Final report
Implementation of the Water release module of the Water Administration System (WAS)
†

Nico Benadé
(NB Systems cc)

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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:

- Sand-Vet Water User Association (WUA)
- Hartbeespoort Irrigation Board (West canal)
- Vaalharts WUA
- Orange-Riet WUA

	Irrigation scheme	Area (ha)	Quota (m^3/ha)	Full quota (m^3)	Abstractions
1	Vaalharts Water Users Association	35 060	9 140	320 448 400	1 873
2	Orange Riet Water Users Association	15 941	11 000	175 351 000	679
3	Hartbeespoort Irrigation Board (West canal)	7 083	6 200	43 912 740	867
4	Sand-Vet Water Users Association (Vet)	7 157	7 200	51 530 400	277
4	Sand-Vet Water Users Association (Sand)	5 175	7 200	37 260 000	239
		70 416		628 502 540	3 935

Figure 1.1: Irrigation scheme data

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 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.

The global water loss is calculated by taking the difference between the total of water released and the total of water ordered. The initial calculation of the base line water loss revealed that there was an inherent flaw in the method that the Department of Water Affairs (DWS) uses to calculate the water loss percentages. Although there are differing schools of thought on the calculation, for the purposes of this study we are utilising the DWS method.

1.2 Project scope

The four irrigation schemes that were selected for this project already used the WAS for a couple of years. The release module of the WAS was however only partially implemented or not implemented at all as summarized below.

- Vaalharts WUA: Partially implemented.
- Orange-Riet WUA: Partially implemented.
- Hartbeespoort IB (West canal): Not implemented.
- Sandvet WUA (Sand canal): Not implemented.
- Sandvet WUA (Vet canal) Not implemented.

As per the details in the Request for Proposals the following was carried out:

- The water release module of WAS was installed at four irrigation schemes that have been selected in consultation with the SPWN ASC using pre-set criteria. These schemes are: Sand-Vet; Hartbeespoort (West canal); Vaalharts; and Orange-Riet.
- All the technical support required to get the release module running was provided to each of the selected irrigation schemes.
- Using data already available, the water savings have been quantified and additional schemes have been identified for the further roll out of the water release module at schemes where WAS has already been implemented.

Chapter 2

Water release calculation

Release calculation

Two methods are available in the WAS to calculate water releases including:

- Twelve hourly distribution sheet that can be setup and calibrated according to the user's requirements. This method is easy to understand and implement which makes it the preferred method among water distribution management personnel.
- Canal network approach that requires a more complicated calibration procedure through the use of cross section properties that are not always available.

Both release calculation methods were introduced at the participating schemes. Their preferred method was then implemented. Release calibrations were done using existing data and water orders. The initial calibration tried to mimic the operational procedures of the specific scheme.

The canal network approach release calibration in WAS is done using a seepage factor and an average velocity per reach to calibrate for the water losses and lag times respectively. However, the current experience has proven that most of the water control officers lack the technical skills to accomplish this task successfully.

This problem was solved by simplifying the release calculation and calibration process by adding the following options:

- A fixed water loss as a flow rate per canal that is available from a lookup table as a function of the flow rate.
- A fixed percentage loss per canal that is available from a lookup table as a function of the flow rate.
- A fixed lag time in minutes per canal that is available from a lookup table as a function of the flow rate.
- Expand and simplify the programmable distribution sheet so that it can be used for release calculations.

The new canal network approach release calculation options are shown in Figure 2.1.

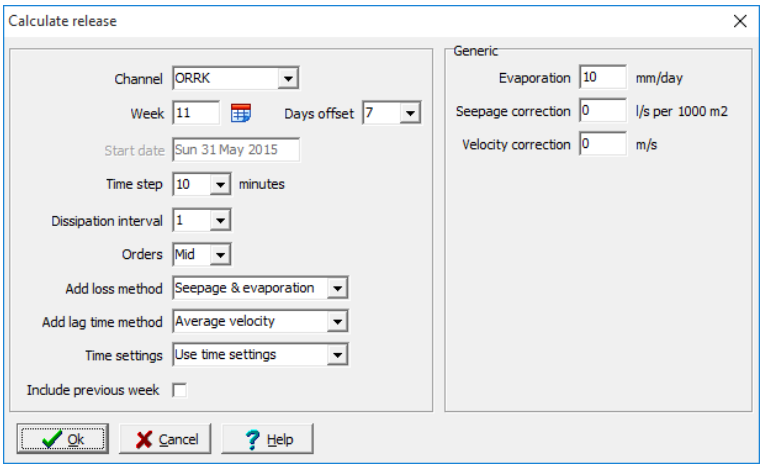


Figure 2.1: Release calculation options

Chapter 3

Sand-Vet WUA

3.1 Background

The Sand-Vet irrigation scheme stretches along the Sand and Vet Rivers about 150 km north-west of Bloemfontein. Their administration offices are situated halfway between Welkom and Bultfontein. The Sand-Vet location map is displayed in Figure 3.1.

Water is released from the Allemanskraal dam into the Sand canal which includes a total of 5 175 ha and 239 abstraction points. Their full quota is 7 200 m^3/ha per year which means that 37 260 000 m^3 is available for distribution each water year under normal conditions.

Water is also released from the Erfenis dam into the Vet canal which includes a total of 7 157 ha and 277 abstraction points. Their full quota is 7 200 m^3/ha per year which means that 51 530 000 m^3 is available for distribution each water year under normal conditions.

The water year of Sand-Vet WUA starts in June. The Water Administration System (WAS) was implemented in 1996 and they have been using it successfully ever since.

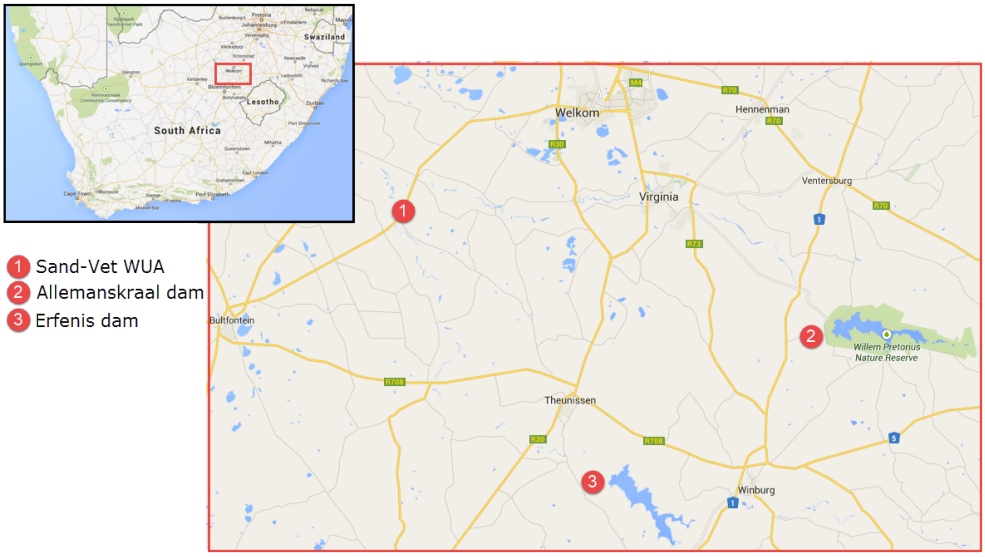


Figure 3.1: Sand-Vet WUA location map

3.2 Inception meeting

An inception meeting was held on the 3rd of December 2014 that was attended by:

- Dr N Benadé - Project leader
- Mr A Labuscagne - CEO
- Mr A van der Merwe - Head water control officer

Since then Mr van der Merwe has resigned at the end of January 2015 after which Mr. R. Fakeer resumed his duties.

3.3 Canal network/distribution sheet data

The canal network and water distribution sheet data for the Sand and the Vet canals had been captured successfully. They have tested both water release calculation methods which included the canal network approach and the distribution sheet method.

They finally decided to use the programmable distribution sheet method to calculate their releases for its ease of use and simplicity. This has been implemented successfully, training has been given and it is fully operational.

3.4 Water orders

The water orders and meter readings at Sand-Vet WUA are up to date. The only concern is the river abstractions down stream of the Vet canal that cannot be quantified due to unreliable and non existing meters. The abstractions cannot therefore be measured and a conservative approach has been taken whereby their full quota has been distributed evenly over the water year.

Accurate measurements of pump abstractions from rivers have always been a challenge. The main problems can be summarized as follows:

- Reliability and durability of the water meters being used to measure raw water river abstractions.
- Water is not ordered which makes the time of the abstraction an unknown.
- Water use is usually captured afterwards, alternatively an estimate of the water use is captured beforehand and then rectified afterwards.
- It is very difficult to control the abstraction rate and duration.

Discussions are taking place to address this problem by means of implementing the crop water use module of WAS. Funds were approved by the WUA for the implementation of the crop water use module in their 2015/2016 budget. The first meeting to implement the crop water use module is scheduled on the 28th of September 2015 at Sandvet WUA.

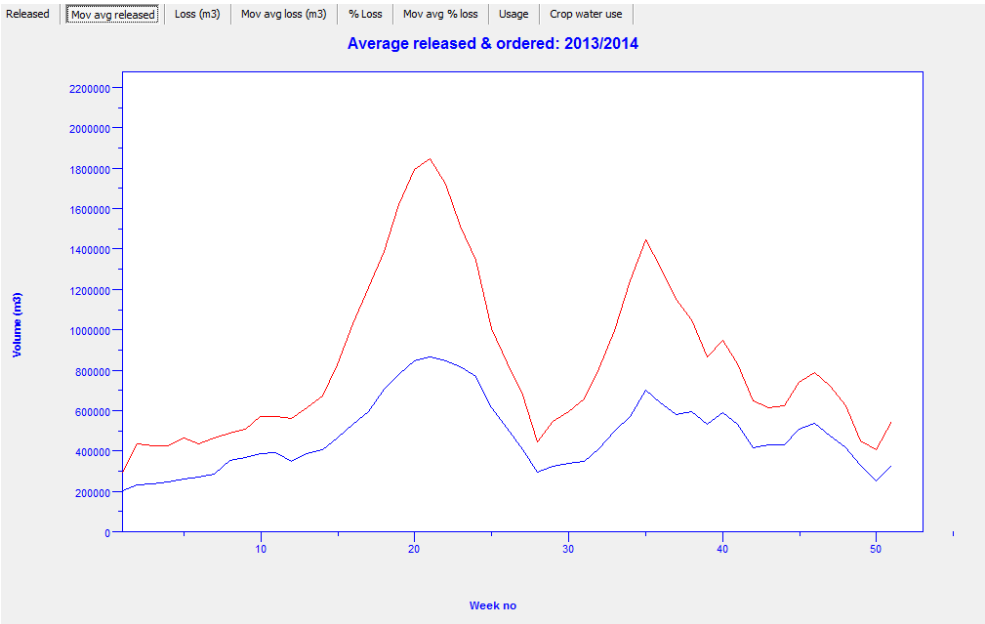


Figure 3.2: Vet canal moving average released & ordered 2013/2014

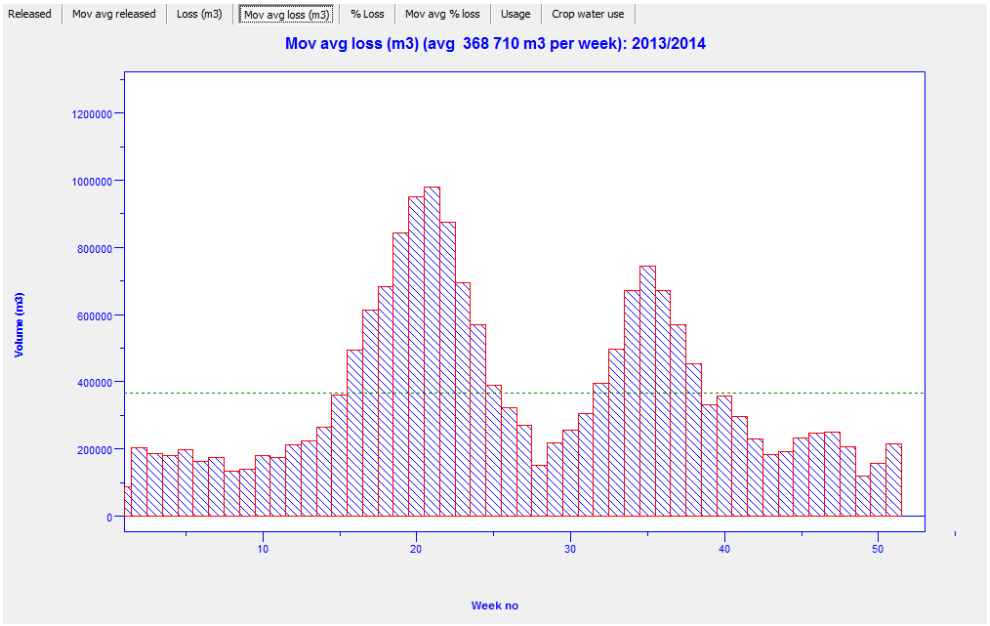


Figure 3.3: Vet canal moving average loss m^3 per week 2013/2014

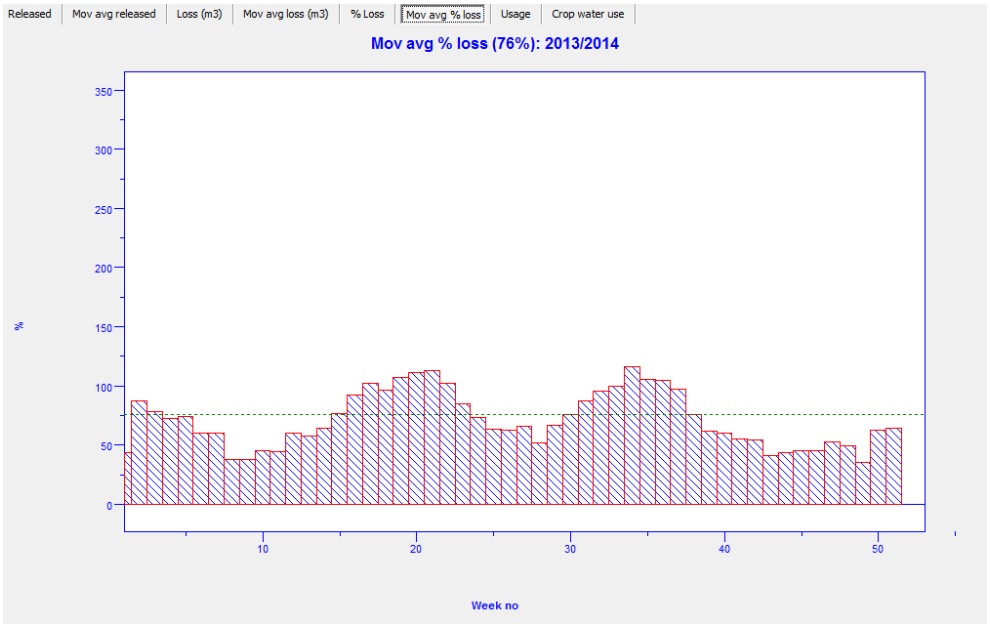


Figure 3.4: Vet canal moving average % loss 2013/2014

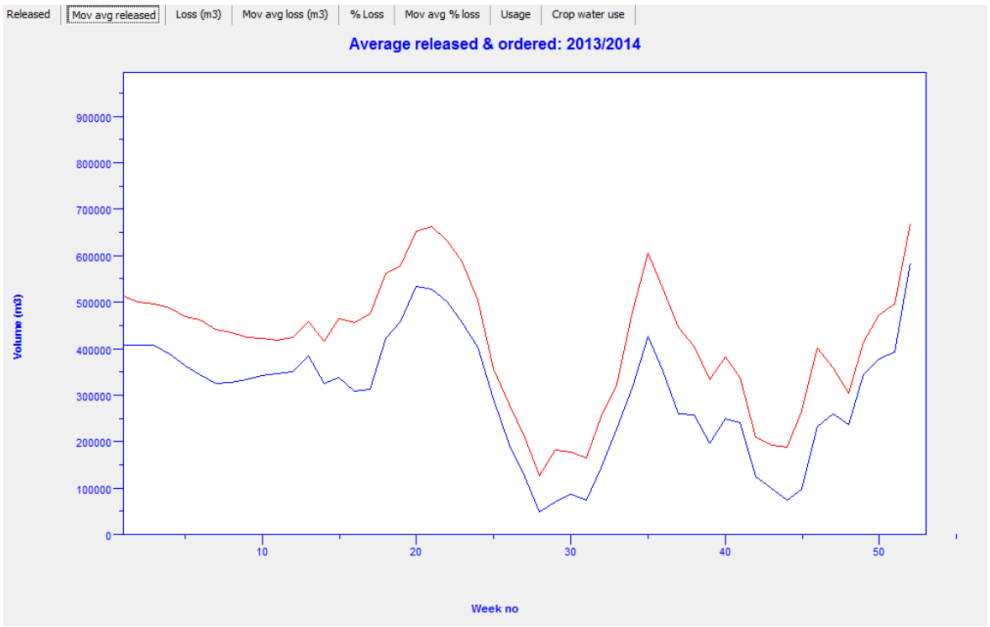


Figure 3.5: Sand canal moving average released & ordered 2013/2014

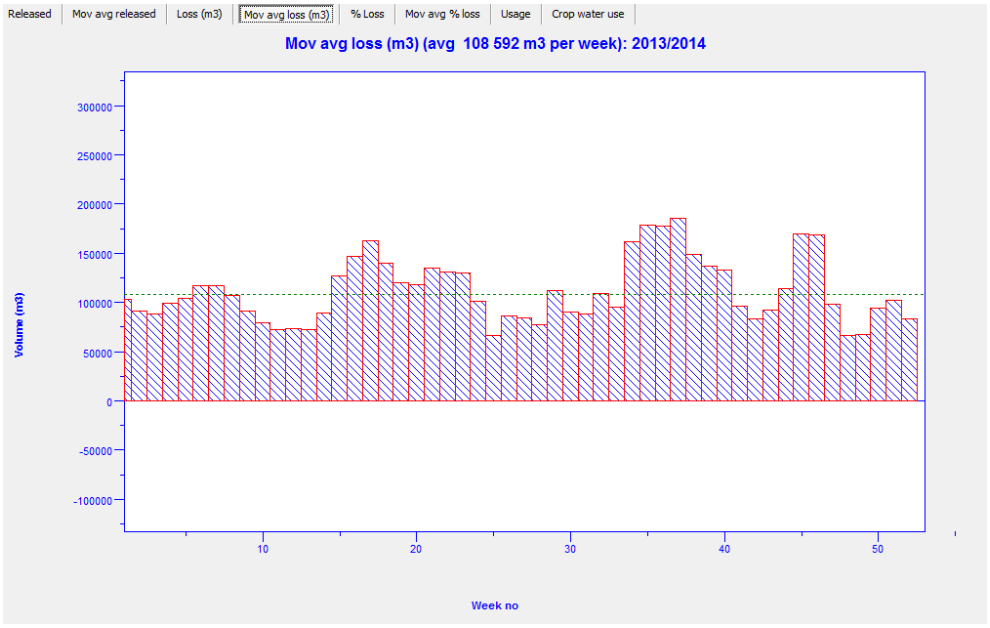


Figure 3.6: Sand canal moving average loss m^3 per week 2013/2014

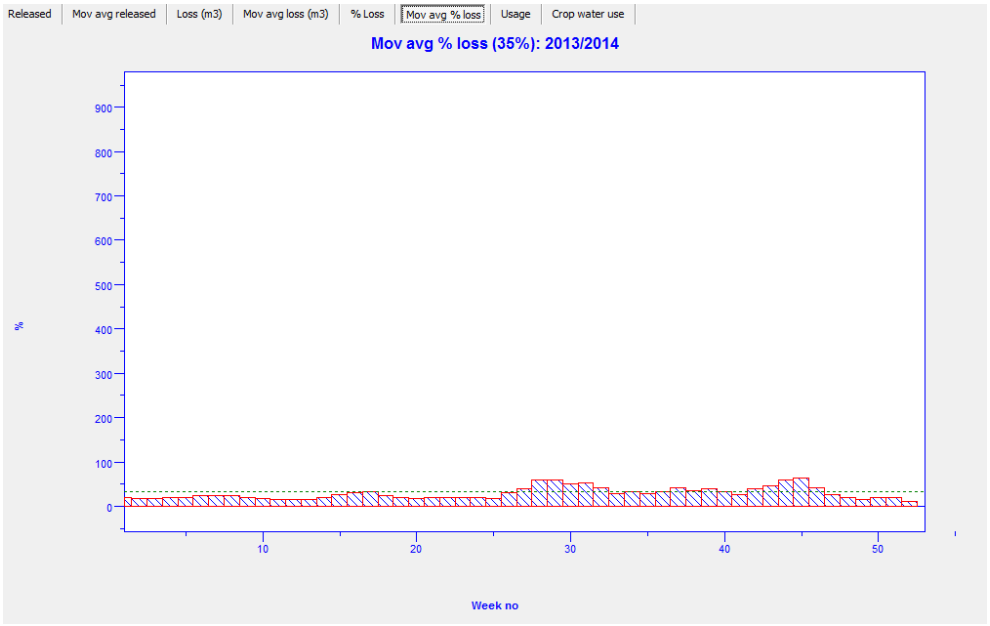


Figure 3.7: Sand canal moving average % loss 2013/2014

Chapter 4

Orange-Riet WUA

4.1 Background

The Orange-Riet Water User Association (WUA) is situated in the Upper Orange River catchment in South Africa as shown in Figure 5.1. 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.

The calibration procedure proved however to be too complicated and it has been decided to simplify this procedure and make it much more practical. The details of the simplification is discussed in Chapter 2

4.2 Inception meeting

An inception meeting was held on the 5th of January 2015 that was attended by:

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

4.3 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.

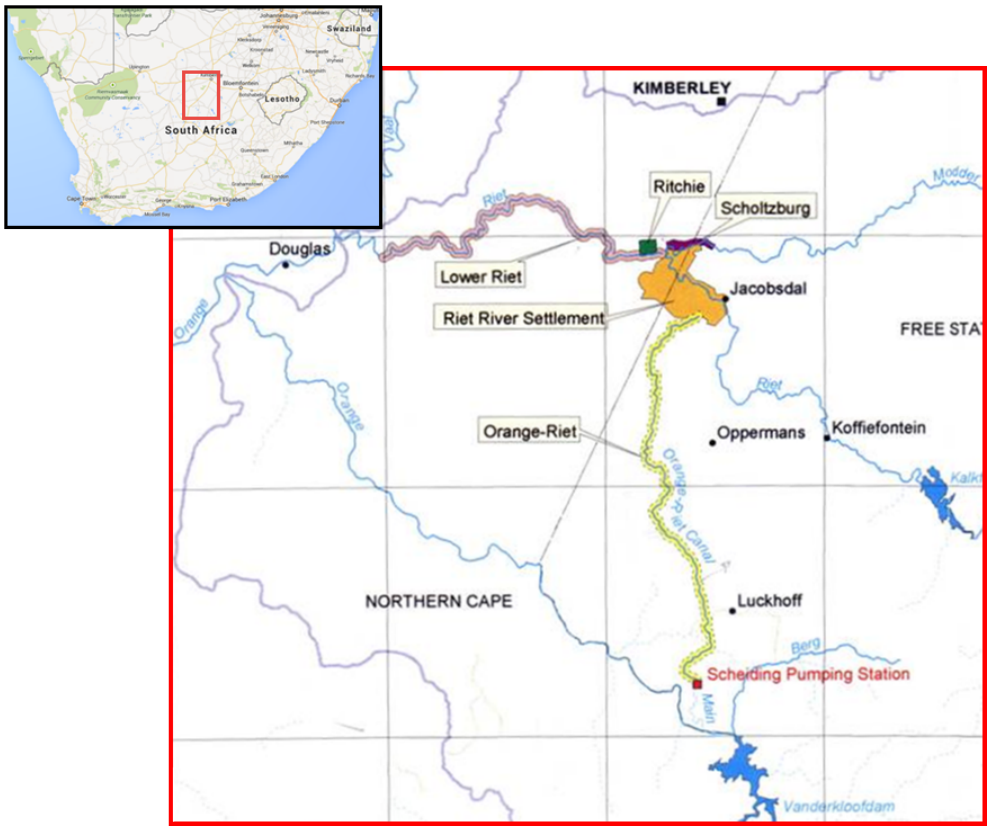


Figure 4.1: ORWUA WUA location map

4.4 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 was distributed evenly over the water year under consideration.

4.5 New development

During the implementation of the project and after the discussions of the results a decision was made to develop a dedicated water management report

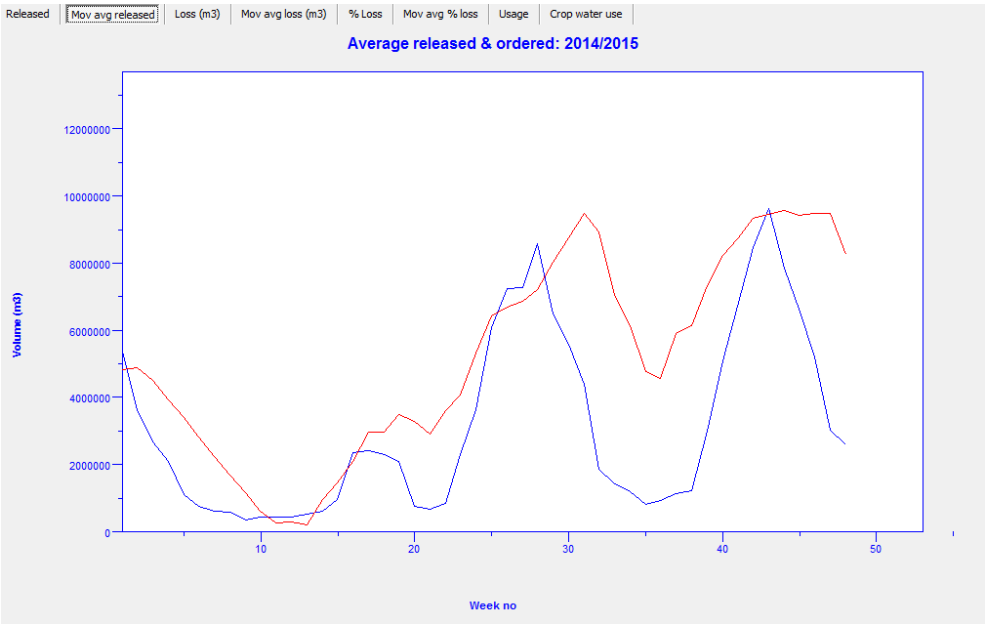


Figure 4.2: Orange-Riet WUA moving average released & ordered 2014/2015

specifically for Oranje-Riet WUA. Although this report did not form part of the initial project specifications, it simplified and added value to their water loss reporting capabilities. Previously, the water distribution personnel at Orange-Riet WUA constantly battled to generate a water use efficiency accounting report successfully. The new dedicated report solved this problem completely and it paved the way to develop similar reports for other schemes that experience the same problem. Clear, accurate and efficient water report functionality in the WAS is paramount for the improvement of water distribution management on irrigation schemes.

This report is generated automatically and includes all the sub-areas of the scheme. The report effectively contains the same information that is included in the water use efficiency accounting report but in a different format required by their management. An enormous amount of time is saved in the process and human errors are virtually eliminated. The interface to generate the report in the WAS is shown in Figure 4.5 and the report itself is shown in Figure A.1.

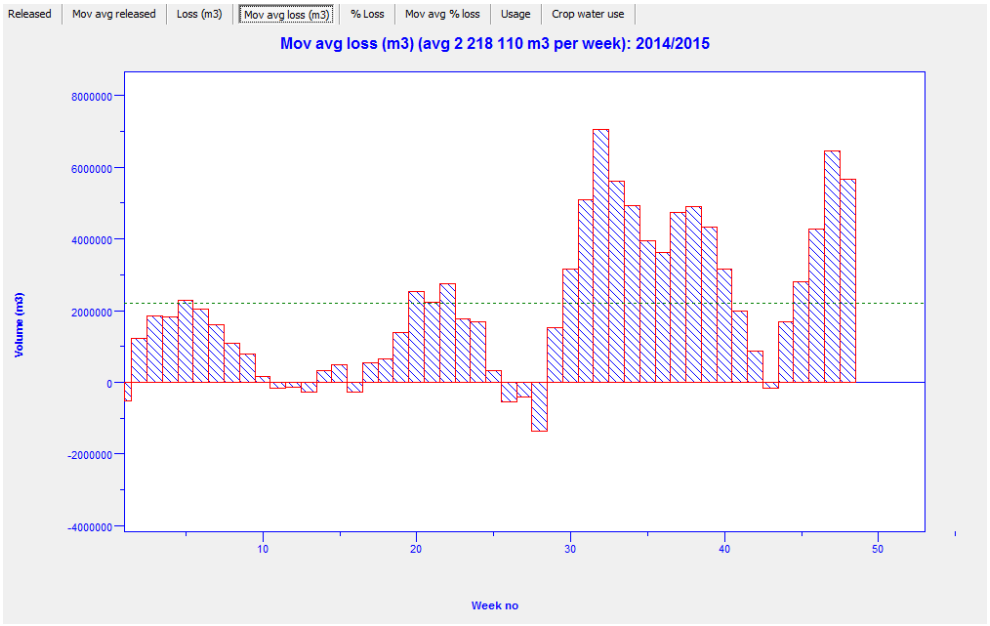


Figure 4.3: Orange-Riet WUA moving average loss m^3 per week 2014/2015

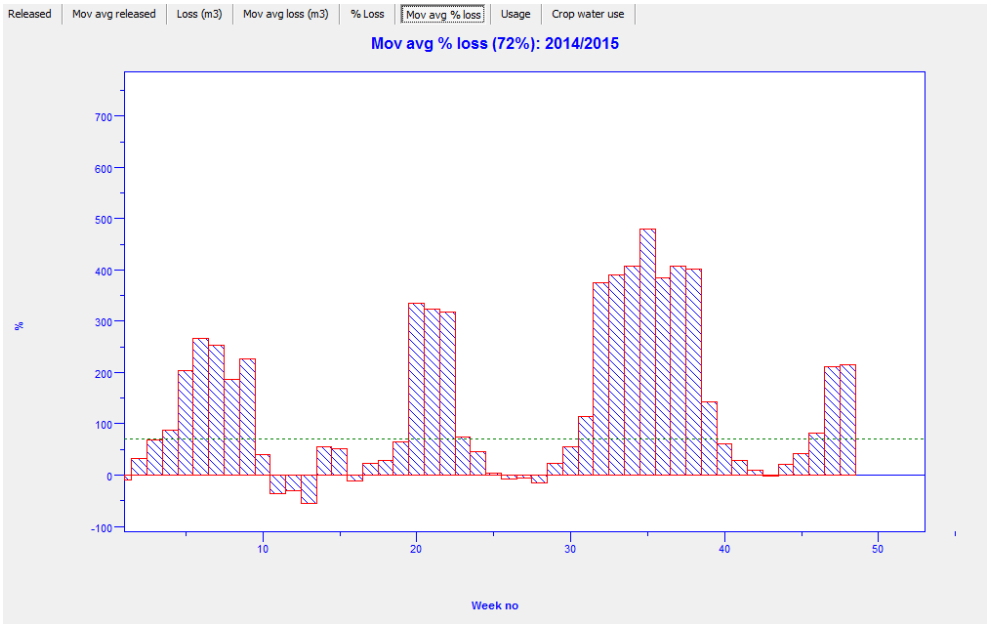
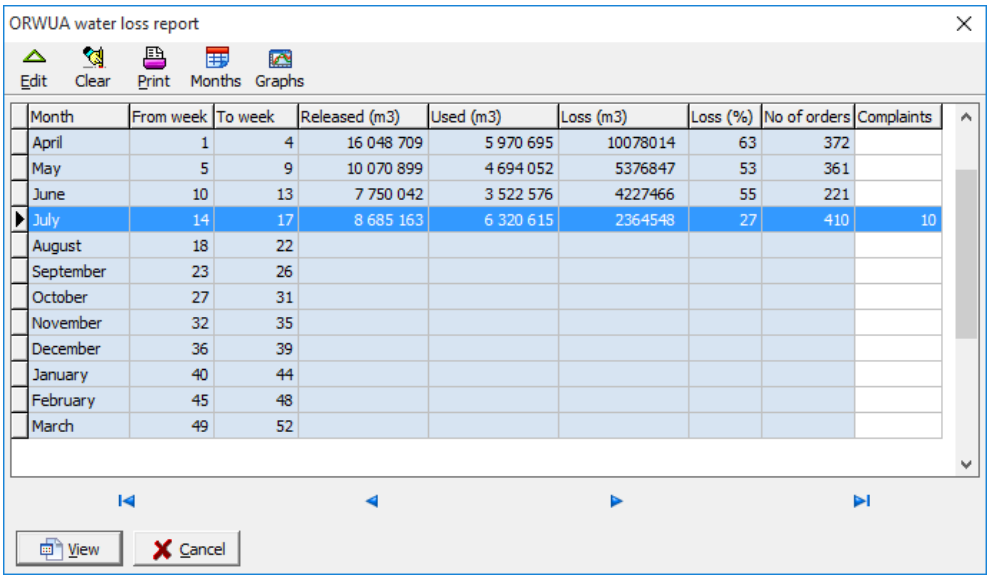


Figure 4.4: Orange-Riet WUA moving average % loss 2014/2015



Month	From week	To week	Released (m3)	Used (m3)	Loss (m3)	Loss (%)	No of orders	Complaints
April	1	4	16 048 709	5 970 695	10078014	63	372	
May	5	9	10 070 899	4 694 052	5376847	53	361	
June	10	13	7 750 042	3 522 576	4227466	55	221	
July	14	17	8 685 163	6 320 615	2364548	27	410	10
August	18	22						
September	23	26						
October	27	31						
November	32	35						
December	36	39						
January	40	44						
February	45	48						
March	49	52						

Figure 4.5: Orange-Riet WUA water loss report interface

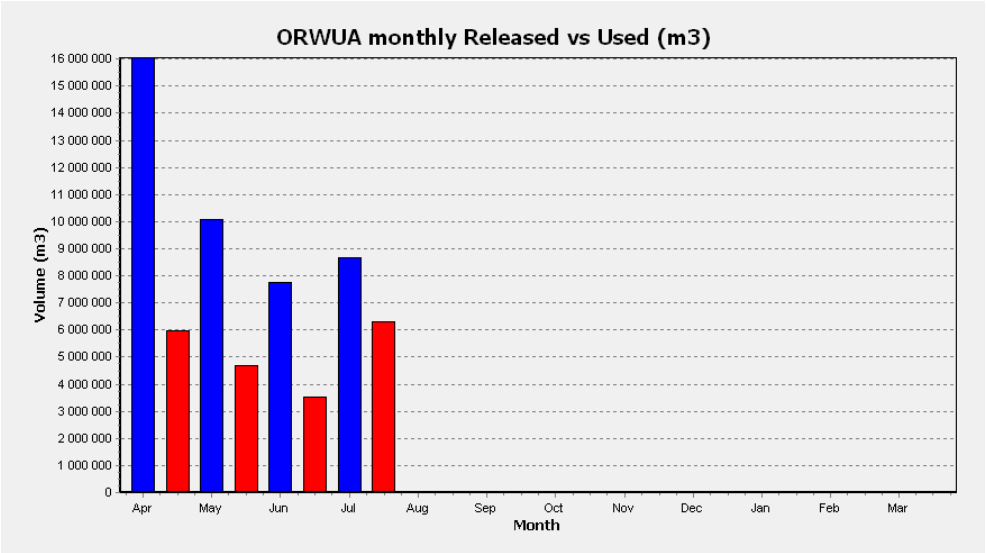


Figure 4.6: Orange-Riet WUA monthly released vs Used (m^3)

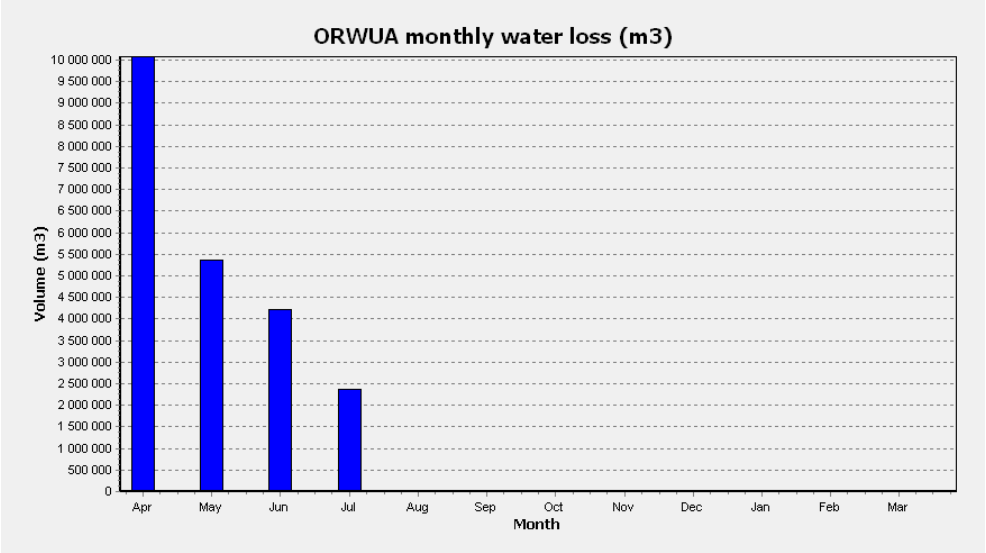


Figure 4.7: Orange-Riet WUA monthly water loss (m^3)

Chapter 5

Hartbeespoort IB

5.1 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 mangagement area. Hartbeespoort Dam is a vital recource 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.

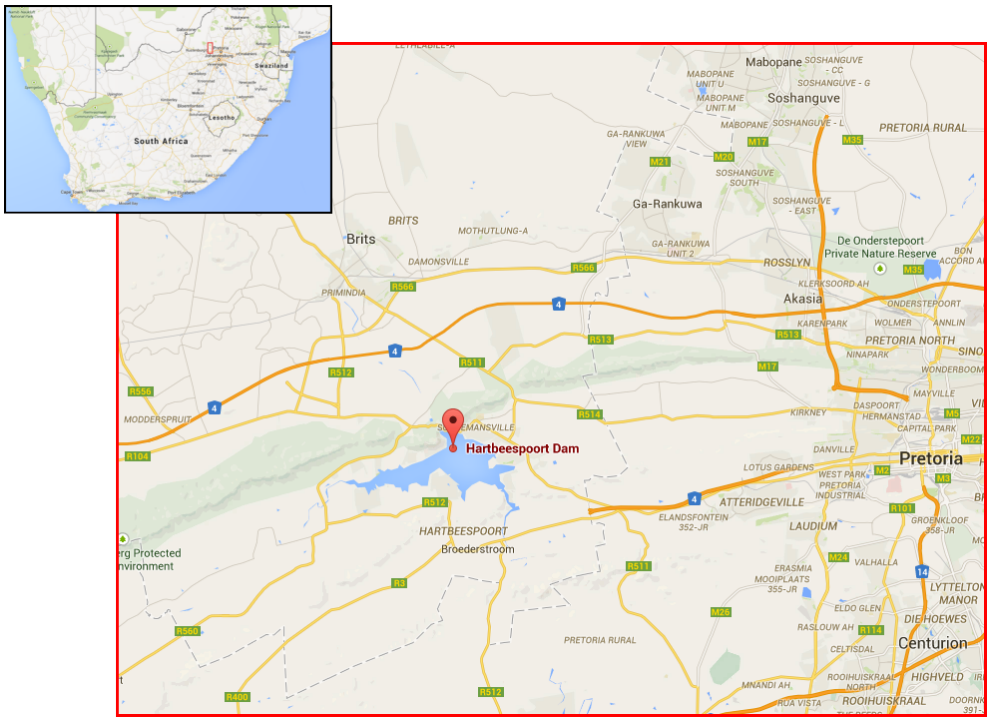


Figure 5.1: Hartbeespoort IB location map

5.2 Inception meeting

An inception meeting was held on the 13th of January 2015 that was attended by:

- Dr N Benadé - Project leader
- Mr J Fourie - DWS

- Mr A Podi - DWS
- Mrs L Sithole - DWS
- Mr T Young - HBP
- Mr A Swanepoel - HBP
- Mrs A de Villiers - HBP
- Mr NL Fourie - HBP
- Mr Voughan Thomas - HBP
- Mr F Louw - HBP
- Mr PJ de Beer - HBP
- Mr Zerwick - HBP

5.3 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.

This problem was rectified and the capturing of the canal network data for the West canal had been completed and verified. Hartbeespoort IB investigated both water release calculation methods which included the canal network approach and the distribution sheet method. They finally decided to use the distribution sheet method to calculate their releases for its ease of use and it mimics their current release calculation procedures.

5.4 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.

Figure 5.2: Hartbeespoort IB moving average released & ordered 2014/2015

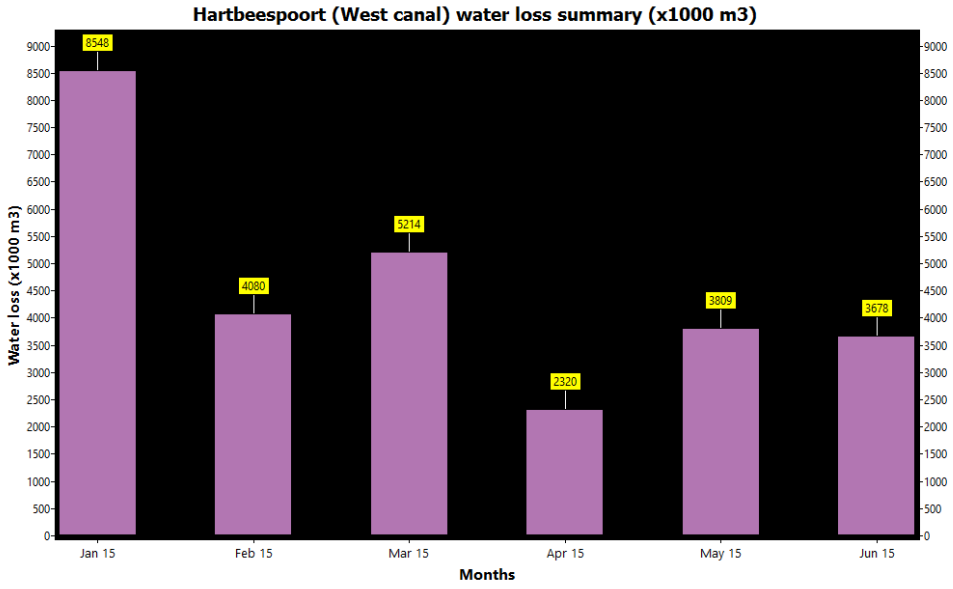


Figure 5.3: Hartbeespoort (West canal) m^3 loss per month 2014/2015

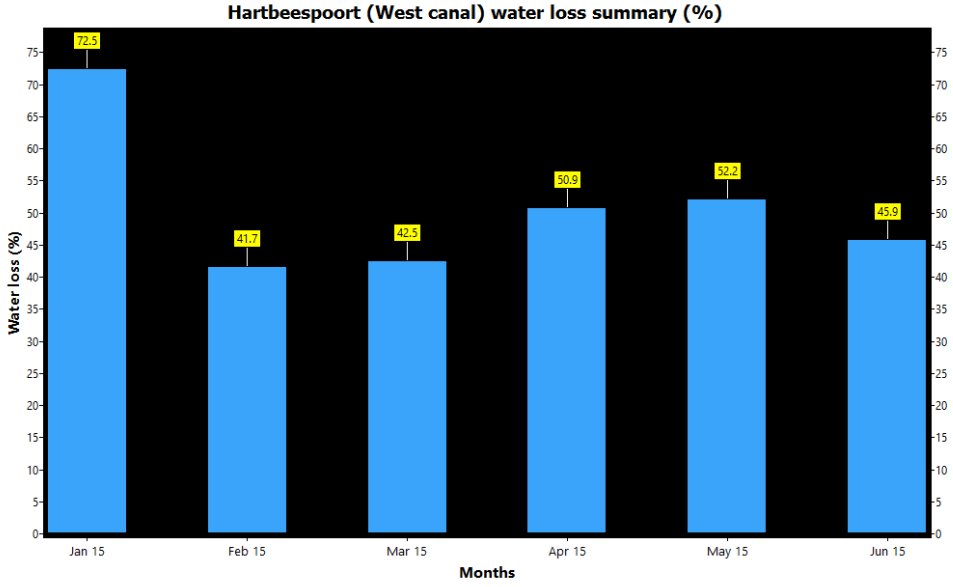


Figure 5.4: Hartbeespoort (West canal) % loss per month 2014/2015

Chapter 6

Vaalharts WUA

6.1 Background

Vaalharts is the largest Irrigation Scheme in South Africa. The scheme borders on the Northern Cape and North-West Provinces. Vaalharts is situated east of the Harts River and is enclosed from the south by the Vaal River. The canal system consists of a total of 1 176 kilometers of concrete-lined canals. It irrigates a total of 39 820 hectares of scheduled area, currently supporting 1 040 irrigation farmers. That number includes roughly 47% of commercial farmers as well as 53% of upcoming small farmers. The scheme also provides industrial water to 6 municipalities and 9 other industrial raw water users.

Water for the scheme is sourced from the Vaalharts weir which, in turn, is fed by water from the Bloemhof dam on the Vaal River.

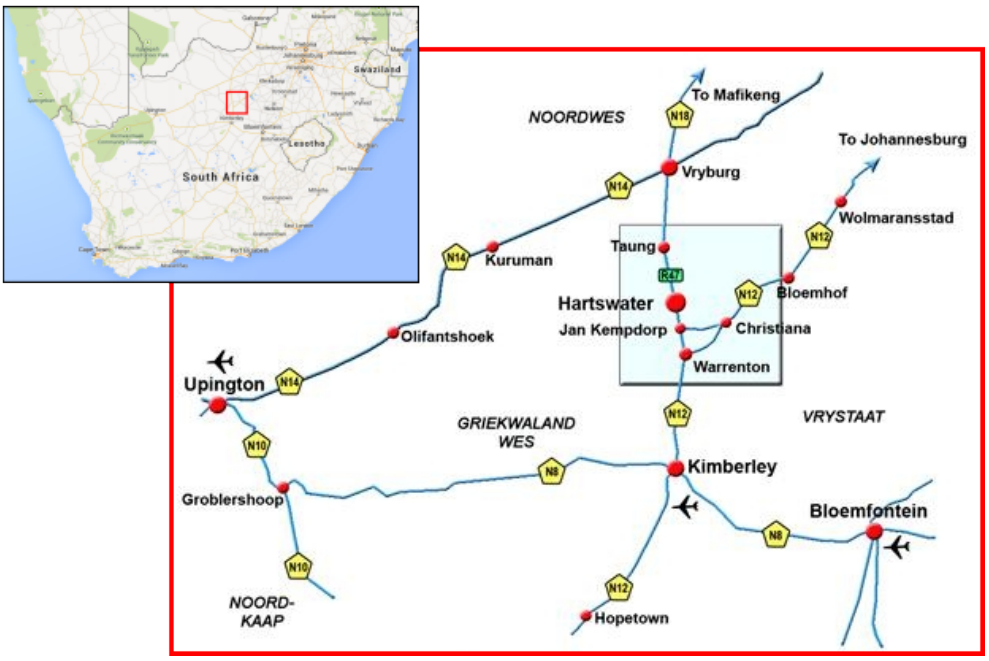


Figure 6.1: Vaalharts WUA location map

6.2 Inception meeting

An inception meeting was held on the 6th of January 2015 that was attended by:

- Dr N Benadé - Project leader
- Mr J Fourie - DWS

- Mr van Dyk - VHWUA
- Mr JH Harbron - VHWUA
- Mr IP Masike - VHWUA
- Mr H Grové - VHWUA

6.3 Canal network data

Vaalharts is using the twelve hourly programmable distribution sheet of the release module to calculate their water releases with great success. The data for Vaalharts canal network has also been captured and verified. The calibration of and training on the use of the water release module are ongoing.

6.4 Water orders

The water orders and meter readings at Vaalharts WUA are captured on a weekly basis and are up to date.

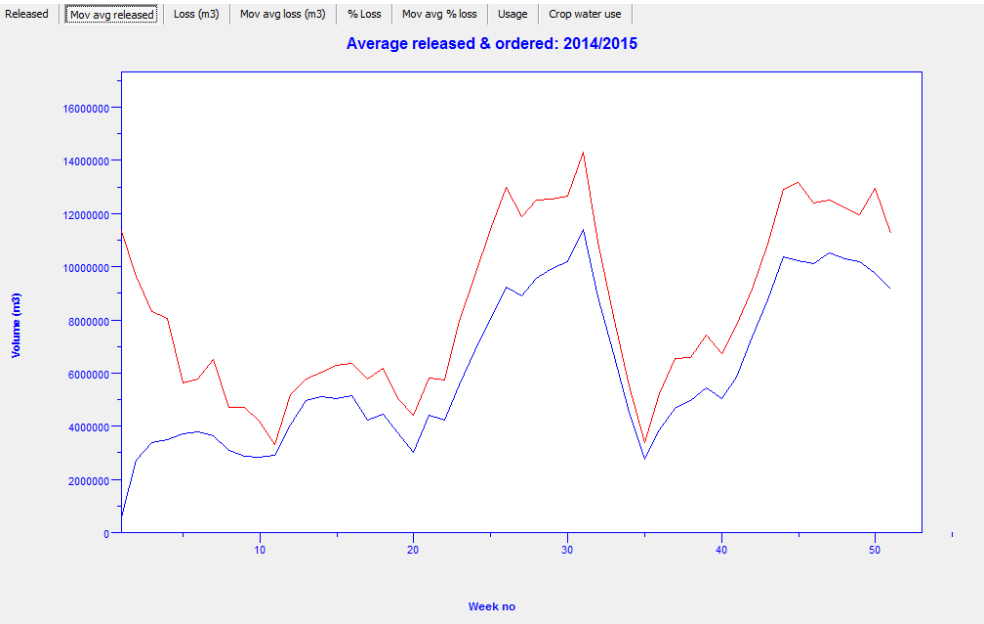


Figure 6.2: Vaalharts WUA moving average released & ordered 2014/2015

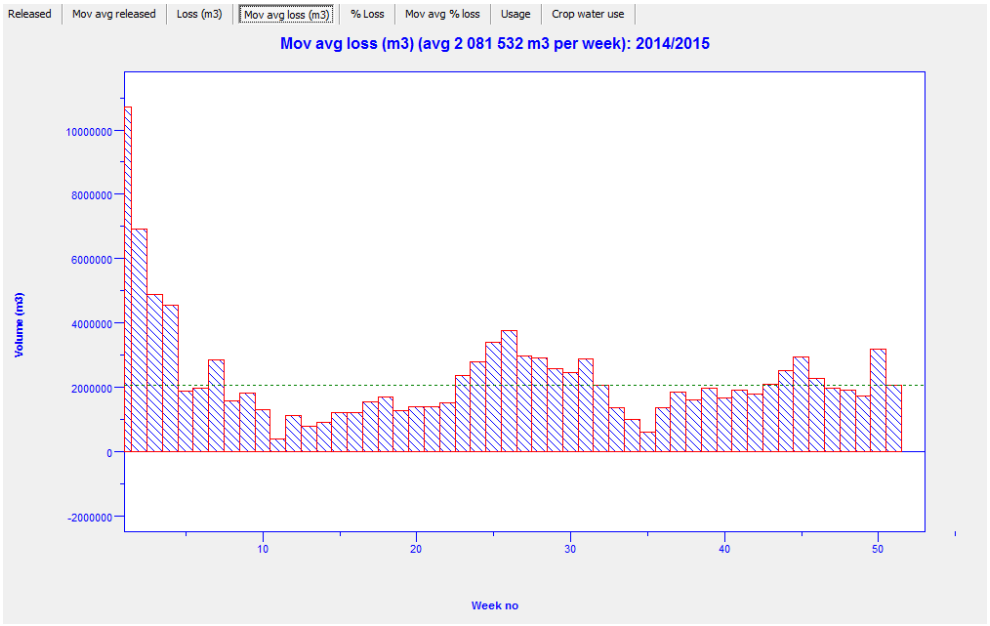


Figure 6.3: Vaalharts WUA moving average loss m^3 per week 2014/2015

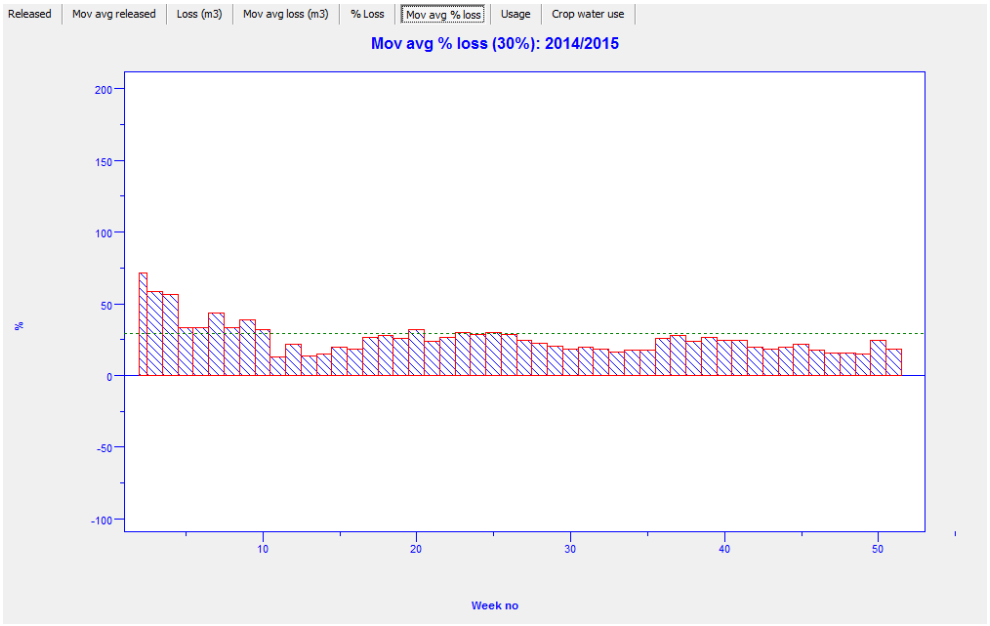


Figure 6.4: Vaalharts WUA moving average % loss 2014/2015

Chapter 7

Water loss calculation

7.1 Calculation of percentage water loss

The initial calculation of the base line water loss revealed that there is a difference between the water loss percentages that are added when the releases are calculated compared to the percentages when water losses are reported on.

The DWS method to calculate and report on the percentage of water lost is as follows:

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

where

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

In comparison the general method used to calculate a release is as follows:

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

which in turn leads to the following water loss % calculation:

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

The difference between the two methods is that when water losses are reported on, the total water lost is divided by the total water released and not by the total water ordered.

Chapter 8

Base line water loss results

8.1 Base line water loss

The base line water loss, as shown in Table 8.1, 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 7.1). The results are shown in Table 8.1.

The base line water loss at Vaalharts WUA has been effected by major construction works that are currently in progress. This has resulted in additional water losses where the main canal had to be emptied 6 times for maintenance. The average volume needed to refill the main canal is approximately 485 000 m^3.

Figure 8.1 displays the base line water loss as a percentage and Figure 8.2 displays the base line water loss per million m^3. A comparison between the two bar charts shows clearly that a water loss stated as a percentage can easily be misinterpreted. Although the 43% water loss from the Vet canal is higher than the 42% water loss from the Orange-Riet, a comparison of the actual volumes proves the opposite. The base line volumes are 0.37 and 2.22 million m^3 for the Vet canal and Orange-Riet WUA respectively, which is a huge difference compared to the percentages.

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.

A similar deduction can be made if the 47% water loss from Hartbeespoort IB is compared to the 25% water loss from Vaalharts WUA. The actual volume of water lost at Vaalharts WUA is as a matter of fact more than twice the loss at Hartbeespoort IB.

Scheme	Scheduled area (ha)	Full quota (m^3)	Avg loss/week (m^3)	Loss (%)	Loss/week (m^3 x 1 000 000)
Vaalharts WUA	35 060	320 448 400	2 081 532	25	2.08
Orange-Riet WUA	15 941	175 351 000	2 218 110	42	2.22
Hartbeespoort IB (West canal)	7 083	43 912 740	907 668	47	0.91
Vet: 2013/2014	7 153	24 331 339	368 710	43	0.37
Sand: 2013/2014	5 175	27 945 897	108 592	26	0.11
	70 412	591 989 376			

Table 8.1: Base line water loss summary

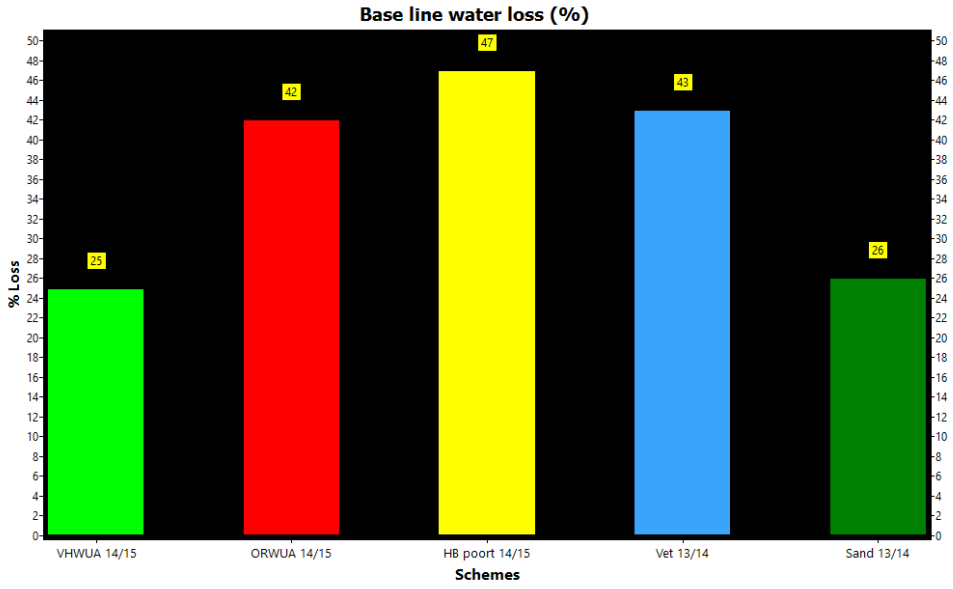


Figure 8.1: Base line water loss %

8.2 Sand-Vet WUA

The calculation of the base line water loss from the available data at Sand-Vet WUA has shown that the 26 % and 43% base line water loss for the Sand and Vet canals respectively are higher than expected. The findings can be summarized as follows:

- The real time measuring stations at Allemanskraal and Erfenis dams were not in a working order and could not be used for the determination of the base line water loss calculation.
- Sand-Vet WUA relied on the digitizing of charts from A.OTT chart recorders to quantify the inflows into the Sand and Vet canals respectively.
- It was decided to use verified historical data from the DWS to calculate the base line water loss for both the Sand and the Vet canals. This data however, has a lag of three months which makes the calculation on current dates impossible.
- A demo measuring station from Ubuntu Water Quality was installed at Erfenis dam which made it possible to download and import real time data into the WAS database for the inflow into the Vet canal.

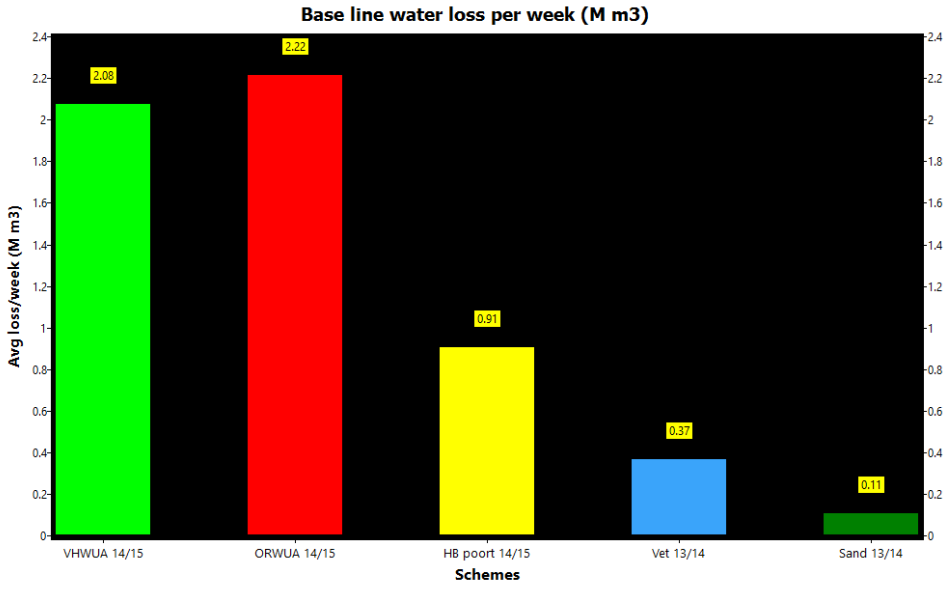


Figure 8.2: Base line water loss (M m^3)

Another demo station from WRP Consulting Engineers was installed at the West canal at Hartbeespoort Irrigation Board. After a trial period of two months the equipment from WRP was selected.

- New real time measuring stations from WRP have been installed at the inflow into the Sand and the Vet canals. Real time data is now available through the Zednet network on the internet.

- River abstractions posed a challenge on the Vet canal where a conservative approach was taken by distributing their full quota evenly over the water year. This had to be done due to unavailable measurements.

The findings stress the fact that continuous and accurate inflow measurements are vital to effective water distribution management through canal networks. This is the first line of defense to minimize water losses.

Calculating the water losses with the WUEA report on a weekly basis in combination with the calculation of the releases with the release module will definitely reduce the water loss at Sand-Vet WUA. The water savings will be quantified once the release module has been operational for a couple of weeks.

The new measuring stations were installed on the 18^{th} of August 2015 and the first full month of release data will only be available at the end of

September 2015. Realistically, a couple of months of data are needed to make any meaningful conclusions.

8.3 Orange-Riet WUA

The calculation of the base line water loss from the available data at Orange-Riet WUA has shown that the 42% base line water loss is much higher compared to the water losses that were calculated manually. The findings can be summarized as follows:

- Much time was spent on the setup of the WUEA report to ensure that all the water use data is included and that the results are correct.
- Orange-Riet WUA is already generating water releases with the release module of WAS on a weekly basis. The calibration process is however time consuming and difficult and it has therefore been decided to simplify the process and make it much more practical. This has been implemented successfully and the system is fully operational. Support will be given on an ongoing basis to improve the calibration of the release calculations.
- Calculating the water losses with the WUEA report on a weekly basis has identified some problems which, if rectified, will definitely improve their current operations. The two main problems that were identified included the following:
    - Meter readings that were not captured in the WAS which was therefore not included in the water loss calculations.
    - Measured water release data that was incorrectly imported or not imported at all.
- A dedicated water distribution management report has been developed for Orange-Riet WUA that is automatically generated by the WAS. This saves an enormous amount of time and prevents human errors.

  This report is one of the spin offs of the implementation of the water release module at Orange-Riet WUA. Similar reports could be helpful to other irrigation schemes which should be developed rolled out in addition to the water release module.
- Solutions are investigated to make it possible to import real time data from the Scheiding measuring station. This will automate the generation of the WUEA report which will improve their water distribution management.

8.4 Vaalharts WUA

The calculation of the base line water loss from the available data at Vaalharts WUA has shown that the 25% base line water loss is on par with their reported losses taking into account the additional water losses that resulted from the construction works on their main canal. The findings can be summarized as follows:

- Vaalharts WUA is the only scheme as part of this project where the inflow measuring station data was up to date in the WAS database.
- It is worth mentioning that Vaalharts WUA installed and evaluated two different electronic measuring stations at the inflow of their main canal. The evaluation period started in November 2014 and they are now in the process of installing fifteen Cello measuring stations throughout the scheme as a first phase.

  In a follow up phase they plan to roll out another thirteen measuring stations which are all funded by the scheme itself. The data from the Cello meters can be imported directly into the WAS database and the information can be viewed on the Zednet website.
- Vaalharts WUA is currently generating their water releases through the use of the programmable distribution sheet in WAS. The programmable distribution sheet is part of the water release module in the WAS. NB Systems is working closely with Mr. K. Harbron from Vaalharts WUA to improve the water release calculation algorithms in the WAS on an ongoing basis.
- The programmable distribution sheet has been upgraded as part of this project. A separate summary of totals sheet can now be generated automatically.

8.5 Hartbeespoort IB

The calculation of the base line water loss for the West canal has resulted in an expected value of 47%. The base line water loss at Hartbeespoort IB could only be based on the period starting from the 21st of January 2015 when the measuring station was installed. This included weeks 17 to 36.

- No real time information from Hartbeespoort IB was available at the inflow of the West canal that could be used for the calculation of the base line water loss.

- A Cello demo measuring station was installed on the 20th of January 2015 at the inflow of the West canal. The water release data can now be imported directly into the WAS database from the Cello logger through the use of the Zednet website.
- The demo measuring station has been functioning at 100% during the testing period. The data can be downloaded and imported into the WAS database with ease.
- The day committee of Hartbeespoort IB indicated that they will purchase the Cello measuring station to improve there water distribution management. They are also looking into the installation of additional measuring stations on scheme which will improve their water distribution management capabilities.

Chapter 9

Current water loss results

9.1 Current water loss results

The latest water loss results of the participating irrigation schemes compared to their respective base line water losses (as described in paragraph 8.1) are shown in Table 9.1.

The table shows the initial base line water loss as a weekly average volume in m^3 compared to the latest weekly average water loss for the period after the base line water loss was calculated for the respective schemes. The time periods under consideration can be seen in the respective water loss summary graphs. The time period under consideration is however too short for the results to be conclusive.

The results will however be updated on an ongoing basis to track their progress over time. This will still continue after the project has been completed by means of the WUEA reports that have to be generated and submitted to the DWS.

The results of each scheme are discussed in the following paragraphs.

Scheme	Scheduled area (ha)	Full quota (m^3)	Base line loss/week (m^3)	Current loss/week (m^3)	Difference (m^3)	Difference (%)
Vaalharts WUA	35 060	320 448 400	2 081 532	1 888 726	192 806	9
Orange-Riet WUA	15 941	175 351 000	2 218 110	1 536 211	681 899	31
Hartbeespoort IB (West canal)	7 083	43 912 740	907 668	854 482	53 186	6
Vet: 2013/2014	7 153	24 331 339	368 710			
Sand: 2013/2014	5 175	27 945 897	108 592			
	70 412	591 989 376			927 891	

Table 9.1: Current water loss summary

9.2 Sand-Vet WUA: Vet canal

The results from the Vet canal are displayed in Figure 9.1. It seems that there is a downward tendency, but the time period is too short to make a meaningful conclusion.

The real time measuring station at Erfenis dam was installed on the 18^{th} of August 2015 and the real time data is now available through the Zednet internet platform.

9.3 Sand-Vet WUA: Sand canal

The results from the Sand canal are displayed in Figure 9.2. For the last couple of weeks no meaningful releases could be made into the Sand canal due to the low levels of the Allemanskraal dam.

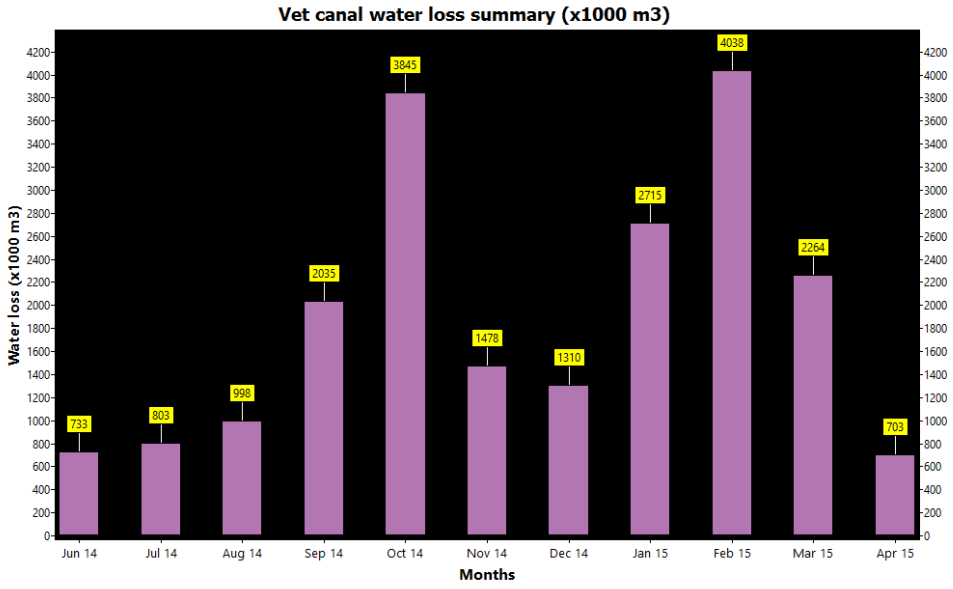


Figure 9.1: Vet canal water loss summary

The real time measuring station at Allemanskraal dam was installed on the 18th of August 2015 and the real time data is now available through the Zednet internet platform.

9.4 Orange-Riet WUA

The results from Orange-Riet WUA are displayed in Figure 9.3. The results show a definite downward trend since February 2015 until July 2015. There was a reduction of 681 899 m^3 compared to their initial base line water loss. This represents a substantial reduction of 30% from their base line loss.

Care should however be taken in the interpretation due to the short time period under consideration. The results from a full water year (12 months), which includes both seasons, will be much more conclusive.

Their inflow data is still extracted manually with a laptop computer after which it is imported into the WAS database. Real time data access through the Zednet internet platform will simplify this operation drastically and virtually eliminate all human errors in the process. A Cello data logger, that can communicate with the Zednet internet platform, will have to be installed to make this possible.

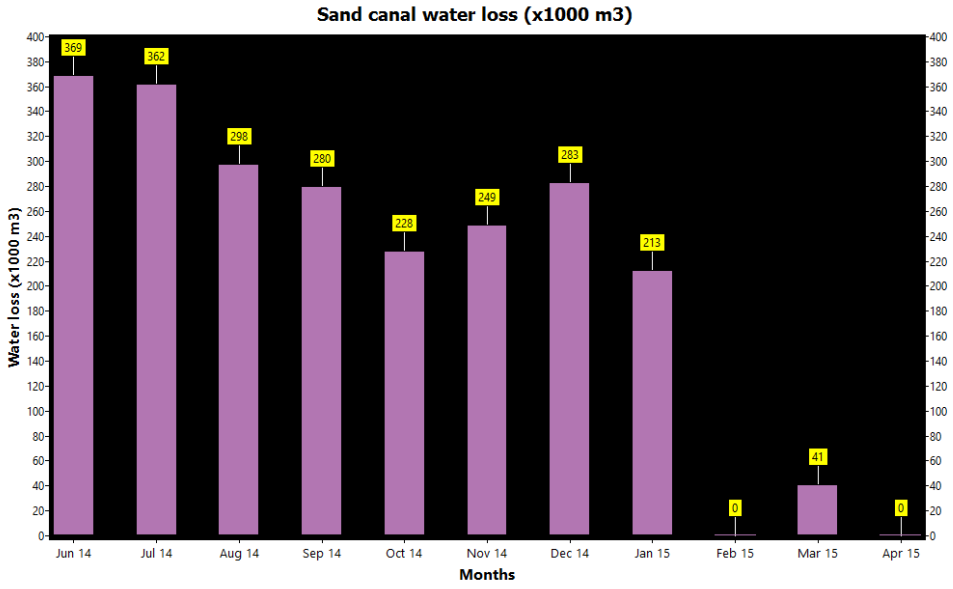


Figure 9.2: Sand canal water loss summary

9.5 Vaalharts WUA

The results from Vaalharts WUA are displayed in Figure 9.4. The graph shows the results of a full water year (2014/2015). The current assessment shows a reduction of 192 806 m^3 from their initial base line water loss. This represents a reduction of 10% from their base line water loss.

It can be expected that the current construction works on their main canal will have a negative effect on their water losses.

The inflow data into the main canal at Vaalharts WUA is available on the Zednet internet platform.

9.6 Hartbeespoort IB

The results from Hartbeespoort IB are displayed in Figure 9.5. The results show a jump downward after January 2015. This happened right after the measuring station was installed on the 20^{th} of January 2015. There was a reduction of 53 186 m^3 compared to their initial base line water loss. This represents a reduction of 6% from their base line loss.

Although the WAS water release module has been implemented at Hartbeespoort IB, they still need to change their operations to get the full benefit from it. The following changes are required:

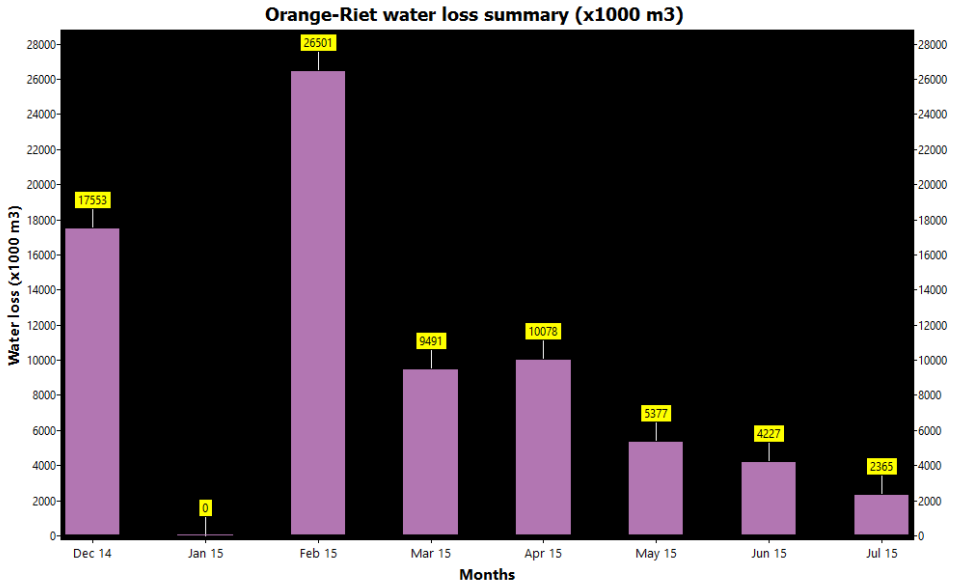


Figure 9.3: Orange-Riet WUA water loss summary

- Capture their water orders in the WAS database in time to calculate the release. Their water orders are currently being captured in the WAS database a week or two after the release was made.
- Calculate the water release with the twelve hourly distribution sheet in the WAS.

A further reduction in water losses can be expected once this is in place.

The inflow data into the West canal at Hartbeespoort IB is available on the Zednet internet platform.

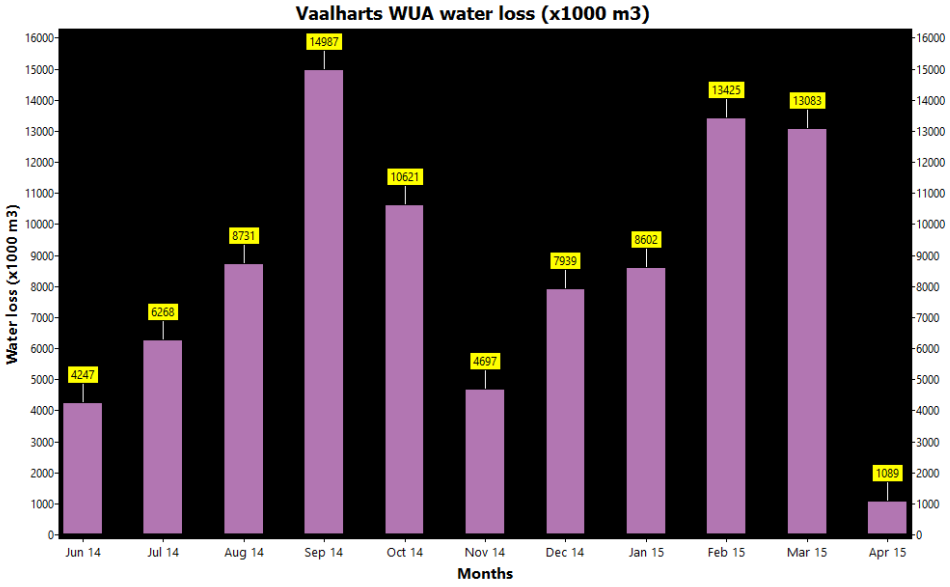


Figure 9.4: Vaalharts WUA water loss summary

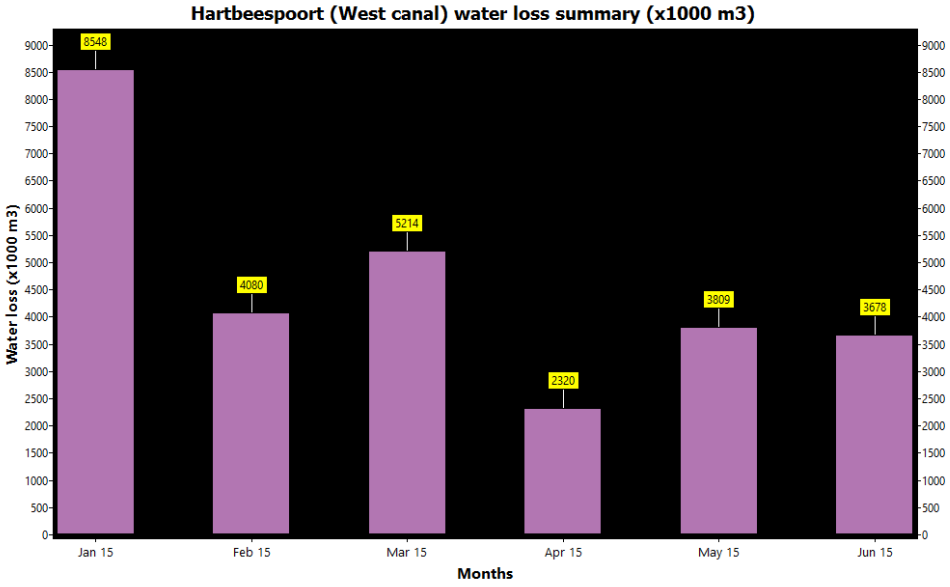


Figure 9.5: Hartbeespoort IB water loss summary

Chapter 10

Measuring stations

Measuring stations

Water flow measurement is the key to effective water distribution management and the minimization of water losses. Water losses cannot be quantified without a reliable and accurate measurement of the inflow into a scheme. The simplest and most effective method to determine the global water loss on an irrigation scheme is by measuring the inflow as accurately as possible and subtracting the total water use.

10.1 Sand canal: Allemanskraal dam

An assessment was made of the measuring stations at Allemanskraal dam, as shown in Figure 10.1, that delivers water into the Sand canal.

The station is in an excellent condition and uses a 10ft Parshall flume. Real time data is however, not available. The base line water loss calculations had to be done using historical data from the DWS which has a lag of at least three months.

10.2 Vet canal: Erfenis dam

An assessment was made of the measuring station at Erfenis dam, as shown in Figure 10.2, that delivers water into the Vet canal.

The station is in an excellent condition and uses a 10ft Parshall flume for flow measurement. Real time data is however, not available. The base line water loss calculations had to be done using historical data from the DWS which has a lag of at least three months. Negotiations with two companies that supply measuring station equipment agreed to install demonstation sites for evaluation purposes at Hartbeespoort West canal, Erfenis dam and at Vaalharts weir.

The demo measuring station at Erfenis dam was supplied by a company by the name of Ubuntu Water Quality which was installed on the 2nd of February 2015. The data was accessible through their web site in real time and was tested over a period of two months. A similar demo site was supplied by a company by the name of WRP Consulting Engineers (WRP) at the West canal at Hartbeespoort irrigation board. After careful consideration it was decided to go with the latter. This decision meant that the Ubuntu measuring station at Erfenis dam was discontinued. After the evaluation period, WRP undertook to install real time measuring stations at both Allemanskraal and Erfenis dams.

Figure 10.1: Measuring station at Allemanskraal dam

Both measuring stations were installed on the 18th of August 2015 and is currently fully operational. Sand-Vet WUA paid for both measuring stations and they have budgeted for another measuring station to measure water delivered to irrigators that abstract water from the river.

10.3 Orange-Riet: Scheiding pump station

An assessment was made of the measuring station at the Scheiding pump station, as shown in Figure 10.3, during a field visit on the 17th of February 2015.

The measuring station is in an excellent condition using a crump weir for flow rate measurement. Real time data is however not available but it is manually downloaded from a logger on a monthly basis. The base line water loss calculations were done using historical data for the 2014/2015 water year.

Installation of equipment that will give real time access to the data at the Scheiding measuring station was investigated. This was however unsuccessful

Figure 10.2: Measuring station at Erfenis dam

and they are currently interested in the follow-up project to acquire this capability. This will enable the water office personnel to generate the WUEA report on a weekly basis which, in turn, will give them better control over their water losses.

10.4 Hartbeespoort IB: West bank main canal

An assessment was made of the measuring station at the West bank main canal, as shown in Figure 10.4. Flow measurement is done making use of a 10^{ft} Parshall flume. The measuring station is in a good condition, but possible drowning of the flume might occur depending on the flow rate and downstream conditions.

Drowning occurs when the downstream water level is at a hight where it has an effect on the upstream water level of the flume. Drowning of the flume will influence the accuracy of the flow measurements. The situation will be monitored to determine whether it is the case or not.

Figure 10.3: Measuring station at Scheiding pump station

Real time data was however not available and a demo Cello measuring station was installed to be able to download and import real time data into the WAS database. The measuring station was installed on the 20th of January 2015 and has been working without any problems ever since.

After the successful installation of the measuring station, the Hartbeespoort Irrigation Board has decided to purchase it. They are also looking into the installation of additional measuring stations on scheme which will improve their water distribution management capabilities.

10.5 Vaalharts: Main canal

An assessment was made of the measuring station at the inflow of the Vaalharts main canal, as shown in Figure 10.5. Flow measurement is done making use of a Crump weir. The measuring station is in a good condition.

Measuring station data is up to date in the WAS database. The flow measurements were initially done by means of an AOTT chart recorder, but they have since installed a Cello measuring station. The flow measurement data is now imported directly into the WAS database.

Vaalharts WUA is also in the process of installing fifteen additional Cello

Figure 10.4: Measuring station at Hartbeespoort IB West canal

measuring stations throughout the scheme which will improve their water distribution management capabilities.

Figure 10.5: Measuring station at Vaalharts main canal

Chapter 11

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 project, it became apparent that real time inflow data was non existent except in the case of Vaalharts WUA.

Fortunately demo measuring stations from different companies were offered to us that could be evaluated. The final choice fell upon the Cello logger that is linked to the Zednet internet interface as shown in 11.1.

This solution proved to be very successful and in the end all the irrigation schemes included in the project, except Orange-Riet WUA, installed Cello loggers and linked up to the Zednet network. The schemes that are using the WAS and where their inlow measuring station is currently linked to the Zednet network includes the following:

- **Hartbeespoort IB**: West canal outlet
- **Sand-Vet WUA**: Allemanskraal dam canal outlet
- **Sand-Vet WUA**: Erfenis dam canal outlet
- **Vaalharts WUA**: Main canal outlet
- **Lower Olifants River WUA**: Bulshoek dam canal outlet

A dedicated WAS data export function was created on the Zednet platform as shown in 11.2. A dedicated Zednet data import function was created in the WAS program as shown in Figure 11.3.

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.

Figure 11.1: Zednet internet interface

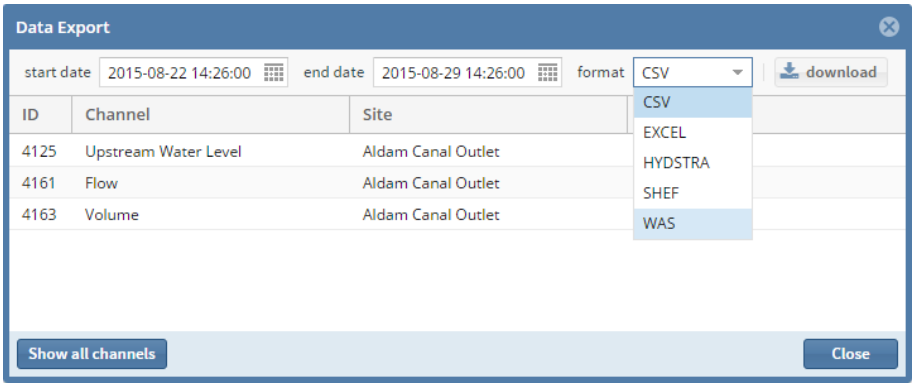


Figure 11.2: Zednet dedicated WAS data export

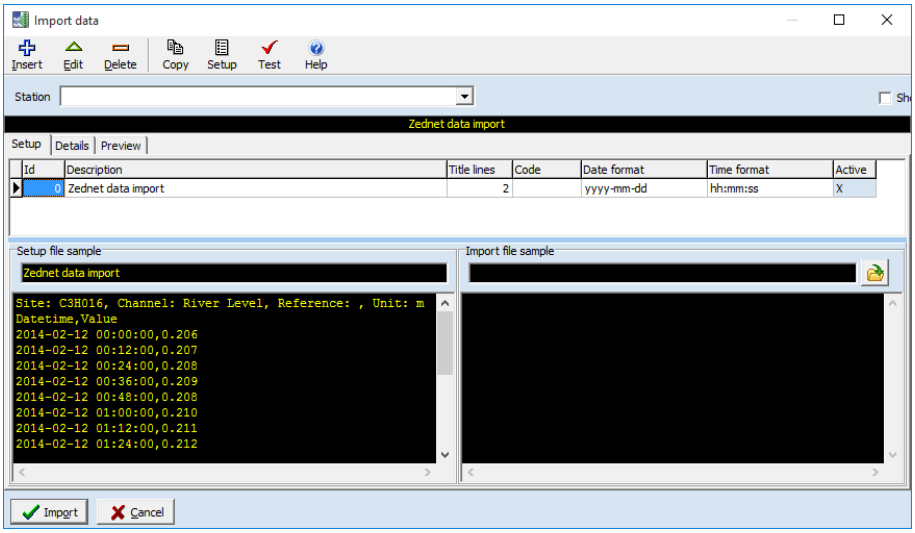


Figure 11.3: WAS dedicated Zednet data import

Chapter 12

Training & support

Training & support

Training and support is done on an ongoing basis. The meetings and work sessions that have been done up to date are shown in Table 12.1. Dropbox is used where possible to exchange information.

Scheme	Description	Date
Sandvet WUA	Inception meeting	03/12/2014
Orange Riet WUA	Inception meeting	05/01/2015
Vaalharts WUA	Inception meeting	06/01/2015
Hartbeespoort IB	Inception meeting	13/01/2015
Hartbeespoort IB	Install WRP measuring station at West canal	20/01/2015
Sandvet WUA	Work session	26/01/2015
Sandvet WUA	Inspect Allemanskraal & Erfenis measuring stations	27/01/2015
Sandvet WUA	Installation of Ubuntu measuring station at Erfenis dam	02/02/2015
Orange Riet WUA	Work session	16/02/2015
Orange Riet WUA	Work session & inspect Scheiding measuring station	17/02/2015
Vaalharts WUA	Work session	18/02/2015
Vaalharts WUA	Work & training session	19/02/2015
Hartbeespoort IB	Meeting & discussions with day committee	26/02/2015
Orange Riet WUA	Work & training session	09/03/2015
Orange Riet WUA	Work & training session	10/03/2015
Sandvet WUA	Work session & training	08/04/2015
Sandvet WUA	Work session & training	09/04/2015
Orange Riet WUA	Work session & training	21/04/2015
Orange Riet WUA	Work session & training	22/04/2015
Hartbeespoort IB	Work session	05/05/2015
Hartbeespoort IB	Work session	22/05/2015
Hartbeespoort IB	Work session	09/06/2015
Hartbeespoort IB	Work session & training	30/07/2015

Table 12.1: Meetings & work sessions

Chapter 13

Conlusions & recommendations

Conclusions & Recommendations

- **Uptake of the water release module**

  All the participation irrigation schemes were positive and they made a huge effort to implement the water release module successfully. Three of the four irrigation schemes have purchased the Cello measuring station equipment and are planning to expand their measuring station networks at their own cost.

- **Skills development and transfer**

  Numerous people were trained in the use of the water release module of the WAS and related matters which include the following:

  - **Vaalharts WUA**: 1
  - **Sand-Vet WUA**: 3
  - **Orange-Riet WUA**: 4
  - **Hartbeespoort IB**: 3

- **Identification of further irrigation scheme needs**

  The implementation of the release module at Orange-Riet WUA resulted in additional work being done to improve the WAS. This includes a dedicated water management report that is generated automatically on a monthly basis.

- **Generation of the WUEAR**

  The WUEAR is generated automatically on a weekly basis and summarized with monthly values. This is of great value to the DWS from a regulatory perspective.

- **Quality inflow data is non-negotiable**

  At the start of the project it was assumed that all the inflow measuring stations were in place and that current and historic data records were readily available. This, however, was not the case.

  No meaningful conclusions can be made without the availability of accurate and reliable inflow data records into a scheme.

- **Using % to quantify water losses is misleading**

  It is clear from the results that the use of percentages to express water losses can be very misleading. The percentage of water lost cannot be

used to compare the water lost between different schemes even if it is over the same time period.

Even the comparison of monthly percentage water losses on the same scheme is also of no use. The reason being that both the numerator (release - water orders) and the denominator (water orders) are variable from month to month.

The solution to this problem is to relate the percentage water loss calculation to a fixed value which can be either a volume or an area. The results in this report were expressed in million m^3 per month but other alternatives will be discussed with the relevant parties to come to a suitable solution.

- **Implement external water auditing**

  Comparing the base line water loss results with the corresponding results of each scheme (generated by themselves) revealed a substantial difference in almost all of them. What also became apparent is that the independent assessment of water losses had an immediate positive response of reducing water losses on most of the schemes that are part of the project.

  A conclusion can therefore be made, that external water auditing produce results and that it is a good practice that needs to be implemented.

- **Expand the Zednet network**

  The lack of the availability of quality data records at most of the inflow measuring stations led to the investigation into an affordable, workable and practical solution. The result was the implementation of Cello loggers that are affordable and accessible through the Zednet internet platform. Four of the five inflow measuring stations, that are part of the project, were fitted with the new system. All of them are currently operational and work without any problems.

  It is therefore recommended that the Zednet enabled measuring stations should be expanded to all the other schemes that are using the WAS. This will, without a doubt, bring water loss reporting up to the next level.

- **Yearly WAS CEO workshop**

  During the implementation of the Release module of the WAS at the different schemes, it became clear that the CEO's lack the knowledge of what the WAS is capable of.

A proposal was made at a South African Association of Water Users Associations (SAAFWUA) management meeting to hold a yearly CEO WAS workshop to address this problem and to address common issues related to the WAS.

- **Regular training courses**

  The need for regular WAS training courses at different levels were identified during the coarse of the project.

Chapter 14

Follow-up project

Background

During the implementation of the Release module of the WAS at the different irrigation schemes, it became evident that the Cello loggers with the Zednet internet platform were the big game changer of the project. Access to accurate and reliable inflow data is by far the most important component for any water loss reporting.

The Zednet internet platform gives access to real time inflow data records at an unlimited number of measuring stations. It simplifies the import of data into the WAS database and in the process limits human errors. Water loss reports can, therefore, be accurately generated and it makes it possible for an external auditor to very the results.

14.1 Proposal

Given the experience from the previous project it is proposed to extend the Zednet internet platform to all the other irrigation schemes that are using the WAS. The following irrigation schemes have already indicated that they are be interested in such a venture:

1. Loskop Irrigation Board (2 x stations)
2. Kalkfontein WUA (1 x station)
3. Gamtoos Irrigation Board (1 x station)
4. Impala WUA (They already have Cello loggers and will only need the Zednet communication package for 2 x stations)
5. Orange-Riet WUA (1 x station)
6. Korente Vette IB (2 x stations)

Lower Olifants River WUA is also interested, but they already have a Cello logger installed that is linked to the Zednet internet platform.

14.2 Website

NB Systems CC has already registered a domain name **www.wateradmin.co.za** with the sole purpose of supporting the WAS related matters for irrigation schemes that are using the WAS.

It is proposed that the water loss related reports should be included on this website that could be accessed by everyone. It will be possible to add functionality to the WAS program to upload these reports automatically.

The main aim will be to develop the **www.wateradmin.co.za** website into a central location for all water related matters on irrigation schemes.

14.3 Budget

The budget of the proposed follow-up project is shown in table 14.1. All prices are excluding of VAT.

Task	Hrs	#	Rate/hr	Expenses	Budget
Site visits & meetings					
Loskop IB	16	2	R 1 000.00	R 1 485.00	R 17 485.00
Kalkfontein WUA	24	2	R 1 000.00	R 6 800.00	R 30 800.00
Gamtoos IB	24	2	R 1 000.00	R 5 000.00	R 29 000.00
Impala WUA	24	2	R 1 000.00	R 4 000.00	R 28 000.00
Orange-Riet WUA	24	2	R 1 000.00	R 6 800.00	R 30 800.00
Korente Vette IB	24	2	R 1 000.00	R 5 000.00	R 29 000.00
Measuring stations roll out (see detailed spreadsheet)					
Hardware & Zednet cost					R 215 550.00
Installation & Commission cost					R 41 685.00
WAS training					
WAS training per person		6	R 50 000.00		R 300 000.00
Web site development					
Web site development (www.wateradmin.co.za)	160		R 1 000.00		R 160 000.00
Reporting					
Inception report	24		R 1 000.00		R 24 000.00
Progress report 1	24		R 1 000.00		R 24 000.00
Progress report 2	24		R 1 000.00		R 24 000.00
Close out report	24		R 1 000.00		R 24 000.00
	392				R 978 320.00

Table 14.1: Budget

Appendix A

Water Use Efficiency Accounting Reports

Water Use Efficiency Accounting Report: Weeks 1 to 52

Sand: Sand new 2013/2014

Week	Year	Mnth	Agriculture (m3)	Industrial (m3)	Municipality (m3)	Household (m3)	Down stream (m3)	Other (m3)	Total (m3)	Released (m3)	Total loss (m3)	Loss (%)	Tail end (m3)	Tail end (%)	Crop used (m3)	Quota used (m3)	Quota avail (m3)	Used (%)	Avail (%)
1	2013	Jun	17 400	380 040	0	11 988	0	0	409 428	513 368	103 940	25.4	0	0.0	0	397 440	27 548 456	1.4	98.6
2	2013	Jun	12 000	383 640	0	11 988	0	0	407 628	488 082	80 454	19.7	0	0.0	0	793 080	27 152 816	2.8	97.2
3	2013	Jun	18 000	380 040	0	11 988	0	0	410 028	491 123	81 095	19.8	0	0.0	0	1 191 120	26 754 776	4.3	95.7
4	2013	Jun	26 400	289 683	0	11 988	0	0	328 071	460 347	132 276	40.3	0	0.0	0	1 507 203	26 438 693	5.4	94.6
5	2013	Jul	25 200	277 560	0	11 988	0	0	314 748	439 652	124 904	39.7	0	0.0	0	1 809 963	26 135 933	6.5	93.5
6	2013	Jul	39 000	277 560	0	11 988	0	0	328 548	461 370	132 822	40.4	0	0.0	0	2 126 523	25 819 373	7.6	92.4
7	2013	Jul	40 800	277 560	0	11 988	0	0	330 348	409 586	79 238	24.0	0	0.0	0	2 444 883	25 501 013	8.7	91.3
8	2013	Jul	49 800	277 560	0	11 988	0	0	339 348	433 669	94 321	27.8	0	0.0	0	2 772 243	25 173 653	9.9	90.1
9	2013	Aug	34 800	291 411	0	11 988	0	0	338 199	399 063	60 864	18.0	0	0.0	0	3 098 454	24 847 442	11.1	88.9
10	2013	Aug	71 400	277 560	0	11 988	0	0	360 948	446 892	85 944	23.8	0	0.0	0	3 447 414	24 498 482	12.3	87.7
11	2013	Aug	61 200	277 560	0	11 988	0	0	350 748	400 395	49 647	14.2	0	0.0	0	3 786 174	24 159 722	13.5	86.5
12	2013	Aug	64 200	277 560	0	11 988	0	0	353 748	451 165	97 417	27.5	0	0.0	0	4 127 934	23 817 962	14.8	85.2
13	2013	Sep	67 800	398 843	0	11 988	0	0	478 631	537 009	58 378	12.2	0	0.0	0	4 594 577	23 351 319	16.4	83.6
14	2013	Sep	111 000	0	0	11 988	0	0	122 988	277 251	154 263	125.4	0	0.0	0	4 705 577	23 240 319	16.8	83.2
15	2013	Sep	104 400	279 960	0	11 988	0	0	396 348	594 563	198 215	50.0	0	0.0	0	5 089 937	22 855 959	18.2	81.8
16	2013	Sep	112 800	113 424	0	11 988	0	0	238 212	416 197	177 985	74.7	0	0.0	0	5 316 161	22 629 735	19.0	81.0
17	2013	Sep	202 800	280 560	0	11 988	0	0	495 348	618 965	123 617	25.0	0	0.0	0	5 799 521	22 146 375	20.8	79.2
18	2013	Oct	240 000	307 039	0	11 988	0	0	559 027	620 660	61 633	11.0	0	0.0	0	6 346 560	21 599 336	22.7	77.3
19	2013	Oct	249 600	281 160	0	11 988	0	0	542 748	660 731	117 983	21.7	0	0.0	0	6 877 320	21 068 576	24.6	75.4
20	2013	Oct	253 800	279 960	0	11 988	0	0	545 748	716 050	170 302	31.2	0	0.0	0	7 411 080	20 534 816	26.5	73.5
21	2013	Oct	173 400	279 960	0	11 988	0	0	465 348	657 819	192 471	41.4	0	0.0	0	7 864 440	20 081 456	28.1	71.9
22	2013	Nov	135 000	305 114	0	11 988	0	0	452 102	496 464	44 362	9.8	0	0.0	0	8 304 554	19 641 342	29.7	70.3
23	2013	Nov	237 000	114 624	0	11 988	0	0	363 612	479 273	115 661	31.8	0	0.0	0	8 656 178	19 289 718	31.0	69.0
24	2013	Nov	320 400	4 800	0	11 988	0	0	337 188	390 504	53 316	15.8	0	0.0	0	8 981 378	18 964 518	32.1	67.9
25	2013	Nov	2 400	0	0	11 988	0	0	14 388	69 145	54 757	380.6	0	0.0	0	8 983 778	18 962 118	32.1	67.9
26	2013	Dec	26 400	27 877	0	11 988	0	0	66 265	188 068	121 803	183.8	0	0.0	0	9 038 055	18 907 841	32.3	67.7
27	2013	Dec	70 800	0	0	11 988	0	0	82 788	192 927	110 139	133.0	0	0.0	0	9 108 855	18 837 041	32.6	67.4
28	2013	Dec	24 000	0	0	11 988	0	0	35 988	60 209	24 221	67.3	0	0.0	0	9 132 855	18 813 041	32.7	67.3
29	2013	Dec	86 400	0	0	11 988	0	0	98 388	291 680	193 292	196.5	0	0.0	0	9 219 255	18 726 641	33.0	67.0
30	2013	Dec	94 200	28 844	0	11 988	0	0	135 032	169 796	34 764	25.7	0	0.0	0	9 342 299	18 603 597	33.4	66.6
31	2014	Jan	21 600	0	0	11 988	0	0	33 588	137 310	103 722	308.8	0	0.0	0	9 363 899	18 581 997	33.5	66.5
32	2014	Jan	297 600	0	0	11 988	0	0	309 588	415 338	105 750	34.2	0	0.0	0	9 661 499	18 284 397	34.6	65.4
33	2014	Jan	425 400	0	0	11 988	0	0	437 388	574 478	137 090	31.3	0	0.0	0	10 086 899	17 858 997	36.1	63.9
34	2014	Jan	465 600	10 800	0	11 988	0	0	488 388	791 791	303 403	62.1	0	0.0	0	10 563 299	17 382 597	37.8	62.2
35	2014	Feb	433 200	27 200	0	11 988	0	0	472 388	642 058	169 670	35.9	0	0.0	0	11 023 699	16 922 197	39.4	60.6
36	2014	Feb	0	0	0	11 988	0	0	11 988	115 073	103 085	859.9	0	0.0	0	11 023 699	16 922 197	39.4	60.6
37	2014	Feb	57 000	0	0	11 988	0	0	68 988	238 003	169 015	245.0	0	0.0	0	11 080 699	16 865 197	39.7	60.3
38	2014	Feb	465 600	0	0	11 988	0	0	477 588	634 352	156 764	32.8	0	0.0	0	11 546 299	16 399 597	41.3	58.7
39	2014	Mar	199 200	19 611	0	11 988	0	0	230 799	352 388	121 589	52.7	0	0.0	0	11 765 110	16 180 786	42.1	57.9
40	2014	Mar	214 800	0	0	11 988	0	0	226 788	312 033	85 245	37.6	0	0.0	0	11 979 910	15 965 986	42.9	57.1
41	2014	Mar	23 400	0	0	11 988	0	0	35 388	57 790	22 402	63.3	0	0.0	0	12 003 310	15 942 586	43.0	57.0
42	2014	Mar	0	0	0	11 988	0	0	11 988	118 832	106 844	891.3	0	0.0	0	12 003 310	15 942 586	43.0	57.0
43	2014	Mar	87 000	30 117	0	11 988	0	0	129 105	287 380	158 275	122.6	0	0.0	0	12 120 427	15 825 469	43.4	56.6
44	2014	Apr	113 400	0	0	11 988	0	0	125 388	295 685	170 297	135.8	0	0.0	0	12 233 827	15 712 069	43.8	56.2
45	2014	Apr	108 000	2 400	0	11 988	0	0	122 388	365 524	243 136	198.7	0	0.0	0	12 344 227	15 601 669	44.2	55.8
46	2014	Apr	204 600	343 644	0	11 988	0	0	560 232	663 941	103 709	18.5	0	0.0	0	12 892 471	15 053 425	46.1	53.9
47	2014	Apr	17 400	206 268	0	11 988	0	0	235 656	114 387	-121 269	-51.5	0	0.0	0	13 116 139	14 829 757	46.9	53.1
48	2014	May	23 400	0	0	11 988	0	0	35 388	77 280	41 892	118.4	0	0.0	0	13 139 539	14 806 357	47.0	53.0
49	2014	May	86 400	455 112	0	11 988	0	0	553 500	800 259	246 759	44.6	0	0.0	0	13 681 051	14 264 845	49.0	51.0
50	2014	May	32 400	646 296	0	11 988	0	0	690 684	903 890	213 206	30.9	0	0.0	0	14 359 747	13 586 149	51.4	48.6
51	2014	May	77 400	209 880	0	11 988	0	0	299 268	209 567	-89 701	-30.0	0	0.0	0	14 647 027	13 298 869	52.4	47.6
52	2014	May	96 600	691 992	0	11 988	0	0	800 580	766 377	-34 203	-4.3	0	0.0	0	15 435 619	12 510 277	55.2	44.8
			6 422 400	**9 013 219**	**0**	**623 376**	**0**	**0**	**16 058 995**	**21 705 759**	**5 646 764**	**35.2**	**0**	**0.0**	**0**	**15 435 619**	**12 510 277**	**55.2**	**44.8**

Table A.1: Sand canal 2013/2014 WUEA Report

Water Use Efficiency Accounting Report: Weeks 1 to 51

Vet: Vet new 2013/2014

Week	Year	Mnth	Agriculture (m3)	Industrial (m3)	Municipality (m3)	Household (m3)	Down stream (m3)	Other (m3)	Total (m3)	Released (m3)	Total loss (m3)	Loss (%)	Tail end (m3)	Tail end (%)	Crop used (m3)	Quota used (m3)	Quota avail (m3)	Used (%)	Avail (%)
1	2013	Jun	0	0	126 000	6 715	73 759	0	206 474	296 511	90 037	43.6	0	0.0	0	126 000	24 205 339	0.5	99.5
2	2013	Jun	54 600	0	126 000	6 715	73 759	0	261 074	581 574	320 500	122.8	0	0.0	0	306 600	24 024 739	1.3	98.7
3	2013	Jun	43 200	0	126 000	6 715	73 759	0	249 674	403 382	153 708	61.6	0	0.0	0	475 800	23 855 539	2.0	98.0
4	2013	Jun	70 800	0	126 000	6 715	73 759	0	277 274	435 027	157 753	56.9	0	0.0	0	672 600	23 658 739	2.8	97.2
5	2013	Jul	68 880	0	126 000	6 715	73 759	0	275 354	443 495	168 141	61.1	0	0.0	0	867 480	23 463 859	3.6	96.4
6	2013	Jul	76 200	0	126 000	6 715	73 759	0	282 674	461 668	178 994	63.3	0	0.0	0	1 069 680	23 261 659	4.4	95.6
7	2013	Jul	110 400	0	126 000	6 715	73 759	0	316 874	518 126	201 252	63.5	0	0.0	0	1 306 080	23 025 259	5.4	94.6
8	2013	Jul	129 600	0	335 370	6 715	73 759	0	545 444	532 218	-13 226	-2.4	0	0.0	0	1 771 050	22 560 289	7.3	92.7
9	2013	Aug	133 200	0	126 000	6 715	73 759	0	339 674	532 966	193 292	56.9	0	0.0	0	2 030 250	22 301 089	8.3	91.7
10	2013	Aug	154 200	0	126 000	6 715	73 759	0	360 674	703 242	342 568	95.0	0	0.0	0	2 310 450	22 020 889	9.5	90.5
11	2013	Aug	132 600	0	126 000	6 715	73 759	0	339 074	523 710	184 636	54.5	0	0.0	0	2 569 050	21 762 289	10.6	89.4
12	2013	Aug	155 400	0	126 000	6 715	73 759	0	361 874	501 583	139 709	38.6	0	0.0	0	2 850 450	21 480 889	11.7	88.3
13	2013	Sep	188 400	0	230 542	6 715	73 759	0	499 416	734 505	235 089	47.1	0	0.0	0	3 269 392	21 061 947	13.4	86.6
14	2013	Sep	229 800	0	126 000	6 715	73 759	0	436 274	943 277	507 003	116.2	0	0.0	0	3 625 192	20 706 147	14.9	85.1
15	2013	Sep	371 400	0	126 000	6 715	73 759	0	577 874	1 144 771	566 897	98.1	0	0.0	0	4 122 592	20 208 747	16.9	83.1
16	2013	Sep	419 400	0	126 000	6 715	73 759	0	625 874	1 298 383	672 509	107.5	0	0.0	0	4 667 992	19 663 347	19.2	80.8
17	2013	Sep	544 200	0	126 000	6 715	73 759	0	750 674	1 462 810	712 136	94.9	0	0.0	0	5 338 192	18 993 147	21.9	78.1
18	2013	Oct	556 200	0	240 195	6 715	73 759	0	876 869	1 663 889	787 020	89.8	0	0.0	0	6 134 587	18 196 752	25.2	74.8
19	2013	Oct	662 400	0	126 000	6 715	73 759	0	868 874	2 070 480	1 201 606	138.3	0	0.0	0	6 922 987	17 408 352	28.5	71.5
20	2013	Oct	684 000	0	126 000	6 715	73 759	0	890 474	1 994 238	1 103 764	124.0	0	0.0	0	7 732 987	16 598 352	31.8	68.2
21	2013	Oct	630 600	0	126 000	6 715	73 759	0	837 074	1 673 756	836 682	100.0	0	0.0	0	8 489 587	15 841 752	34.9	65.1
22	2013	Nov	435 600	0	280 006	6 715	73 759	0	796 080	1 159 460	363 380	45.6	0	0.0	0	9 205 193	15 126 146	37.8	62.2
23	2013	Nov	547 800	0	126 000	6 715	73 759	0	754 274	1 236 927	482 653	64.0	0	0.0	0	9 878 993	14 452 346	40.6	59.4
24	2013	Nov	497 400	0	126 000	6 715	73 759	0	703 874	1 310 612	606 738	86.2	0	0.0	0	10 502 393	13 828 946	43.2	56.8
25	2013	Nov	0	0	126 000	6 715	73 759	0	206 474	321 514	115 040	55.7	0	0.0	0	10 628 393	13 702 946	43.7	56.3
26	2013	Dec	44 400	0	264 134	6 715	73 759	0	389 008	483 544	94 536	24.3	0	0.0	0	10 936 927	13 394 412	44.9	55.1
27	2013	Dec	129 000	0	126 000	6 715	73 759	0	335 474	602 146	266 672	79.5	0	0.0	0	11 191 927	13 139 412	46.0	54.0
28	2013	Dec	43 200	0	126 000	6 715	73 759	0	249 674	385 687	136 013	54.5	0	0.0	0	11 361 127	12 970 212	46.7	53.3
29	2013	Dec	128 400	0	126 000	6 715	73 759	0	334 874	720 060	385 186	115.0	0	0.0	0	11 615 527	12 715 812	47.7	52.3
30	2013	Dec	129 600	0	232 336	6 715	73 759	0	442 410	686 907	244 497	55.3	0	0.0	0	11 977 463	12 353 876	49.2	50.8
31	2014	Jan	175 800	0	117 600	6 715	73 759	0	373 874	838 598	464 724	124.3	0	0.0	0	12 270 863	12 060 476	50.4	49.6
32	2014	Jan	297 600	0	117 600	6 715	73 759	0	495 674	989 513	493 839	99.6	0	0.0	0	12 686 063	11 645 276	52.1	47.9
33	2014	Jan	486 600	0	126 000	6 715	73 759	0	693 074	1 488 382	795 308	114.8	0	0.0	0	13 298 663	11 032 676	54.7	45.3
34	2014	Jan	530 400	0	126 000	6 715	73 759	0	736 874	1 670 555	933 681	126.7	0	0.0	0	13 955 063	10 376 276	57.4	42.6
35	2014	Feb	504 000	0	308 810	6 715	73 759	0	893 284	1 649 919	756 635	84.7	0	0.0	0	14 767 873	9 563 466	60.7	39.3
36	2014	Feb	24 000	0	126 000	6 715	73 759	0	230 474	438 602	208 128	90.3	0	0.0	0	14 917 873	9 413 466	61.3	38.7
37	2014	Feb	271 200	0	117 600	6 715	73 759	0	469 274	859 272	389 998	83.1	0	0.0	0	15 306 673	9 024 666	62.9	37.1
38	2014	Feb	593 400	0	117 600	6 715	73 759	0	791 474	1 256 643	465 169	58.8	0	0.0	0	16 017 673	8 313 666	65.8	34.2
39	2014	Mar	375 600	0	189 359	6 715	73 759	0	645 433	910 691	265 258	41.1	0	0.0	0	16 582 632	7 748 707	68.2	31.8
40	2014	Mar	265 200	0	117 600	6 715	73 759	0	463 274	780 673	317 399	68.5	0	0.0	0	16 965 432	7 365 907	69.7	30.3
41	2014	Mar	42 000	0	117 600	6 715	73 759	0	240 074	386 372	146 298	60.9	0	0.0	0	17 125 032	7 206 307	70.4	29.6
42	2014	Mar	127 200	0	117 600	6 715	73 759	0	325 274	517 547	192 273	59.1	0	0.0	0	17 369 832	6 961 507	71.4	28.6
43	2014	Mar	294 000	0	325 036	6 715	73 759	0	699 510	776 900	77 390	11.1	0	0.0	0	17 988 868	6 342 471	73.9	26.1
44	2014	Apr	273 000	0	117 600	6 715	73 759	0	471 074	826 908	355 834	75.5	0	0.0	0	18 379 468	5 951 871	75.5	24.5
45	2014	Apr	349 800	0	117 600	6 715	73 759	0	547 874	853 383	305 509	55.8	0	0.0	0	18 846 868	5 484 471	77.5	22.5
46	2014	Apr	247 200	0	117 600	6 715	73 759	0	445 274	702 497	257 223	57.8	0	0.0	0	19 211 668	5 119 671	79.0	21.0
47	2014	Apr	57 000	0	297 686	6 715	73 759	0	435 160	518 408	83 248	19.1	0	0.0	0	19 566 354	4 764 985	80.4	19.6
48	2014	May	61 800	0	105 600	6 715	73 759	0	247 874	433 857	185 983	75.0	0	0.0	0	19 733 754	4 597 585	81.1	18.9
49	2014	May	7 200	0	117 600	6 715	73 759	0	205 274	161 895	-43 379	-21.1	0	0.0	0	19 858 554	4 472 785	81.6	18.4
50	2014	May	0	0	42 000	6 715	73 759	0	122 474	529 027	406 553	332.0	0	0.0	0	19 900 554	4 430 785	81.8	18.2
51	2014	May	557 400	0	117 600	6 715	73 759	0	755 474	1 067 819	312 345	41.3	0	0.0	0	20 575 554	3 755 785	84.6	15.4
			12 911 280	**0**	**7 664 274**	**342 465**	**3 761 709**	**0**	**24 679 728**	**43 483 929**	**18 804 201**	**76.2**	**0**	**0.0**	**0**	**20 575 554**	**3 755 785**	**84.6**	**15.4**

Table A.2: Vet canal 2013/2014 WUEA Report

Water Use Efficiency Accounting Report: Weeks 1 to 48

ORWUA: Riet: ORWUA 2014/2015

Week	Year	Mnth	Agriculture (m3)	Industrial (m3)	Municipality (m3)	Household (m3)	Down stream (m3)	Other (m3)	Total (m3)	Released (m3)	Total loss (m3)	Loss (%)	Tail end (m3)	Tail end (%)	Crop used (m3)	Quota used (m3)	Quota avail (m3)	Used (%)	Avail (%)
1	2014	Apr	4 931 472	0	6 000	8 724	0	416 666	5 362 862	4 830 194	-532 668	-9.9	0	0.0	0	5 354 137	136 179 989	3.8	96.2
2	2014	Apr	1 945 581	0	0	8 724	0	0	1 954 305	4 951 818	2 997 513	153.4	0	0.0	0	7 299 718	134 234 408	5.2	94.8
3	2014	Apr	699 700	0	13 200	8 724	0	0	721 624	3 811 125	3 089 501	428.1	0	0.0	0	8 012 618	133 521 508	5.7	94.3
4	2014	Apr	371 100	0	8 400	8 724	0	0	388 224	2 225 124	1 836 900	473.2	0	0.0	0	8 392 118	133 142 008	5.9	94.1
5	2014	May	1 010 523	0	6 000	8 724	0	416 666	1 441 913	2 705 811	1 263 898	87.7	0	0.0	0	9 825 307	131 708 819	6.9	93.1
6	2014	May	308 050	198 100	6 000	8 724	0	0	520 874	2 570 846	2 049 972	393.6	0	0.0	0	10 337 457	131 196 669	7.3	92.7
7	2014	May	182 700	0	0	8 724	0	0	191 424	1 512 743	1 321 319	690.3	0	0.0	0	10 520 157	131 013 969	7.4	92.6
8	2014	May	194 629	0	4 800	8 724	0	0	208 153	0	-208 153	-100.0	0	0.0	0	10 719 586	130 814 540	7.6	92.4
9	2014	Jun	66 923	0	16 800	8 724	0	416 666	509 113	589 152	80 039	15.7	0	0.0	0	11 219 974	130 314 152	7.9	92.1
10	2014	Jun	670 700	190 611	16 800	8 724	0	0	886 835	409 341	-477 494	-53.8	0	0.0	0	12 098 085	129 436 041	8.5	91.5
11	2014	Jun	180 650	0	16 800	8 724	0	0	206 174	127 856	-78 318	-38.0	0	0.0	0	12 295 535	129 238 591	8.7	91.3
12	2014	Jun	229 200	0	16 800	8 724	0	0	254 724	140 099	-114 625	-45.0	0	0.0	0	12 541 535	128 992 591	8.9	91.1
13	2014	Jun	313 400	0	16 800	8 724	0	416 666	755 590	235 827	-519 763	-68.8	0	0.0	0	13 288 401	128 245 725	9.4	90.6
14	2014	Jul	1 059 417	175 626	16 800	8 724	0	0	1 260 567	3 361 187	2 100 620	166.6	0	0.0	0	14 540 244	126 993 882	10.3	89.7
15	2014	Jul	1 561 307	0	16 800	8 724	0	0	1 586 831	2 155 999	569 168	35.9	0	0.0	0	16 118 351	125 415 775	11.4	88.6
16	2014	Jul	5 879 142	0	16 800	8 724	0	0	5 904 666	2 635 863	-3 268 803	-55.4	0	0.0	0	22 014 292	119 519 834	15.6	84.4
17	2014	Jul	504 500	0	16 800	8 724	0	416 666	946 690	3 823 054	2 876 364	303.8	0	0.0	0	22 952 258	118 581 868	16.2	83.8
18	2014	Aug	732 230	0	18 000	8 724	0	0	758 954	3 296 553	2 537 599	334.4	0	0.0	0	23 702 488	117 831 638	16.7	83.3
19	2014	Aug	619 280	204 278	16 800	8 724	0	0	849 082	4 309 905	3 460 823	407.6	0	0.0	0	24 542 846	116 991 280	17.3	82.7
20	2014	Aug	445 730	0	16 800	8 724	0	0	471 254	1 760 136	1 288 882	273.5	0	0.0	0	25 005 376	116 528 750	17.7	82.3
21	2014	Aug	648 687	0	16 800	8 724	0	0	674 211	2 329 272	1 655 061	245.5	0	0.0	0	25 670 863	115 863 263	18.1	81.9
22	2014	Aug	1 028 111	0	16 800	8 724	0	416 666	1 470 301	6 115 706	4 645 405	315.9	0	0.0	0	27 132 440	114 401 686	19.2	80.8
23	2014	Sep	6 510 155	141 048	16 800	8 724	0	0	6 676 727	6 192 406	-484 321	-7.3	0	0.0	0	33 800 443	107 733 683	23.9	76.1
24	2014	Sep	5 739 156	0	16 800	8 724	0	0	5 764 680	6 715 011	950 331	16.5	0	0.0	0	39 556 399	101 977 727	27.9	72.1
25	2014	Sep	10 487 546	0	16 800	8 724	0	0	10 513 070	6 718 996	-3 794 074	-36.1	0	0.0	0	50 060 745	91 473 381	35.4	64.6
26	2014	Sep	5 614 022	30	16 800	8 724	0	416 666	6 056 242	7 144 754	1 088 512	18.0	0	0.0	0	56 108 263	85 425 863	39.6	60.4
27	2014	Oct	6 618 402	168 451	16 800	8 724	0	0	6 812 377	6 908 737	96 360	1.4	0	0.0	0	62 911 916	78 622 210	44.4	55.6
28	2014	Oct	11 023 094	0	16 800	8 724	0	0	11 048 618	8 131 614	-2 917 004	-26.4	0	0.0	0	73 951 809	67 582 317	52.3	47.7
29	2014	Oct	2 089 794	0	16 800	8 724	0	0	2 115 318	9 978 183	7 862 865	371.7	0	0.0	0	76 058 404	65 475 722	53.7	46.3
30	2014	Oct	1 969 883	0	16 800	8 724	0	416 666	2 412 073	10 026 269	7 614 196	315.7	0	0.0	0	78 461 753	63 072 373	55.4	44.6
31	2014	Nov	2 068 218	0	16 800	8 724	0	0	2 093 742	9 902 997	7 809 255	373.0	0	0.0	0	80 546 771	60 987 355	56.9	43.1
32	2014	Nov	723 818	147 825	16 800	8 724	0	0	897 167	5 861 707	4 964 540	553.4	0	0.0	0	81 435 214	60 098 912	57.5	42.5
33	2014	Nov	335 081	0	16 800	8 724	0	0	360 605	2 490 541	2 129 936	590.7	0	0.0	0	81 787 095	59 747 031	57.8	42.2
34	2014	Nov	1 073 716	0	0	8 724	0	416 666	1 499 106	6 381 737	4 882 631	325.7	0	0.0	0	83 277 477	58 256 649	58.8	41.2
35	2014	Nov	520 267	0	16 800	8 724	0	0	545 791	4 449 092	3 903 301	715.2	0	0.0	0	83 814 544	57 719 582	59.2	40.8
36	2014	Dec	1 168 057	176 955	16 800	8 724	0	0	1 370 536	5 009 494	3 638 958	265.5	0	0.0	0	85 176 356	56 357 770	60.2	39.8
37	2014	Dec	1 209 958	0	16 800	8 724	0	0	1 235 482	7 823 174	6 587 692	533.2	0	0.0	0	86 403 114	55 131 012	61.0	39.0
38	2014	Dec	1 299 413	0	16 800	8 724	0	416 666	1 741 603	7 280 205	5 538 602	318.0	0	0.0	0	88 135 993	53 398 133	62.3	37.7
39	2014	Dec	7 678 661	0	16 800	8 724	0	0	7 704 185	9 268 622	1 564 437	20.3	0	0.0	0	95 831 455	45 702 671	67.7	32.3
40	2015	Jan	9 672 883	0	16 800	8 724	0	0	9 698 407	8 646 659	-1 051 748	-10.8	0	0.0	0	105 521 136	36 012 990	74.6	25.4
41	2015	Jan	7 717 808	0	16 800	8 724	0	0	7 743 332	9 743 950	2 000 618	25.8	0	0.0	0	113 255 744	28 278 382	80.0	20.0
42	2015	Jan	8 270 920	0	16 800	8 724	0	416 666	8 713 110	9 731 314	1 018 204	11.7	0	0.0	0	121 960 132	19 573 994	86.2	13.8
43	2015	Jan	12 420 965	0	16 800	8 724	0	0	12 446 489	9 725 123	-2 721 366	-21.9	0	0.0	0	134 397 896	7 136 230	95.0	5.0
44	2015	Feb	2 554 572	0	16 800	8 724	0	0	2 580 096	9 123 467	6 543 371	253.6	0	0.0	0	136 969 268	4 564 858	96.8	3.2
45	2015	Feb	2 357 815	402 060	16 800	8 724	0	0	2 785 399	9 185 013	6 399 614	229.8	0	0.0	0	139 745 943	1 788 183	98.7	1.3
46	2015	Feb	2 600 154	0	16 800	8 724	0	416 666	3 042 344	9 929 643	6 887 299	226.4	0	0.0	0	142 779 563	-1 245 437	100.9	-0.9
47	2015	Feb	3 733 910	0	16 800	8 724	0	0	3 759 434	9 741 621	5 982 187	159.1	0	0.0	0	146 530 273	-4 996 147	103.5	-3.5
48	2015	Mar	842 376	0	16 800	8 724	0	0	867 900	4 269 552	3 401 652	391.9	0	0.0	0	147 389 449	-5 855 323	104.1	-4.1
			139 883 676	**1 804 984**	**700 800**	**418 752**	**0**	**4 999 992**	**147 808 204**	**254 277 492**	**106 469 288**	**72.0**	**0**	**0.0**	**0**	**147 389 449**	**-5 855 323**	**104.1**	**-4.1**

Table A.3: Orange-Riet 2014/2015 WUEA Report

Water Use Efficiency Accounting Report: Weeks 1 to 51

VHS: vhs 2014 2015 2014/2015

Week	Year	Mnth	Agriculture (m3)	Industrial (m3)	Municipality (m3)	Household (m3)	Down stream (m3)	Other (m3)	Total (m3)	Released (m3)	Total loss (m3)	Loss (%)	Tail end (m3)	Tail end (%)	Crop used (m3)	Quota used (m3)	Quota avail (m3)	Used (%)	Avail (%)
1	2014	Apr	31 310	0	0	20 446	561 433	0	613 189	11 332 335	10 719 146	1748.1	49 581	8.1	0	0	3 473 395	0.0	100.0
2	2014	Apr	3 401 640	2 400	0	20 446	1 391 446	18 000	4 833 932	8 002 356	3 168 424	65.5	68 793	1.4	0	0	3 473 395	0.0	100.0
3	2014	Apr	3 068 642	31 128	1 120 472	20 446	532 502	12 600	4 785 790	5 624 127	838 337	17.5	75 876	1.6	0	371 595	3 101 800	10.7	89.3
4	2014	Apr	2 905 468	2 400	0	20 446	841 876	14 400	3 784 590	7 303 124	3 518 534	93.0	207 751	5.5	0	371 595	3 101 800	10.7	89.3
5	2014	May	2 010	0	0	20 446	1 526 714	0	1 549 170	1 648 204	99 034	6.4	110 205	7.1	0	371 595	3 101 800	10.7	89.3
6	2014	May	2 731 500	0	0	20 446	2 297 606	18 000	5 067 552	8 535 785	3 468 233	68.4	106 420	2.1	0	371 595	3 101 800	10.7	89.3
7	2014	May	2 821 200	0	0	20 446	1 446 572	19 800	4 308 018	8 685 670	4 377 652	101.6	152 573	3.5	0	371 595	3 101 800	10.7	89.3
8	2014	May	0	20 703	1 006 459	20 446	524 449	0	1 572 057	16 654	-1 555 403	-98.9	182 773	11.6	0	628 995	2 844 400	18.1	81.9
9	2014	Jun	0	0	0	20 446	592 500	0	612 946	1 625 132	1 012 186	165.1	179 638	29.3	0	628 995	2 844 400	18.1	81.9
10	2014	Jun	2 083 926	2 400	0	20 446	2 849 469	16 200	4 972 441	6 477 527	1 505 086	30.3	125 711	2.5	0	628 995	2 844 400	18.1	81.9
11	2014	Jun	2 057 894	2 400	0	20 446	2 422 958	36 000	4 539 698	5 268 139	728 441	16.0	157 746	3.5	0	628 995	2 844 400	18.1	81.9
12	2014	Jun	2 709 320	13 117	939 218	20 446	2 455 380	18 000	6 155 481	7 459 905	1 304 424	21.2	140 084	2.3	0	927 059	2 546 336	26.7	73.3
13	2014	Jun	2 248 370	2 400	0	20 446	1 956 651	7 200	4 235 067	3 904 118	-330 949	-7.8	41 152	1.0	0	927 059	2 546 336	26.7	73.3
14	2014	Jul	3 489 560	0	0	20 446	2 109 680	18 000	5 637 686	7 609 962	1 972 276	35.0	34 663	0.6	0	927 059	2 546 336	26.7	73.3
15	2014	Jul	2 641 830	2 400	0	20 446	1 534 638	36 000	4 235 314	6 218 482	1 983 168	46.8	70 851	1.7	0	927 059	2 546 336	26.7	73.3
16	2014	Jul	3 803 390	25 513	996 528	20 446	1 694 421	18 000	6 558 298	7 863 447	1 305 149	19.9	51 549	0.8	0	1 317 224	2 156 171	37.9	62.1
17	2014	Jul	0	0	0	20 446	502 915	0	523 361	1 530 414	1 007 053	192.4	18 510	3.5	0	1 317 224	2 156 171	37.9	62.1
18	2014	Aug	5 534 920	2 400	0	20 446	1 038 831	18 000	6 614 597	9 189 340	2 574 743	38.9	58 879	0.9	0	1 317 224	2 156 171	37.9	62.1
19	2014	Aug	1 800	0	0	20 446	1 338 331	0	1 360 577	1 658 507	297 930	21.9	18 394	1.4	0	1 317 224	2 156 171	37.9	62.1
20	2014	Aug	2 547 010	0	0	20 446	1 099 156	1 800	3 668 412	5 421 261	1 752 849	47.8	64 126	1.7	0	1 317 224	2 156 171	37.9	62.1
21	2014	Aug	3 313 150	20 717	815 662	20 446	1 909 557	21 600	6 101 132	7 078 281	977 149	16.0	63 633	1.0	0	1 632 658	1 840 737	47.0	53.0
22	2014	Aug	4 137 510	1 200	0	20 446	1 619 542	18 000	5 796 698	8 925 089	3 128 391	54.0	58 919	1.0	0	1 632 658	1 840 737	47.0	53.0
23	2014	Sep	4 582 110	2 400	0	20 446	2 129 200	25 200	6 759 356	10 411 694	3 652 338	54.0	63 628	0.9	0	1 632 658	1 840 737	47.0	53.0
24	2014	Sep	6 654 524	2 400	0	20 446	2 172 518	10 800	8 860 688	12 306 218	3 445 530	38.9	55 428	0.6	0	1 632 658	1 840 737	47.0	53.0
25	2014	Sep	7 619 364	20 075	802 023	20 446	2 195 171	14 400	10 671 479	14 121 445	3 449 966	32.3	39 491	0.4	0	1 902 746	1 570 649	54.8	45.2
26	2014	Sep	8 263 254	2 400	0	20 446	2 411 784	23 400	10 721 284	15 232 945	4 511 661	42.1	47 127	0.4	0	1 902 746	1 570 649	54.8	45.2
27	2014	Oct	4 173 460	2 400	0	20 446	1 209 032	9 000	5 414 338	5 930 496	516 158	9.5	48 752	0.9	0	1 902 746	1 570 649	54.8	45.2
28	2014	Oct	9 051 324	2 400	0	20 446	2 496 876	18 000	11 589 046	14 821 627	3 232 581	27.9	59 370	0.5	0	1 902 746	1 570 649	54.8	45.2
29	2014	Oct	8 067 834	25 198	1 261 020	20 446	2 653 119	14 400	12 042 017	14 217 882	2 175 865	18.1	64 293	0.5	0	2 371 525	1 101 870	68.3	31.7
30	2014	Oct	9 104 654	2 400	0	20 446	2 660 937	18 000	11 806 437	15 753 840	3 947 403	33.4	66 362	0.6	0	2 371 525	1 101 870	68.3	31.7
31	2014	Nov	7 574 724	0	0	20 446	2 697 732	14 400	10 307 302	12 504 481	2 197 179	21.3	123 181	1.2	0	2 371 525	1 101 870	68.3	31.7
32	2014	Nov	118 010	0	0	20 446	1 183 151	18 000	1 339 607	1 343 127	3 520	0.3	147 446	11.0	0	2 371 525	1 101 870	68.3	31.7
33	2014	Nov	1 655 888	19 509	1 108 657	20 446	778 322	18 000	3 600 822	2 941 796	-659 026	-18.3	108 680	3.0	0	2 645 458	827 937	76.2	23.8
34	2014	Nov	2 305 844	2 400	0	20 446	551 680	21 600	2 901 970	5 381 904	2 479 934	85.5	144 498	5.0	0	2 645 458	827 937	76.2	23.8
35	2014	Nov	2 046 600	0	0	20 446	1 262 048	9 000	3 338 094	3 982 662	644 568	19.3	118 884	3.6	0	2 645 458	827 937	76.2	23.8
36	2014	Dec	4 154 760	2 400	0	20 446	1 474 299	18 000	5 669 905	8 703 649	3 033 744	53.5	119 381	2.1	0	2 645 458	827 937	76.2	23.8
37	2014	Dec	3 956 760	22 189	1 147 522	20 446	1 719 913	18 000	6 884 830	8 171 125	1 286 295	18.7	125 017	1.8	0	2 946 199	527 196	84.8	15.2
38	2014	Dec	2 520 264	2 400	0	20 446	1 552 582	18 000	4 113 692	5 623 539	1 509 847	36.7	190 626	4.6	0	2 946 199	527 196	84.8	15.2
39	2014	Dec	3 965 760	2 400	0	20 446	1 139 491	18 000	5 146 097	7 233 552	2 087 455	40.6	255 674	5.0	0	2 946 199	527 196	84.8	15.2
40	2015	Jan	2 360 220	0	0	20 446	1 693 436	10 800	4 084 902	5 922 950	1 838 048	45.0	278 023	6.8	0	2 946 199	527 196	84.8	15.2
41	2015	Jan	7 425 360	2 400	0	20 446	2 657 016	18 000	10 123 222	12 442 814	2 319 592	22.9	281 662	2.8	0	2 946 199	527 196	84.8	15.2
42	2015	Jan	6 403 464	16 832	1 114 356	20 446	2 612 152	16 200	10 183 450	11 160 118	976 668	9.6	283 586	2.8	0	3 250 522	222 873	93.6	6.4
43	2015	Jan	7 996 224	2 400	0	20 446	2 604 262	18 000	10 641 332	13 958 166	3 316 834	31.2	285 511	2.7	0	3 250 522	222 873	93.6	6.4
44	2015	Feb	8 273 424	0	0	20 446	2 249 094	18 000	10 560 964	14 099 740	3 538 776	33.5	214 900	2.0	0	3 250 522	222 873	93.6	6.4
45	2015	Feb	8 116 824	2 400	0	20 446	1 388 695	18 000	9 546 365	13 538 447	3 992 082	41.8	173 583	1.8	0	3 250 522	222 873	93.6	6.4
46	2015	Feb	8 845 824	2 400	0	20 446	887 147	18 000	9 773 817	8 073 150	-1 700 667	-17.4	173 532	1.8	0	3 250 522	222 873	93.6	6.4
47	2015	Feb	8 390 424	16 634	1 263 364	20 446	2 560 737	18 000	12 269 605	14 421 935	2 152 330	17.5	188 960	1.5	0	205 728 644	96 153 614	68.1	31.9
48	2015	Mar	7 398 624	0	0	20 446	2 315 907	18 000	9 752 977	12 971 790	3 218 813	33.0	205 293	2.1	0	213 145 268	88 736 990	70.6	29.4
49	2015	Mar	7 137 264	2 400	0	20 446	1 867 732	18 000	9 045 842	12 408 499	3 362 657	37.2	195 754	2.2	0	220 302 932	81 579 326	73.0	27.0
50	2015	Mar	6 798 360	2 400	0	20 446	1 165 921	18 000	8 005 127	12 057 098	4 051 971	50.6	183 741	2.3	0	227 121 692	74 760 566	75.2	24.8
51	2015	Mar	7 428 624	23 041	1 289 332	20 446	1 167 309	18 000	9 946 752	7 670 914	-2 275 838	-22.9	182 831	1.8	0	235 880 689	66 001 569	78.1	21.9
			221 920 220	**311 056**	**12 864 613**	**1 042 746**	**85 703 890**	**784 800**	**322 627 325**	**428 785 462**	**106 158 137**	**32.9**	**6 463 041**	**2.0**	**0**	**235 880 689**	**66 001 569**	**78.1**	**21.9**

Table A.4: Vaalharts 2014/2015 WUEA Report

Water Use Efficiency Accounting Report: Weeks 17 to 36

Hartbeespoort-besproeiingsraad: Weskanaal 2014/2015

Week	Year	Mnth	Agriculture (m3)	Industrial (m3)	Municipality (m3)	Household (m3)	Down stream (m3)	Other (m3)	Total (m3)	Released (m3)	Total loss (m3)	Loss (%)	Tail end (m3)	Tail end (%)	Crop used (m3)	Quota used (m3)	Quota avail (m3)	Used (%)	Avail (%)
17	2015	Jan	1 521 960	0	0	1 315	0	0	1 523 275	2 882 448	1 359 173	89.2	0	0.0	0	14 786 300	31 449 986	32.0	68.0
18	2015	Feb	1 242 840	199 953	0	1 315	0	0	1 444 108	2 382 985	938 877	65.0	0	0.0	0	16 229 093	30 007 193	35.1	64.9
19	2015	Feb	1 280 040	0	0	1 315	0	0	1 281 355	2 428 448	1 147 093	89.5	0	0.0	0	17 509 133	28 727 153	37.9	62.1
20	2015	Feb	1 763 880	0	0	1 315	0	0	1 765 195	3 077 232	1 312 037	74.3	0	0.0	0	19 273 013	26 963 273	41.7	58.3
21	2015	Feb	1 211 160	0	0	1 315	0	0	1 212 475	1 894 003	681 528	56.2	0	0.0	0	20 484 173	25 752 113	44.3	55.7
22	2015	Mar	1 318 440	164 980	0	1 315	0	0	1 484 735	2 418 925	934 190	62.9	0	0.0	0	21 967 593	24 268 693	47.5	52.5
23	2015	Mar	1 791 120	0	0	1 315	0	0	1 792 435	2 974 439	1 182 004	65.9	0	0.0	0	23 758 713	22 477 573	51.4	48.6
24	2015	Mar	1 780 200	0	0	1 315	0	0	1 781 515	2 932 966	1 151 451	64.6	0	0.0	0	25 538 913	20 697 373	55.2	44.8
25	2015	Mar	1 162 080	0	0	1 315	0	0	1 163 395	2 284 977	1 121 582	96.4	0	0.0	0	26 700 993	19 535 293	57.7	42.3
26	2015	Mar	821 400	0	0	1 315	0	0	822 715	1 647 520	824 805	100.3	0	0.0	0	27 522 393	18 713 893	59.5	40.5
27	2015	Apr	371 520	194 962	0	1 315	0	0	567 797	846 348	278 551	49.1	0	0.0	0	28 088 875	18 147 411	60.8	39.2
28	2015	Apr	487 320	0	0	1 315	0	0	488 635	1 194 044	705 409	144.4	0	0.0	0	28 576 195	17 660 091	61.8	38.2
29	2015	Apr	532 080	0	0	1 315	0	0	533 395	1 258 911	725 516	136.0	0	0.0	0	29 108 275	17 128 011	63.0	37.0
30	2015	Apr	643 560	0	0	1 315	0	0	644 875	1 255 510	610 635	94.7	0	0.0	0	29 751 835	16 484 451	64.3	35.7
31	2015	May	460 800	227 282	0	1 315	0	0	689 397	1 021 630	332 233	48.2	0	0.0	0	30 439 917	15 796 369	65.8	34.2
32	2015	May	604 680	0	0	1 315	0	0	605 995	1 521 888	915 893	151.1	0	0.0	0	31 044 597	15 191 689	67.1	32.9
33	2015	May	766 440	0	0	1 315	0	0	767 755	1 710 290	942 535	122.8	0	0.0	0	31 811 037	14 425 249	68.8	31.2
34	2015	May	629 280	0	0	1 315	0	0	630 595	1 484 510	853 915	135.4	0	0.0	0	32 440 317	13 795 969	70.2	29.8
35	2015	May	346 200	167 958	0	1 315	0	0	515 473	1 564 784	1 049 311	203.6	0	0.0	0	32 954 475	13 281 811	71.3	28.7
36	2015	Jun	558 000	0	0	1 315	0	0	559 315	1 645 938	1 086 623	194.3	0	0.0	0	33 512 475	12 723 811	72.5	27.5
			19 293 000	**955 135**	**0**	**26 300**	**0**	**0**	**20 274 435**	**38 427 796**	**18 153 361**	**89.5**	**0**	**0.0**	**0**	**33 512 475**	**12 723 811**	**72.5**	**27.5**

Table A.5: Hartbeespoort 2014/2015 WUEA Report

Appendix A

Orange-Riet Water Loss Report

ORWUA: Watervoorsiening
Maandverslag - Julie 2015/2016 Weke 14 tot 17

Oranje Riet	Volume (m3)
Gebruik besproeiing	2 113 623
Huishoudelik en Vee	6 644
Industrieel	33 333
Sub totaal	**2 153 600**

Rietrivier	Volume (m3)
Gebruik besproeiing	2 582 139
Huishoudelik en Vee	24 092
Munisipaliteit (Ritchie)	73 450
Industrieel (Bastion & Delmar)	2 475
Sub totaal	**2 682 156**

Scholtzburg	Volume (m3)
Gebruik besproeiing	195 691
Sub totaal	**195 691**

Benede-Riet	Volume (m3)
Gebruik besproeiing	1 191 927
Industrieel (Delwers)	1 030
Industrieel (Transnet)	0
Industrieel (Westra)	57
Rivier ontsouting	96 154
Sub totaal	**1 289 168**

Opsomming	
Totaal gelewer by Scheiding pompstasie (m3): (A)	8 685 163
Totaal gebruik (m3): (B)	6 320 615
Verlies (m3): (A - B)	2 364 548
% Verlies: (A - B) / A	27

Doeltreffendheid	
Aantal aanvrae & kansellasies	410
Aantal kortlope & klagtes	10
% Klagtes	2
Doeltreffendheid (%)	98

Figure A.1: Orange-Riet water loss report

Appendix B

Attendance registers

DEPARTEMENT OF WATER AFFAIRS

5 JANUARY 2015 JACOBSDAL

SWPM Water Release Modelling - ORWUA Jacobsdal (Inception meeting)

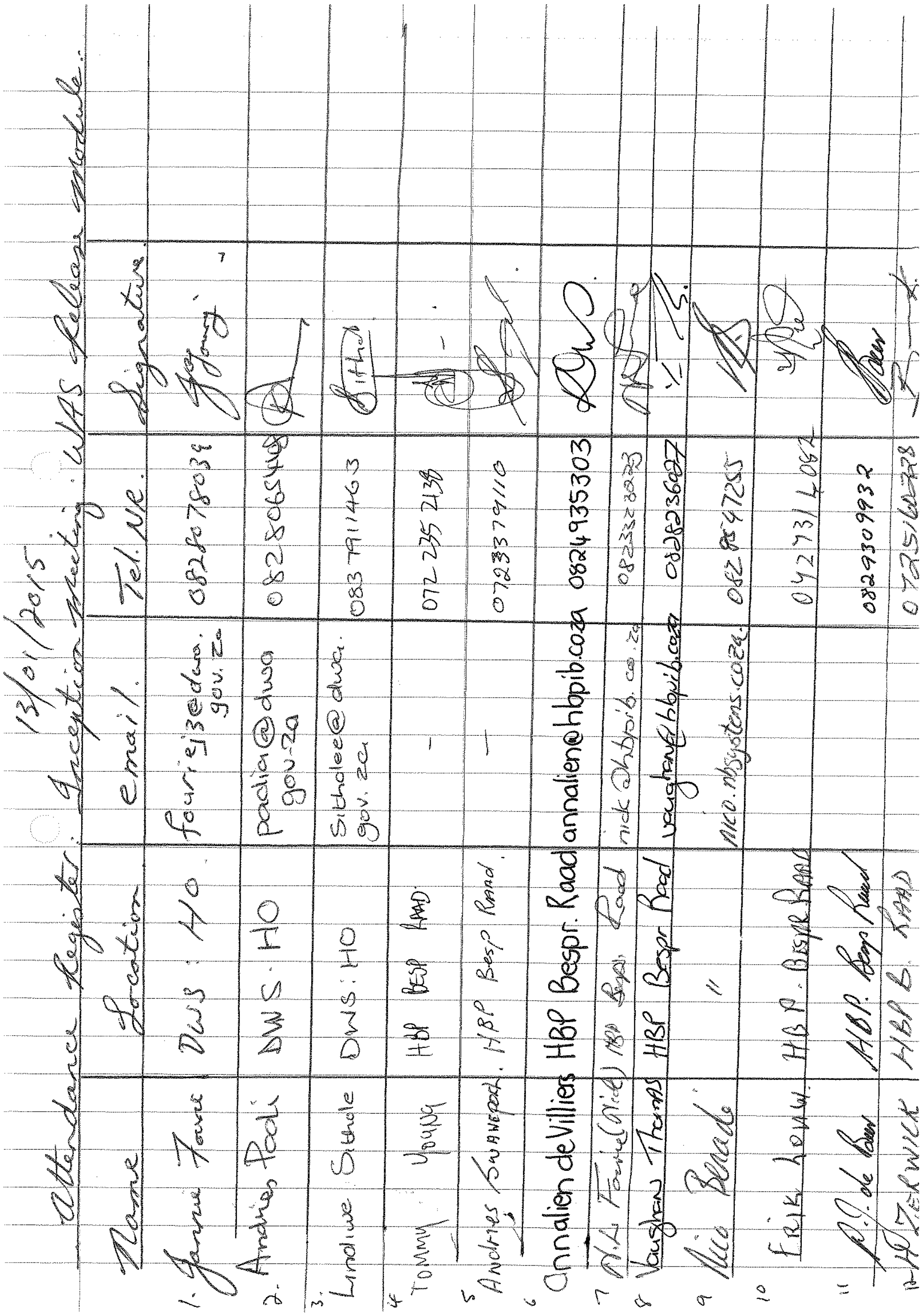
NAME	DEPARTMENT	ADDRES	TEL CELL	SIGNATURE
HL DU TOIT	ORWUA	P.O 203 Jacobsdal	053-5919200	[signature]
Jannie Fourie	DWS	Head Office.	0828078039.	[signature]
R Malan	ORWUA	PO Box 203 Jacobsdal	053-5919208	[signature]
I-P MASIKE	DWS:-DWUE	12 FRANCIS BAARD PRETORIA, 0001	012 336-6793 082-804-3323	[signature]
N. BENADE	NB Systems	33 Dr Vdl-Mosuwe Montana, Pretoria	082 8547255	[signature]

Table B.1: Inception meeting at ORWUA attendance register

VERGADERING GEHOU TE JAN KEMPDORP
2015-01-06
KONFERENSIESAAL
SWPN : Inception meeting : WAS Release Module
PRESENSIELYS

VAN EN VOORLETTERS SURNAME AND INTIALS	SEL NOMMER CEL NUMBER	HANDTEKENING SIGNATURE
VAN DYK GSD	vandykg@dwa.gov.za 0828092408	
Grové. H	0726419942	
J.M Marbron.	kobus@vhwater.co.za 0823248614	
I.P MASIKE	MASIKEI@DWA.GOV.ZA 0828043375	
Jacqui Fourie. (J.A.)	0828078039	
Nico Benade	0828597255	

Table B.2: Inception meeting at VHWUA attendance register



13/01/2015

Attendance Register: Inception meeting: WAS Release module.

Name	Location	email.	Tel. NR.	Signature.
1. Jannie Fourie	DWS : HO	fourieji3@dwa.gov.za	0828078039	
2. Andries Podi	DWS · HO	padia@dwa gov.za	0828065448	
3. Lindiwe Sithole	DWS : HO	Sitholee@dwa.gov.za	083 7911463	
4 TOMMY YOUNG	HBP BESP RAAD	–	072 235 2138	
5 Andries Swanepoel	HBP Besp Raad	–	0723379110	
6 Annalien de Villiers	HBP Bespr. Raad	annalien@hbpib.coza	0824935303	
7 N.L. Fourie (Nick)	HBP Besp. Raad	nick@hbpib.co.za	0823328023	
8 Vaughan Thomas	HBP Bespr Raad	vaughan@hbpib.coza	0828236027	
9 Nico Berade	"	nico.nbsystems.coza	082 8547255	
10 Frik Louw	HBP. Bespr Raad		0427314082	
11 P.J. de Boer	HBP. Besp Raad		0829309932	
12 H Zerwick	HBP B. RAAD		0725160228	

Table B.3: Inception meeting at Hartbeespoort attendance register