couple of minutes.

- **Calculation of water releases**

  Using the WAS to calculate or re-calculate a water release takes only a couple of minutes once all the water orders have been captured. The effect of additional water orders or the cancellation of water orders on the system is therefore almost immediately available. The same cannot be said for a manual system that takes at least 2.5 to 3 hours.

- **Generation of a dedicated water report for ORWUA**

  The dedicated monthly water use and water loss report of ORWUA combines four sub-areas which is generated in seconds. This report can also be uploaded to the *wateradmin* website automatically. Compiling the same report by hand will take at least a couple of hours.

- **Generation of weekly time tables**

  At the start of every water year weekly time tables are compiled with the relevant information for each week. This process takes at least a day if it is done manually and mistakes are often made with the weekly date ranges.

  The WAS generates the weekly time table instantaneously without the possibility of any errors. The capturing of specific weekly notes thereafter might take a maximum of two hours. An added benefit is the fact that it can be uploaded to the *wateradmin* website automatically for all the farmers to see.

- **Generation of temporary water transfers documentation**

  The manual completion of a temporary water transfer form between two farmers is a time consuming task where attention to detail is very important. This process takes at least 5 minutes per application and can, depending on the number of applications, be very time consuming.

  The WAS generates and prints a temporary water transfer application in 30 seconds.

- **Water use information lookup per farmer**

  One of the main benefits of using the WAS is the speed by which water use information per farmer can be extracted. A single farmer often has 10 or more sluices of which water use information is needed. The WAS can display and print this information immediately. This is virtually impossible with a manual system.

- **Generation of water balance sheets per abstraction point**

  Previously, with the manual system, water balance sheets were compiled and distributed every six weeks. Currently, with the WAS, the water balance sheets are available in real time. For example at Vaalharts WUA the number of water bailiffs were reduced from 7 to 4 because of the time saved in this process.

- **Generation of water distribution sheets**

  Hours are saved to generate the water distribution sheets of an irrigation scheme with the WAS compared to the previous manual method.

- **Generation of discharge tables**

  The WAS can generate discharge tables for any size of Parshall flume, rectangular weir or V-notch in a matter of seconds. To do the same by hand is error prone and time consuming.

- **E-mail & bulk sms communication**

  Service delivery to farmers has been improved by automating the communication to farmers using an e-mail and a bulk sms system from within the WAS. This functionality was not previously available.

- **Water use and debit accounting integration**

  One of the major advantages of the WAS is the fact that the water use information per farmer is integrated with the built in debit accounting module. Information is cross-referenced and available on request.

8.1.3 Maintenance and support costs

The business model of the WAS is based on a monthly maintenance and support fee that is updated from time to time. The current fees were updated on the 1st of January 2017.

The following paragraphs describe the agreement between NB Systems Cc and the irrigation schemes that are using the WAS.

WAS

The WAS software is used by an irrigation scheme for water distribution and debit accounts management. A monthly maintenance and support fee is payable in advance per computer on which the WAS software is installed.

The maintenance fee is based on a sliding scale depending on the number of installations. The cost per SMS that is sent through the integrated Bulk SMS system in the WAS is 35c (VAT excl.) per SMS.

WAS-client

The WAS-client software is used by individual farmers to capture and maintain their own water orders. The software can upload and download water orders to and from the WAS database. This allows farmers to capture and keep a record of their own water orders for multiple sluices and synchronise it with the WAS database remotely through the internet.

WAS-client is available to all farmers on a scheme that uses WAS at no extra cost and can be downloaded from ***www.wateradmin.co.za*** website for the specific scheme.

Travel and accommodation

The monthly fee does not include any travel and accommodation costs which is payable by the client. Travel and accommodation costs will be shared with other clients in areas where possible.

Services

Support through the internet is free of charge. The following services are not included in the monthly fee but are charged at an hourly rate of R850.00 (VAT excl.).

- Support on site.
- Installation.
- Training.
- Data backup and restore.

NB Systems Cc will release new versions of the software from time to time free of charge. Users are encouraged to send through any specific needs or ideas for improvements which will be included in the upgrades as far as possible.

Development outside the scope of the WAS and WAS-client software will be done on a time and cost basis. Such developments will be available to all other users at no extra cost.

Chapter 9

Zednet measuring station data network

Zednet network

To quantify water losses on an irrigation scheme, accurate and reliable inflow data into an irrigation scheme is non negotiable. During the evaluation of the measuring stations that form part of the first phase of the project, it became apparent that accurate and reliable real time inflow data was a problem.

Cello loggers that are linked to the Zednet Internet interface, as shown in 9.2, were installed during Phase 1. This has proven to be a good decision because:

- The data was reliable.
- The data was easily accessible through the Zednet Internet interface.
- The Zednet interface is fast and stable.
- A dedicated WAS data export function was created on the Zednet platform as shown in Figure 9.3.
- An automatic import procedure was created in WAS using the Zednet application programming interface (API). This enables a WAS operator to import the data from an unlimited number of measuring stations automatically.

  It is now virtually impossible to import data into a wrong measuring station.

  This added functionality makes it very easy to import data from the Zednet platform into the WAS database where after water loss reports can automatically be generated in the WAS.

The measuring stations with installed Cello loggers that are currently in operation as part of the Phase 1 and 2 of the project are listed in Figure 9.1 below. All the measuring stations included in Phase 1 and 2 are now equipped with Cello loggers that are linked to the Zednet Internet platform. The only exception is the measuring station at the inflow into the Nzhelele GWS main canal where data is received from the DWS on a monthly basis. A lack of a cellphone signal makes it impossible to connect to the Zednet network at this site.

Measuring stations			
Description	**Logger**	**Data**	**Note**
Phase 1			
Hartbeespoort IB: West canal	Cello: Installed	Zednet	
Sand-Vet WUA: Allemanskraal dam canal	Cello: Installed	Zednet	
Sand-Vet WUA: Erfenis dam canal	Cello: Installed	Zednet	
Vaalharts WUA: Main canal	Cello: Installed	Zednet	
Orange-Riet WUA: Scheiding main canal	Cello: Installed	Zednet	
Phase 2			
Hartbeespoort IB: East canal	Cello: Installed	Zednet	
Loskop IB: Left bank canal	Cello: Installed	Zednet	
Loskop IB: Right bank canal	Cello: Installed	Zednet	
Lower Olifants River WUA: Bulshoek dam canal	Cello: Existing	Zednet	
Impala WUA: Grootdraai canal	Cello: Existing	Zednet	
Impala WUA: Transvaal canal	Cello: Existing	Zednet	
Orange-Riet WUA: Scheiding main canal	Cello: Installed	Zednet	
Nzhelele GWS: Main canal		Manual	Receive data from DWS monthly

Figure 9.1: Measuring stations

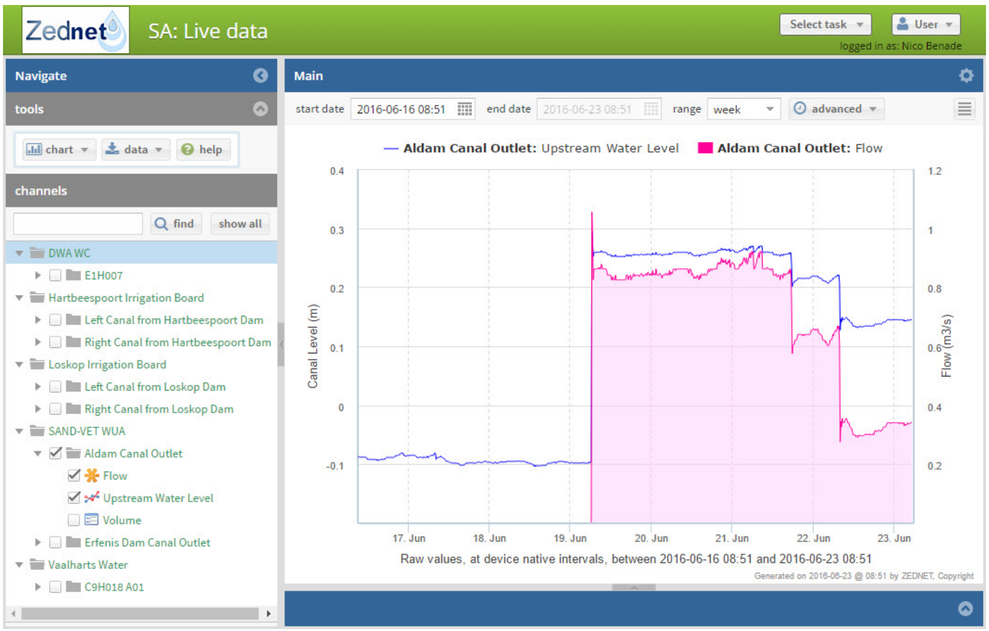

Figure 9.2: Zednet internet interface

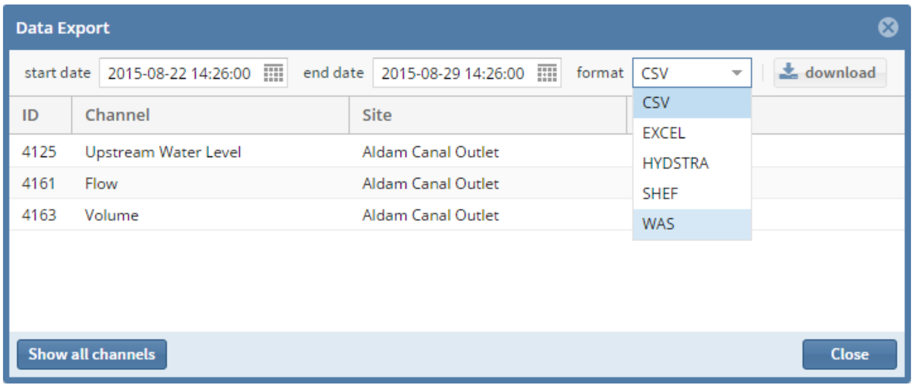

Figure 9.3: Zednet dedicated WAS data export

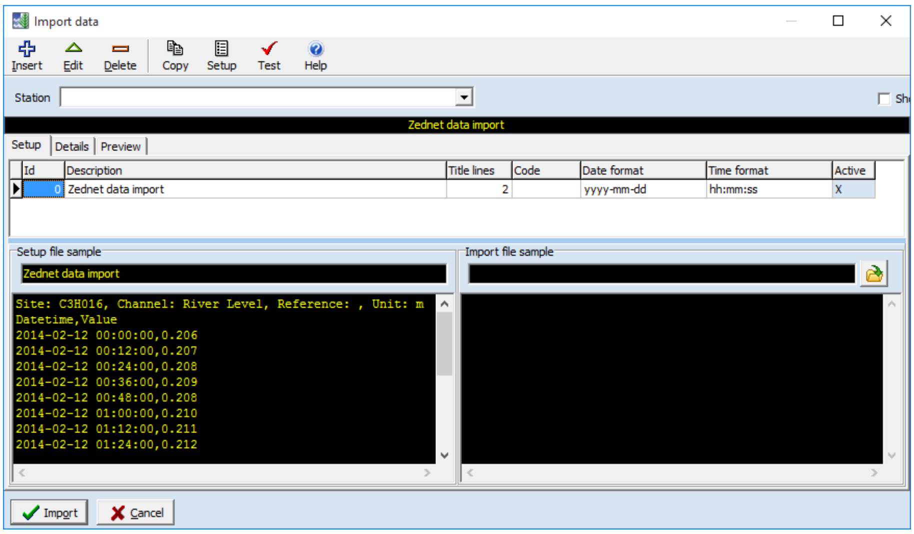

Figure 9.4: WAS dedicated Zednet data import

Chapter 10

Attendance registers

Inception meetings			
Name & Surname	**Organisation**	**Telephone**	**E-mail**
Hartbeespoort Irrigation Board 19/04/2016			
Annalien de Villiers	Hartbeespoort IB	0713546822	annalien@hbpib.co.za
Andries M Padi	DWS Head Office	0828065448	padia@dws.gov.za
Lindiwe Sithole	DWS Head Office	(012) 336 7515	sitholee@dws.gov.za
Glen Brown	Hartbeespoort IB	0798566021	
Nick Fourie	Hartbeespoort IB	0823323223	nick@hbpib.co.za
Nico Benadé	NB Systems	0828547255	nico@nbsystems.co.za
Andries Swanepoel	Hartbeespoort IB	0723379110	
Loskop Irrigation Board 21/04/2016			
Lindiwe Sithole	DWS Head Office	(012) 336 7515	sitholee@dws.gov.za
Andries Padi	DWS Head Office	0828065448	padia@dws.gov.za
Johan van Stryp	Loskop IB	0829609585	hjvstryp@ctecg.co.za
Pieter Pretorius	Loskop IB		
Nico Benadé	NB Systems	0828547255	nico@nbsystems.co.za
Orange Riet WUA 04/05/2016			
Retha Malan	Orange-Riet WUA	0535919200	retha@oranjeriet.co.za
Sydney Montshiwa	Orange-Riet WUA	0535919200	sydney@oranjeriet.co.za
Hanke du Toit	Orange-Riet WUA	0535919200	hanke@oranjeriet.co.za
Martin Smith	Orange-Riet WUA	0535919200	
Nico Benadé	NB Systems	0828547255	nico@nbsystems.co.za
Impala WUA 17/05/2016			
Nico Benadé	NB Systems	0828547255	nico@nbsystems.co.za
Andries Padi	DWS Head Office	0828065448	padia@dws.gov.za
Johan Boonzaaier	Impala WUA	0836261718	jhb@impalawater.co.za
Fanie Cronje	Impala WUA	0823250987	fc@impalawater.co.za
Nzhelele GWS 23/05/2016			
Simon Chauke	DWS Nzhelele	0829410747	chaukeS@dws.gov.za
Andries Padi	DWS Head Office	0828065448	padia@dws.gov.za
Christopher Lusenga	DWS Tzaneen	0823216700	lusengac@dws.gov.za
Nico Benadé	NB Systems	0828547255	nico@nbsystems.co.za
Lower Olifants River WUA 09/06/2016			
N Benadé	NB Systems	0828547255	nico@nbsystems.co.za
J Fourie	DWS Head Office	0828078039	FourieJ3@dws.gov.za
M James	LORWUA	0272132043	
C Visagie	LORWUA	0272132043	
J Matthee	LORWUA	0272135043	johanm@lorwua.co.za
C Smith	LORWUA	0836388636	cliffs@lorwua.co.za
K Wiese	LORWUA	0836367147	

Table 10.1: Inception meetings attendance register

Chapter 11

Meetings & Training

WAS roll-out phase 2		
Scheme	**Description**	**Date**
Hartbeespoort IB	Inception meeting	19/04/2016
Loskop IB	Inception meeting	21/04/2016
Orange Riet WUA	Inception meeting	04/05/2016
Impala WUA	Inception meeting & Training	17 & 18/05/2016
Nzhelele GWS	Inception meeting & Training	23/05/2016
Lower Olifants River WUA	Inception meeting & Training	08 & 09/06/2016
Vaalharts WUA	Training	19 & 20/07/2016
Loskop IB	Training & site visit	12/04/2017
Hartbeespoort IB	Training & site visit	19/04/2017
Loskop IB	Training & meeting	17/05/2017
Lower Olifants River WUA	Training & meeting	21/06/2017
Orange Riet WUA	Training & meeting	10/07/2017
Nzhelele GWS	Training & meeting	21/07/2017
Impala WUA	Training & meeting	04/08/2017

WAS roll-out phase 3		
Scheme	**Description**	**Date**
Boegoeberg WUA	Inception meeting & site visit	02 to 05/05/2017
Kakamas WUA	Inception meeting & site visit	02 to 05/05/2017
Mooiriver GWS	Inception meeting & site visit	10/08/2017
Schoonspruit GWS	Inception meeting & site visit	10/08/2017
Gamtoos IB	Inception meeting & site visit	28/08/2017
Lower Sundays River WUA	Inception meeting & site visit	29/08/2017
Kakamas WUA	Training (using TeamViewer)	05/09/2017
Kakamas WUA	Training	09/10/2017
Boegoeberg WUA	Site visit & training on data download	10/10/2017
Luvuvhu GWS	Inception meeting & site visit	16 & 17/11/2017

Table 11.1: Inception meetings & Training sessions

WAS training courses	
Name	Scheme
Vaalharts: 19 - 20 July 2016	
Nico Benadé	NB Systems
Cor Lensley	Vaalharts WUA
Floors Coetzee	Vaalharts WUA
Michael Matheatau	Vaalharts WUA
Archie Scorgie	Vaalharts WUA
Piet van Riet	Vaalharts WUA
Pretoria: 18 - 19 August 2016	
Nico Benadé	NB Systems
Annemarie de Vries	Loskop Irrigation Board
Pieter Pretorius	Loskop Irrigation Board
Nico Ujdur	Loskop Irrigation Board
Susanna Kalcic	Groot Marico GWS
Fazel M Sindlet	van der Kloof Irrigation Board
Pretoria: 29 - 30 August 2016	
Nico Benadé	NB Systems
Simon Chauke	Nzhelele Irrigation Board
Fanie Cronje	Impala Irrigation Board
Kobus Botha	Impala Irrigation Board
Orange-Riet: 6 - 7 September 2016	
Nico Benadé	NB Systems
Tjaart Voster	ORWUA
Norman Kok	ORWUA
Aaron Vala	ORWUA
Hamson Ngoqo	ORWUA
Pretoria: 17 - 18 October 2016	
Nico Benadé	NB Systems
Derick de Klerk	Impala Irrigation Board
Pierre van Vuuren	Impala Irrigation Board
Glen Brown	Hartbeespoort Irrigation Board

Table 11.2: WAS training courses

Chapter 12

Results

12.1 Base line water loss

The base line water loss, as shown in Figure 12.1, has been calculated through the use of the Water Use Efficiency Accounting Report (WUEAR) in the WAS. The percentage water loss is calculated relative to the total of water released as has been the practice by the DWS over the years (see paragraph 1.1). The results are shown in Table 12.2.

A comparison between the two bar charts shows clearly that there is no relation between the volumetric and the percentage values. Care should therefore be taken when the results are interpreted.

The volumetric water losses are the critical indicator for water distribution managers and the DWS particularly when assessing or determining potential for water loss reduction.

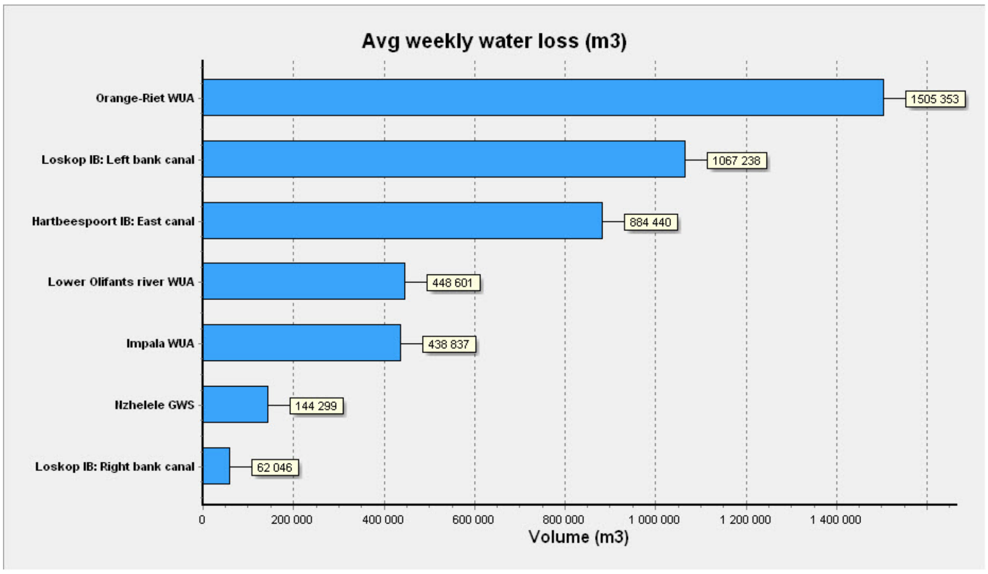

Figure 12.1: Average weekly water loss (m^3)

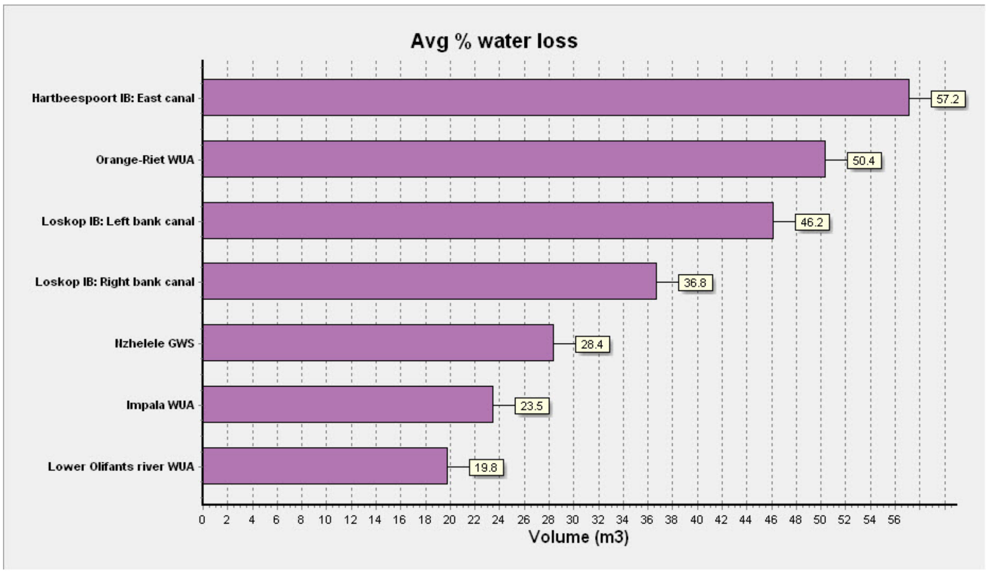

Figure 12.2: Average % water loss

Chapter 13

Summary & Discussion

Summary & Discussion

1. Baseline water losses have been successfully calculated for the irrigation schemes included in phase 2 of the project.

2. A comparison between the volumetric water losses compared to the percentage values shows clearly that there is no relation between the volumetric and the percentage values. Care should therefore be taken when the results are interpreted.

3. At the leftbank measuring station at Loskop Irrigation Board a 200mm difference on the measuring plate was picked up and corrected during the installation. This means that their base line water loss are currently much higher than their below 25% that they are used to. Loskop Irrigation Board paid a visit to the site and verified the readings.

   The current difference is believe to be only 20mm. This will hopefully be resolved once DWS visits the site and do official measurements.

4. An automatic import procedure was created in WAS using the Zednet application programming interface (API). This enables a WAS operator to import the data from an unlimited number of measuring stations automatically.

   It is now virtually impossible to import data into a wrong measuring station.

   This added functionality makes it very easy to import data from the Zednet platform into the WAS database where after water loss reports can automatically be generated in the WAS.

5. All the measuring stations included in Phase 1 and 2 are now equipped with Cello loggers that are linked to the Zednet Internet platform. The only exception is the measuring station at the inflow into the Nzhelele GWS main canal where data is received from the DWS on a monthly basis. A lack of a cellphone signal makes it impossible to connect to the Zednet network at this site.

   The list of Zednet measuring stations is shown in Table 13.1 and the total number is currently fifty. The Cello loggers that is linked to the Zednet Internet platform is very successful and irrigation schemes are starting to expand their networks at their own cost.

6. Phase 2 of the project has shown again how important accurate and reliable measurements are for effective water distribution management.

Measuring station readings should be verified regularly. Water losses cannot be quantified without accurate measurements.

7. The public platform ***www.wateradmin.co.za*** (Site map, Appendix A.1, page 66) has been developed and implemented successfully for all the irrigation schemes that are part of phases 1 & 2 of the project. It is now possible for individual schemes to upload their own reports onto the website.

   The main objective is to report on water use and water loss information nationally through the use of this website.

8. The WAS business case has been described in detail starting at paragraph 8.1. The reality is that the difference that the WAS makes on an irrigation scheme is of such an extend that it is difficult to quantify in monetary terms. The bigger the scheme the bigger the difference.

   The WAS has proven with the number of schemes under its management that it has the capability to be rolled out nationally and report on water use and water losses with ease.

9. The current water savings summary is shown in Table 13.3. Nzhelele do not have results due to a lack of water released data. The data logger at the inflow into the main canal needs to be downloaded manually and we depend on the DWS to do so.

10. The WAS-client software has been improved. The new version has automated the set-up which makes the roll-out of the WAS-client software to the farmers very easy.

    There has been a request from Vaalharts WUA to include crop survey data and irrigation systems data into the WAS-client. This will make the WAS-client even more useful and the target date for this roll-out is the end of February 2018.

Zednet measuring stations

Id	Scheme	Description
3264	HartbeespoortIB	Left bank canal (West canal)
5633	HartbeespoortIB	Right bank canal (East canal)
5634	LoskopIB	Right bank main canal
5635	LoskopIB	Left bank main canal
3125	VHWUA	C9H018 A01
4377	VHWUA	Noord Kanaal Tvv10 Crump
4378	VHWUA	Noord Kanaal Tvv16 na Taung
4379	VHWUA	Taung Cump Dam 1
4387	VHWUA	Taung BOP Hoofkanaal
4388	VHWUA	Dam 7 Uitlaat
4389	VHWUA	Invloei Dam 7
4390	VHWUA	Invloei Dam 6
4394	VHWUA	KB Uitlaat
4395	VHWUA	Noord Kanaal Crump
4396	VHWUA	Wes Kanaal Uitlaat
4397	VHWUA	Wes Kanaal Dam Uitlaat
4402	VHWUA	Vhp 11-33 Uitlaat
4124	SandVetWUA	Erfenis Dam Canal
4125	SandVetWUA	Allemanskraal Dam Canal
4912	SandVetWUA	Drein 47 (Klippet)
4913	SandVetWUA	Condova
1145	DWAWCWAS	LORWUA: Bulshoek Dam left Canal
5691	OranjeRietWUA	ORWUA: Scheiding canal
5785	ImpalaWUA	Groot Draai water (river level upstream)
5786	ImpalaWUA	Weggooi Water Level Transvaal verdeling (river level upstr)
5787	ImpalaWUA	Nochane Water Level Transvaal verdeling (river level upstr)
5947	ImpalaWUA	Nqumile Water level Mbega eindpunt (river level upstream)
5985	ImpalaWUA	Mhlati weir (river level upstream)
5986	ImpalaWUA	Notchane eindpunt (canal level)
6011	ImpalaWUA	Wonderfontein Hk water level Natal verdeling (canal level)
6035	ImpalaWUA	Sitilo Hk dorpsverdeling (canal level)
6044	ImpalaWUA	Drein Sitilo weggooi (canal level)
6045	ImpalaWUA	Tvl Hk verdeling (canal level)
6046	ImpalaWUA	D9 Hk water level: Dorpsverdeling (canal level)
6047	ImpalaWUA	Weggooi Water Sitilo Eindpunt (canal level)
6048	ImpalaWUA	Natal Hk verdeling (canal level)
6049	ImpalaWUA	Mbega water level Natal verdeling (canal level)
6050	ImpalaWUA	Mbega weggooi Naltal verdeling (canal level)
6051	ImpalaWUA	Privaat kanaal Mbega (canal level)
6075	ImpalaWUA	Upper Pongola (river level upstream
6076	ImpalaWUA	Bivane Dam Weir (river level upstream)
6104	ImpalaWUA	Tlc (canal level)
6105	ImpalaWUA	Wonderfontein Weggooi Kanaal (canal level)
6106	ImpalaWUA	Wonderfontein Weggooi (canal level)
6107	ImpalaWUA	Wonderfontein Eindpunt (canal level)
6387	ImpalaWUA	Bivane Dam (dam level)
6402	ImpalaWUA	Tk 11 eindpunt (canal level)
7760	KakamasWUAWAS	Left bank main canal
7761	KakamasWUAWAS	Right bank maincanal
7762	KakamasWUAWAS	Inflow at Augrabies

Table 13.1: List of Zednet measuring stations

Water savings (2015 to 2016)

Scheme	Year	Ordered (x1000m3)	Released (x1000m3)	Total loss (x1000m3)	Loss (%)	Savings (x1000m3)
Hartbeespoort IB: West canal	2015	54 842	104 935	50 093	47.7	
	2016	46 544	97 865	51 318	52.4	-1 225
						-1 225
Hartbeespoort IB: East canal	2015	41 238	92 675	51 439	55.5	
	2016	33 862	76 975	43 110	56.0	8 329
						8 329
Impala WUA	2014	126 445	192 310	65 865	34.2	
	2015	121 994	180 453	58 460	32.4	7 405
	2016	118 884	137 004	18 121	13.2	40 339
						47 744
Loskop IB: Left bank canal	2016	78 829	132 857	54 028	40.7	
Loskop IB: Right bank canal	2016	6197	9 078	2 881	31.7	
Lower Olifants river WUA	2014	106 374	137 665	31 290	23.2	
	2015	92 013	119 784	27 769	23.2	3 521
	2016	83 503	108 596	25 094	23.1	2 675
						6 196
Nzhelele GWS	2017	3200	4158	957	23.0	
Orange-Riet WUA	2014	151 773	264 304	112 532	42.6	
	2015	199 637	302 674	103 036	34.0	9 496
	2016	194 017	292 413	98 397	33.6	4 639
						14 135
Sandvet WUA (Sand)	2015	20 371	18 238	-2 129	- 11.7	
	2016	9 307	11 930	2 623	22.0	
Sandvet WUA (Vet)	2015	23 184	45 210	22 027	48.7	
	2016	25 215	40 987	15 773	38.5	6 254
						6 254
Vaalharts WUA	2014	290 934	412 919	121 987	29.5	
	2015	361 496	494 224	132 729	26.9	-10 742
	2016	301 580	395 521	93 940	23.8	38 789
						28 047
TOTAL						109 480

Table 13.2: Water savings summary (2015 to 2016)

Water savings (2015 to 2017)

Scheme	Year	Ordered (x1000m3)	Released (x1000m3)	Total loss (x1000m3)	Loss (%)	Savings (x1000m3)
Hartbeespoort IB: West canal	2015	54 842	104 935	50 093	47.7	
	2016	46 544	97 865	51 318	52.4	-1 225
	2017	34 365	70 977	36 611	51.6	14 707
						13 482
Hartbeespoort IB: East canal	2015	41 238	92 675	51 439	55.5	
	2016	33 862	76 975	43 110	56.0	8 329
	2017	27 067	60 750	33 682	55.4	9 428
						17 757
Impala WUA	2014	126 445	192 310	65 865	34.2	
	2015	121 994	180 453	58 460	32.4	7 405
	2016	118 884	137 004	18 121	13.2	40 339
	2017	124 511	148 719	24 209	16.3	-6 088
						41 656
Loskop IB: Left bank canal	2016	78 829	132 857	54 028	40.7	
	2017	83 950	111 475	27 507	24.7	26 521
						26 521
Loskop IB: Right bank canal	2016	6197	9 078	2 881	31.7	
	2017	9864	84 408	2 887	22.6	-6
						-6
Lower Olifants river WUA	2014	106 374	137 665	31 290	23.2	
	2015	92 013	119 784	27 769	23.2	3 521
	2016	83 503	108 596	25 094	23.1	2 675
						6 196
Nzhelele GWS	2017	3200	4158	957	23.0	
Orange-Riet WUA	2014	151 773	264 304	112 532	42.6	
	2015	199 637	302 674	103 036	34.0	9 496
	2016	194 017	292 413	98 397	33.6	4 639
	2017	108 476	184 656	76 182	41.3	22 215
						36 350
Sandvet WUA (Sand)	2015	20 371	18 238	-2 129	- 11.7	
	2016	9 307	11 930	2 623	22.0	-4 752
	2017	15 035	19 169	4 133	21.6	-1 510
						-6 262
Sandvet WUA (Vet)	2015	23 184	45 210	22 027	48.7	
	2016	25 215	40 987	16 047	38.5	5 980
	2017	45 193	64 170	18 972	29.6	-2 925
						3 055
Vaalharts WUA	2014	290 934	412 919	121 987	29.5	
	2015	361 496	494 224	132 729	26.9	-10 742
	2016	301 580	395 521	93 940	23.8	38 789
	2017	202 643	271 972	69 329	25.5	24 611
						52 658
TOTAL						191 407

Table 13.3: Water savings summary (2015 to 2017)

Appendix A

Wateradmin site map

A.1 Wateradmin site map

The following depicts the link structure of the ***www.wateradmin.co.za*** website. Each tree represents a page on the site. The irrigation scheme links as well as the WAS information link is expanded upon on the indicated pages.

All of the reports and graphs on the Wateradmin website are generated and uploaded using the WAS and iScheme. This illustrates some of the information that is available on the website.

- Water Administration System (WAS)
  - Irrigation schemes
    - Hartbeespoort IB (page 67)
    - Impala WUA (page 68)
    - Loskop IB (page 69)
    - Lower Olifants River WUA (page 70)
    - Nzhelele GWS (page 71)
    - Orange Riet WUA (page 72)
    - Sand-Vet WUA: (SAND) (page 73)
    - Sand-Vet WUA: (Vet) (page 74)
    - Vaalharts WUA (page 75)
    - Groenland WUA (page 76)
    - Summary: Water loss graphs
      - Average loss (%)
      - Average monthly loss (m3)
    - Summary: Water loss table
    - Downloads
  - WAS information (page 77)
  - Contact information

Figure A.1: ***wateradmin*** home page

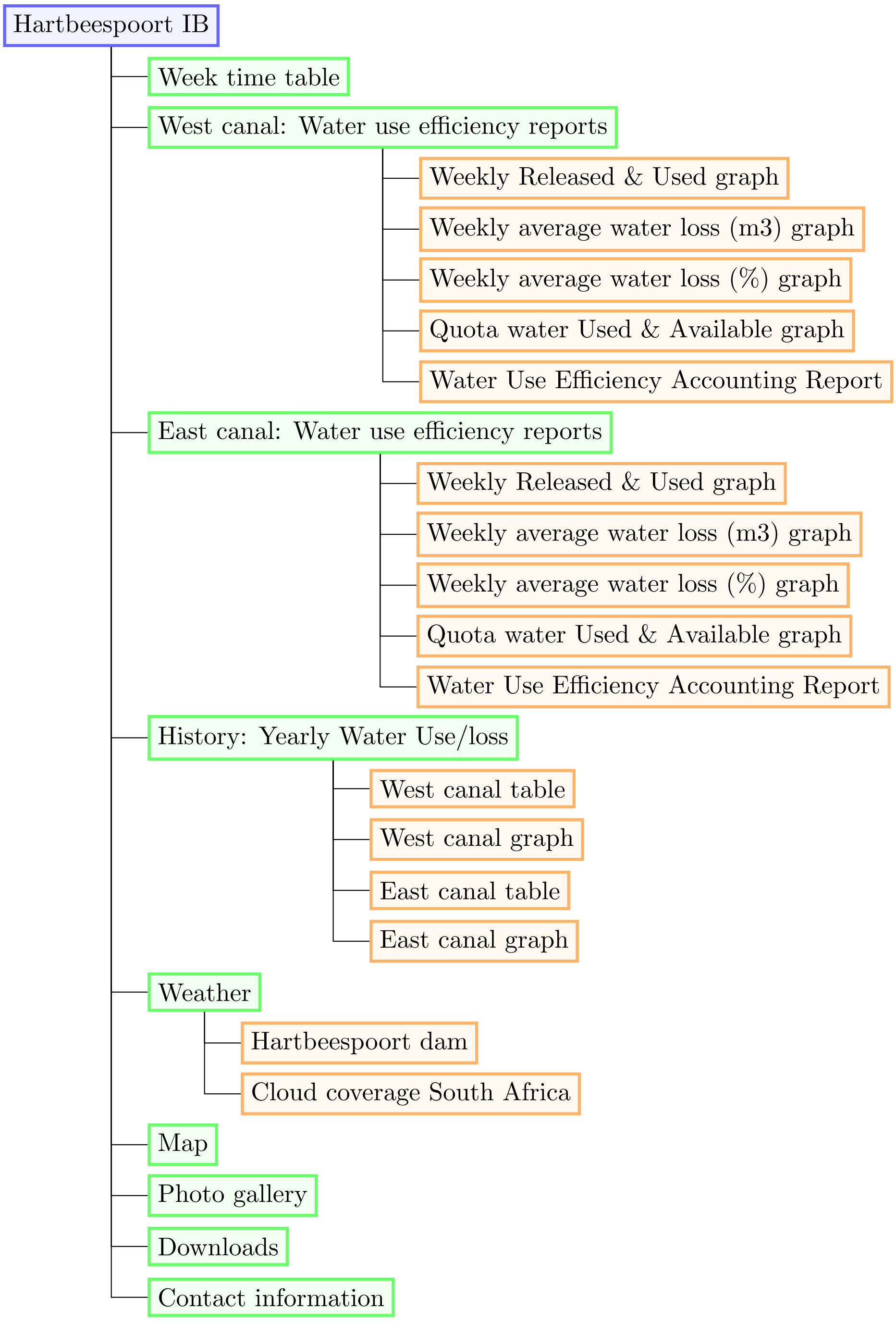

Figure A.2: Hartbeespoort page

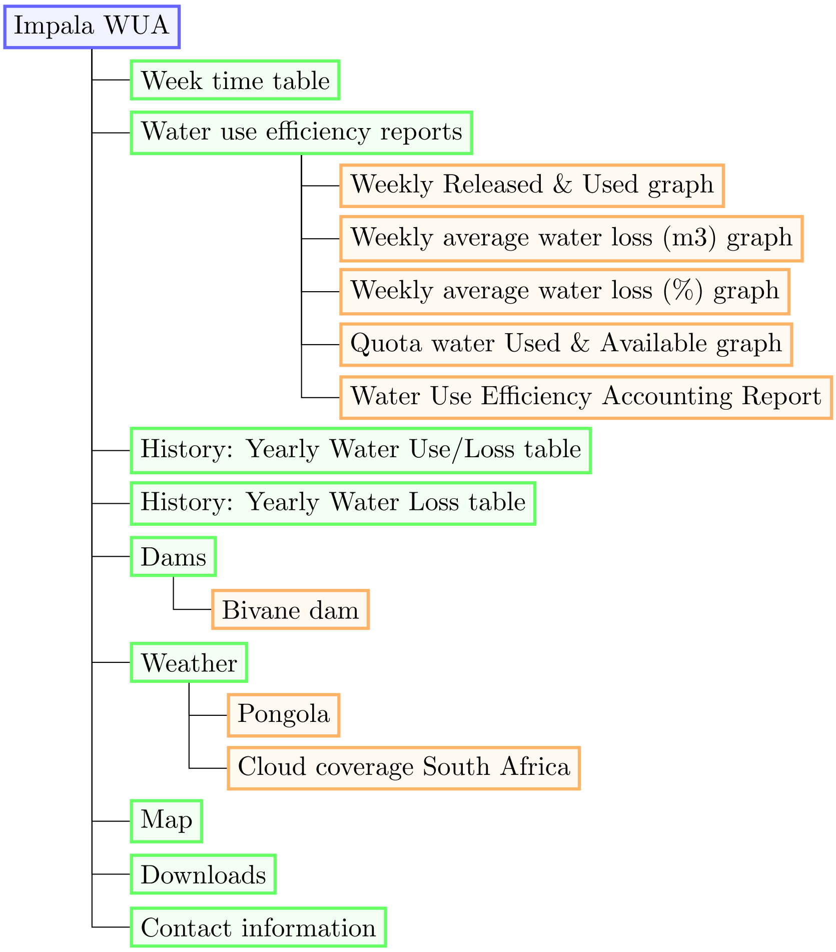

Figure A.3: Impala WUA page

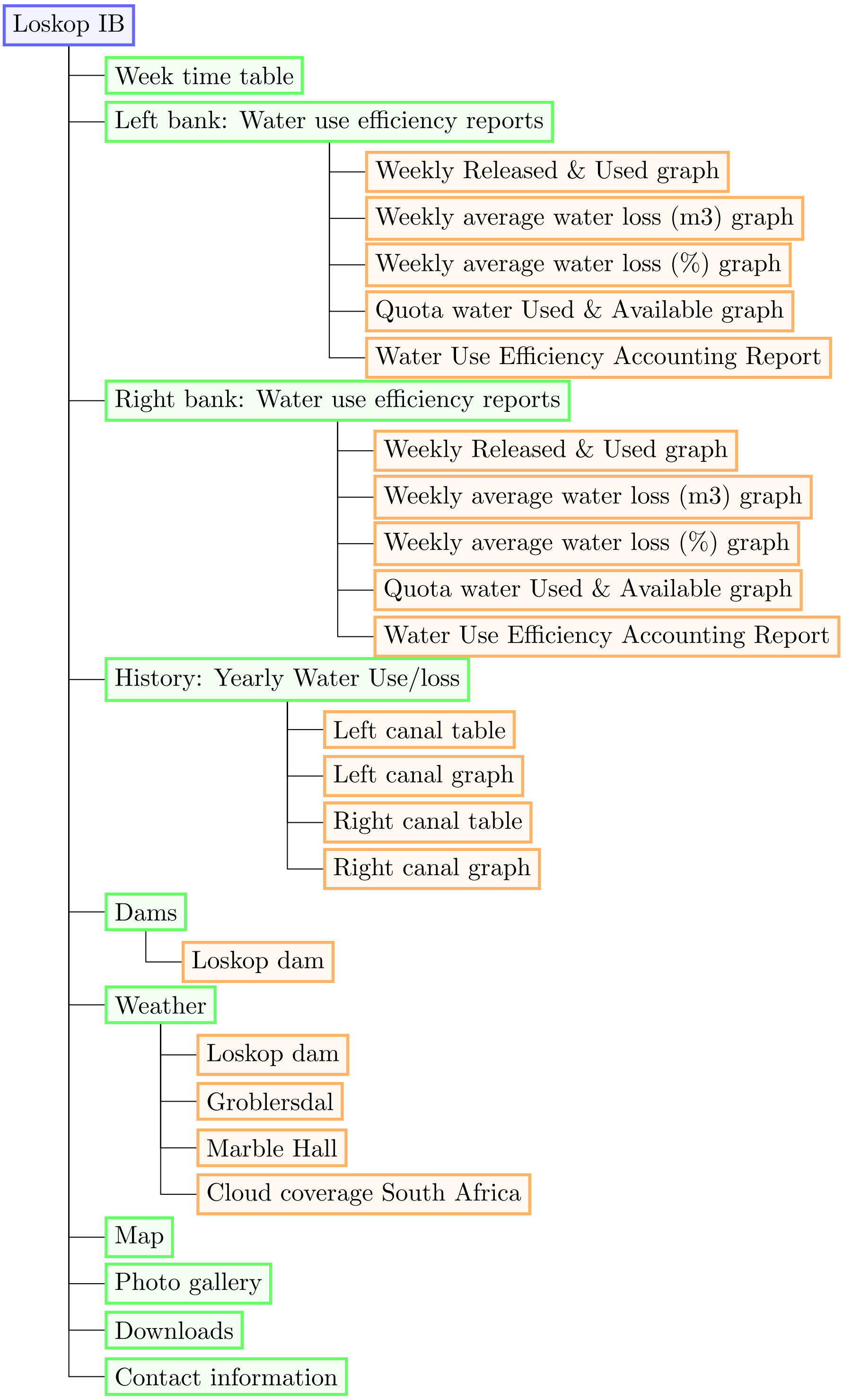

Figure A.4: Loskop IB page

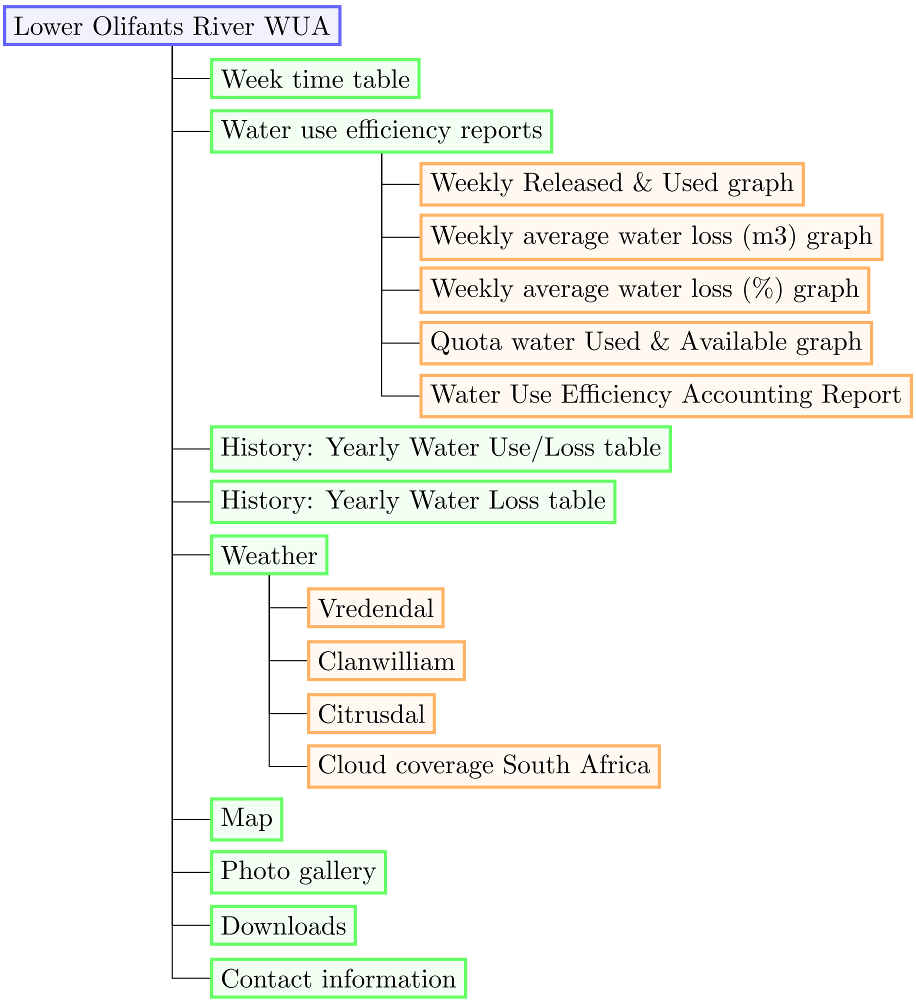

Figure A.5: Lower Olifants River WUA page

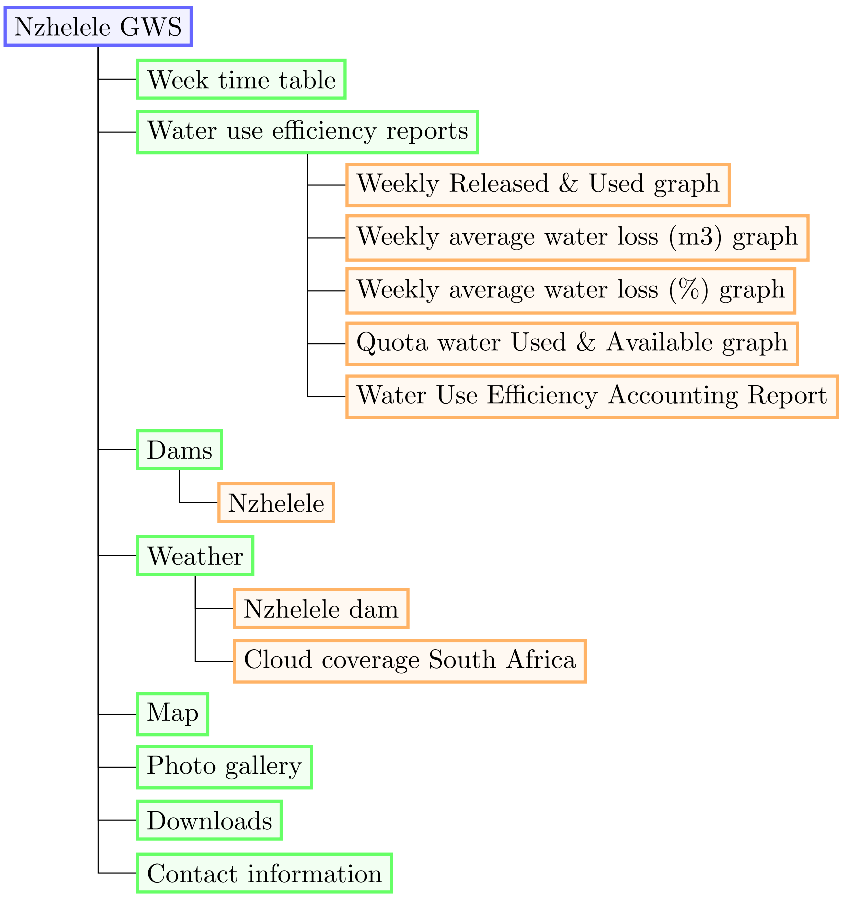

Figure A.6: Nzhelele GWS page

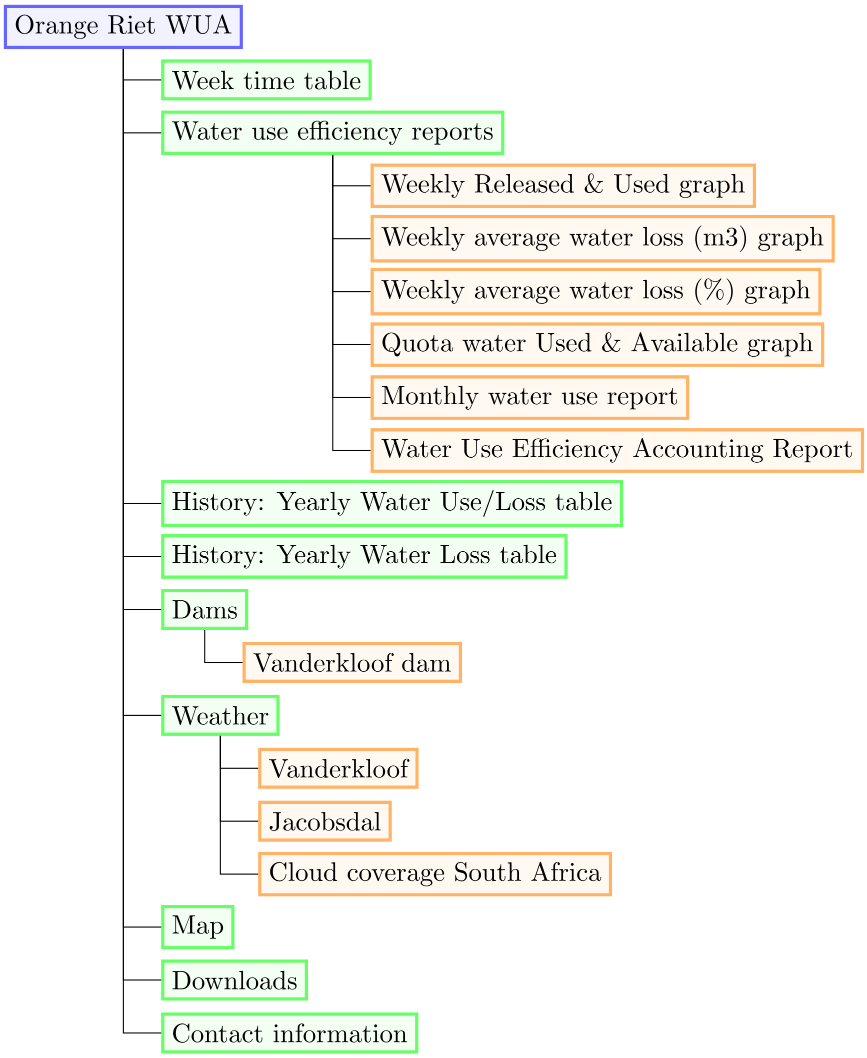

Figure A.7: Orange Riet WUA page

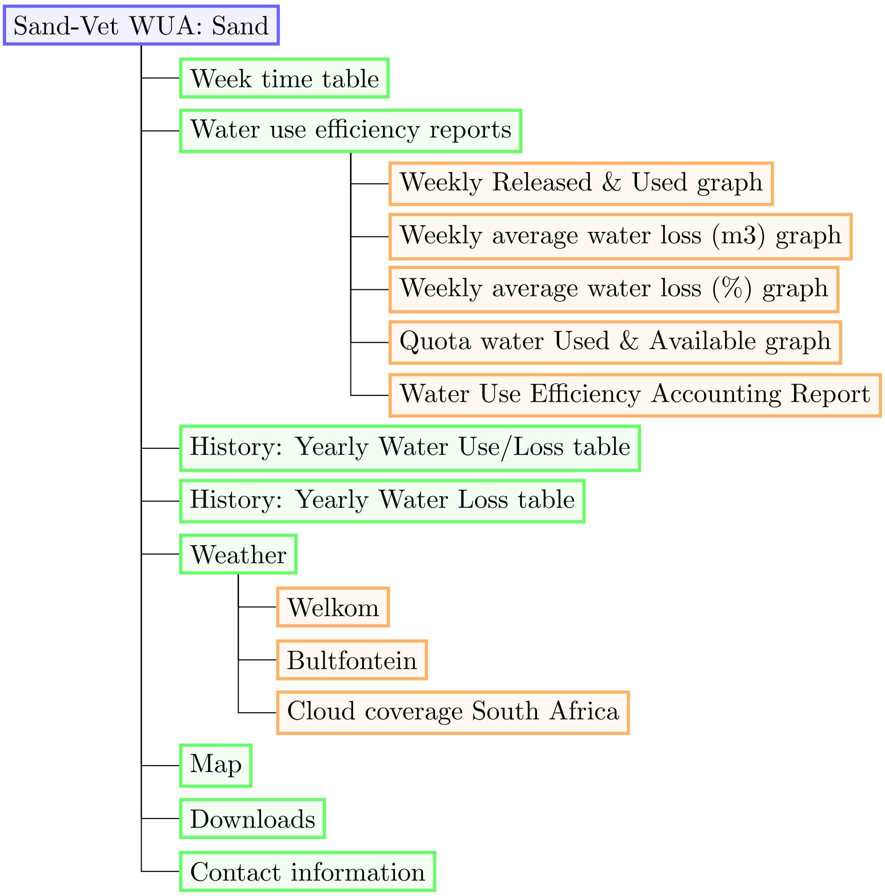

Figure A.8: Sand-Vet WUA (SAND) page

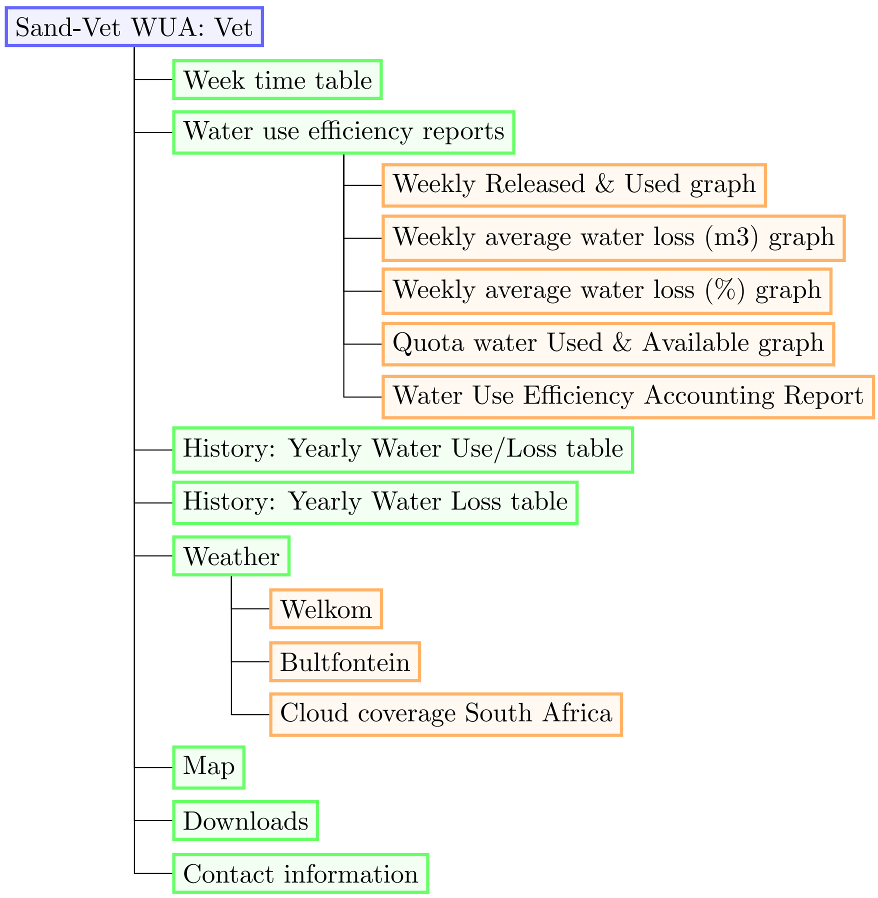

Figure A.9: Sand-Vet WUA (Vet) page

- Vaalharts WUA
  - Week time table
  - Water use efficiency reports
    - Weekly Released & Used graph
    - Weekly average water loss (m3) graph
    - Weekly average water loss (%) graph
    - Quota water Used & Available graph
    - Water Use Efficiency Accounting Report
  - History: Yearly Water Use/Loss table
  - History: Yearly Water Loss table
  - Dams
    - Bloemhof dam
    - Spitskop dam
    - Taung dam
    - Vaalharts stuwal
  - Weather
    - Jan Kempdorp
    - Taung
    - Cloud coverage South Africa
  - Map
  - Photo gallery
  - Downloads
  - Contact information

Figure A.10: Vaalharts WUA page

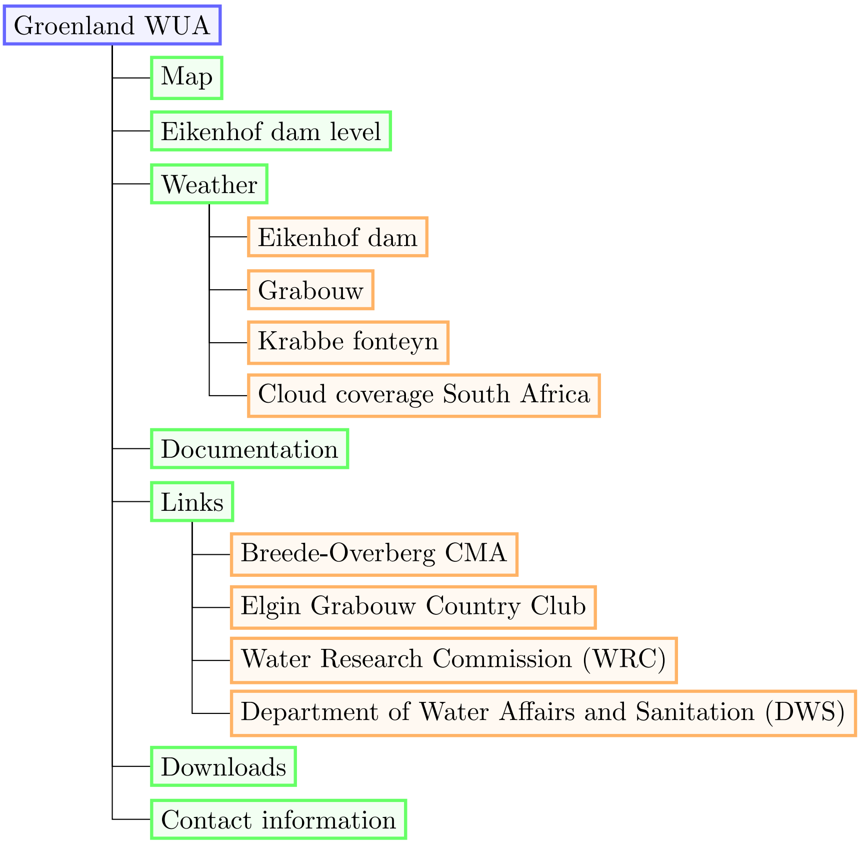

Figure A.11: Groenland WUA page

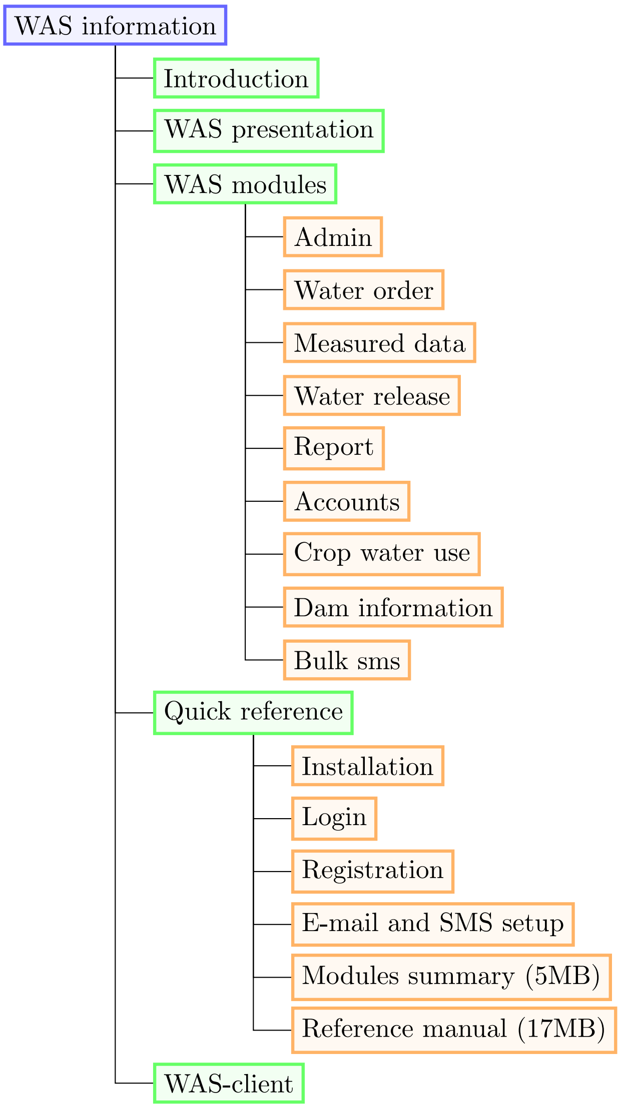

Figure A.12: WAS information page

Appendix B

Results summary phases 1 & 2

B.1 Summary of results for phases 1 & 2

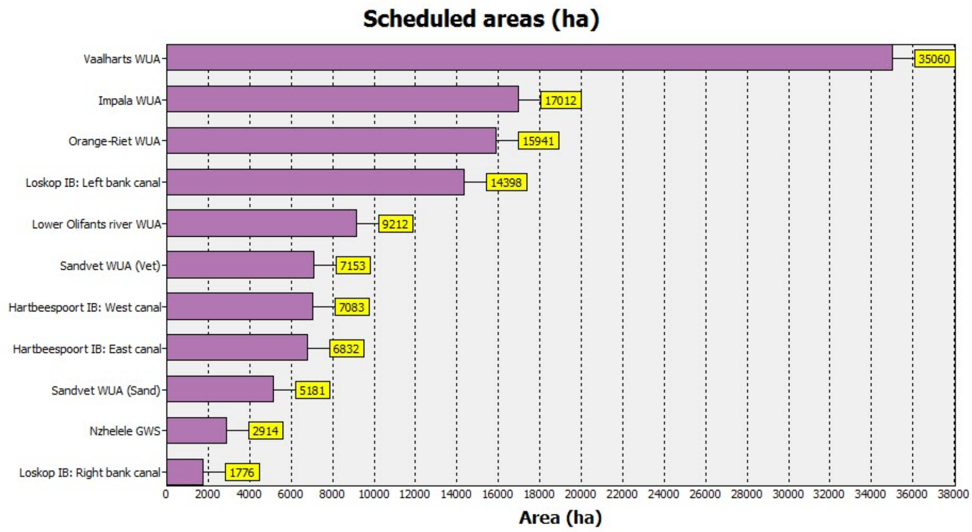

Figure B.1: Scheduled areas (ha)

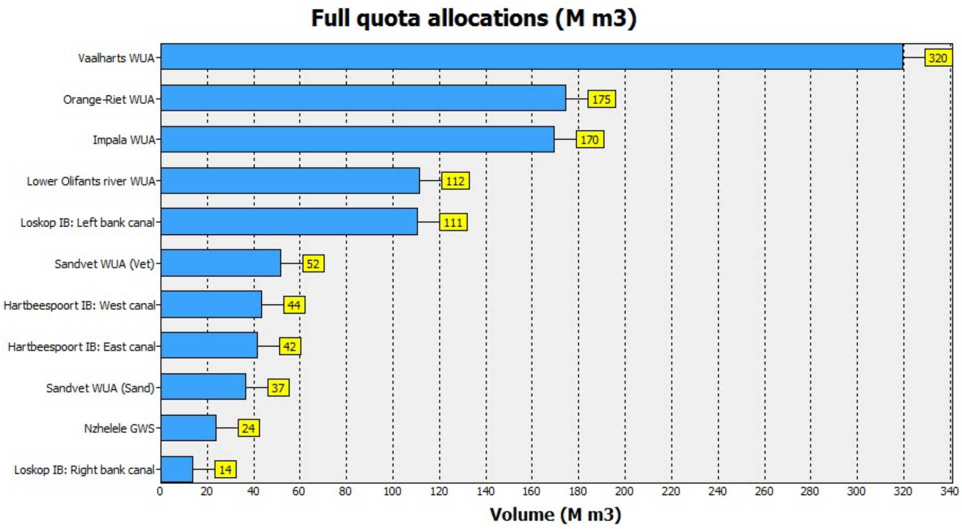

Figure B.2: Full quota alloacations (M m^3)

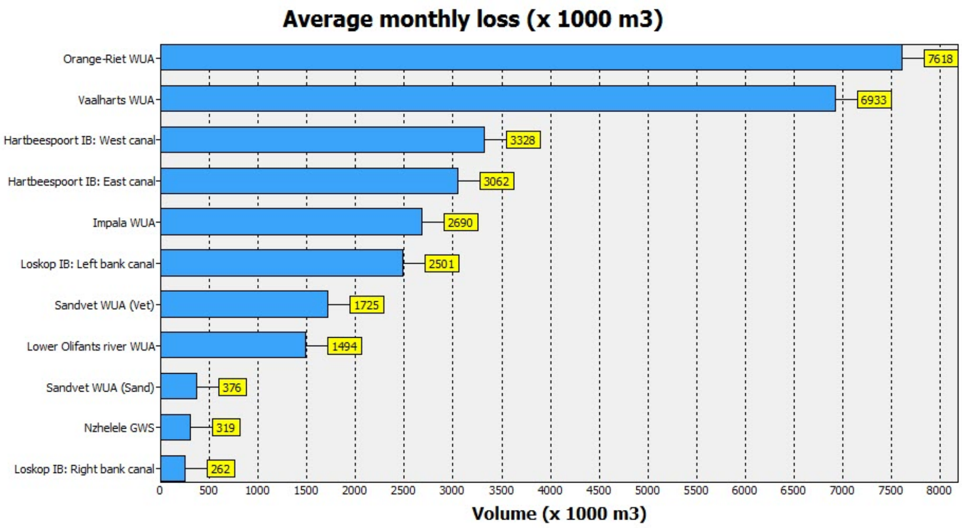

Figure B.3: Average monthly loss (x 1000 m^3)

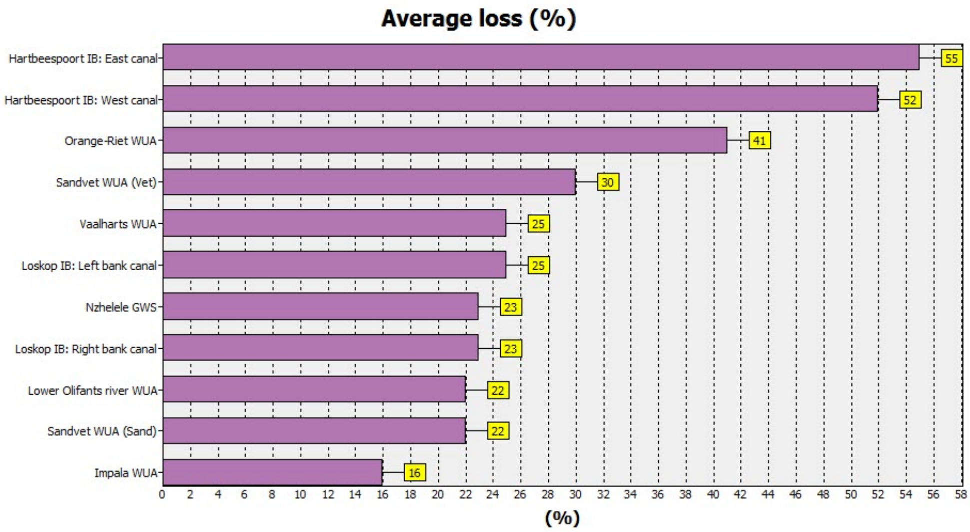

Figure B.4: Average loss(%)