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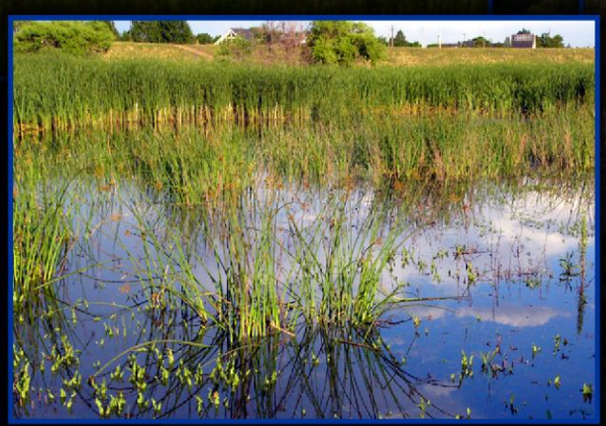
Classification of Significant Water Resources(Rivers, Wetlands, Groundwater and Lakes) in the Upper Middle and Lower Vaal Water Management Areas (WMA) 8,9,10

STATUS QUO REPORT



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Prepared by:

WRP Consulting Engineers (Pty) Ltd in association with DMM Development Consultants CC, Rivers for Africa eFlows Consulting (Pty) Ltd, Conningarth Economists, Koekemoer Aquatic Services and Zitholele Consulting (Pty) Ltd.

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DOCUMENT INDEX

Reports as part of this project (report status as in July 2011):

Index number	RDM Report number	Report title
1.1	RDM/WMA8,9,10/00/CON/CLA/0111	Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10, Inception Report
1.2	**RDM/WMA8,9,10/00/CON/CLA/0211**	Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10, Status Quo Report

Bold indicates this report.

Title:	***Status Quo Report***
Authors:	*R Cloete, G Huggins, S Koekemoer, D Louw, W Mullins, K Sami, P Scherman, S Swart, P van Rooyen*
Study Name:	***Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10***
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Dr Piet Kotze	Clean Stream Biological Services
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Dr Rob Palmer	Nepid Consultants

Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10

Status Quo Report

Executive Summary

1. BACKGROUND

*This study entitled "Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10" was commissioned by the Chief Directorate Resource Directed Measures (RDM) of the Department of Water Affairs (DWA) in October 2010. The ultimate purpose of the study is the implementation of the Water Resource Classification System (WRCS) in the above-mentioned three Vaal WMAs according to the 7 step process proposed by the WRCS (**DWAF, 2007**) as described in **Figure D-1** of **Appendix D**.*

The delineated Integrated Units of Analysis (IUAs) are described in this document. Information on the water resource infrastructure, water requirements, ecosystem characteristics, available socio-economic data and communities are described and summarised for each of the IUAs. The main objective of this document is to describe the status quo of the water resources within each of the IUAs in terms of the following aspects:

- *Water resource infrastructure and availability;*
- *Ecological status;*
- *Socio-economic conditions (including framework for impact assessment); and*
- *Goods and services (communities and their well-being).*

2. STUDY AREA

The core of the study area consists of the Upper, Middle and Lower Vaal River Water Management Areas (WMAs), however, due to the numerous inter-basin transfers that link this core area with other WMAs, the Ecological Reserve (ER) assessments had to be undertaken in the context of the Integrated Vaal River

System (IVRS) which also includes portions of the Komati, Usutu, Thukela, Senqu River (located in Lesotho) and Upper Orange (Riet-Modder River) catchments. The study area, therefore, comprises of the water resource and bulk supply systems of the entire Integrated Vaal River System as shown in ***Figure 1.1.*** *A detailed description of the operation of the IVRS is provided in* ***Appendix E****. It is important to note that the Riet-Modder catchment, which forms part of the Orange River WMA, is not included in the study area.*

3. SELECTION OF BIOPHYSICAL NODES

*The key biophysical nodes are the Ecological Water Requirement (EWR) sites and the selection process of these sites is documented in the recent Reserve studies (****DWAF, 2008e****;* ***DWAF 2009a*** *and* ***b****). Large sections of the catchment are still unaccounted for and additional biophysical nodes (referred to as desktop biophysical nodes) had to be selected. Various tools and information such as the Desktop EcoClassification results generated during the recent Reserve studies and the National Freshwater Ecosystem Priority Areas (NFEPA) was used to identify additional nodes. All attempts were made to select nodes that fairly represent the different conditions and operational procedures in the catchment. A total of 115 biophysical nodes were selected in the three Water Management Areas.*

4. DELINEATION OF INTEGRATED UNITS OF ANALYSIS

The identification and selection of the Integrated Units of Analysis (IUAs) were based on the following considerations:

- *The resolution of the hydrological analysis and available water resource network configurations currently being modelled.*
- *Location of significant water resource infrastructure.*
- *Distinctive functions of the catchments in context of the larger system.*
- *Available budget for refinement of the existing network and undertaking scenario analysis of each IUA.*
- *The biophysical nodes and the Present Ecological State (PES) and Recommended Ecological Category (REC) for each node were also considered.*

A properly calibrated higher resolution network water resource model is not available for use in the classification process of the Vaal River System. Furthermore, it has been recognised that the characteristics of individual small tributaries can significantly differ from the larger rivers and may warrant a different management class. It was therefore proposed in the Inception Report that a practical qualitative evaluation

*method be applied where necessary, which only considers the ecological aspects as well as likely implications on goods and services in a qualitative manner. The identification of the tributary catchments formed part of the IUA delineation (**Task 3a**).*

As already described in the approach to select biophysical nodes, the results (if available) of the current PES and Environmental Importance-Environmental Sensitivity (EI-ES) would also have contributed largely to the delineation of the IUA as the proportions of the different Ecological Categories for all the river reaches could play a vital role in the delineation.

*The identified Integrated Units of Analysis (IUAs) for the three Vaal Water Management Areas are shown in **Figures A-1**, **A-2** and **A-3** of **Appendix A**.*

5. WATER RESOURCES ASSESSMENT

*Due to the highly developed nature of the IVRS and the various inter-basin transfers that exist in the system, operating rules were developed that regulate when and how much water is transferred. The management and implementation of these operating rules (which include the dilution of the TDS concentration downstream of Vaal Barrage) are undertaken by the application of the Water Resource Planning Model (WRPM). The WRPM will subsequently be used as the Decision Support System (DSS) for this study. The WRPM system schematics are included in **Appendix C**.*

*The WRPM configuration of the IVRS includes the hydrological database resulting from the Vaal River System Analysis Update (VRSAU) Study (**DWAF, 1999**). The VRSAU hydrology covers the period October 1920 to September 1995 (i.e. a period of 75 years). It is important to note that the hydrological analyses of the VRSAU study were not necessarily undertaken at quaternary catchment level as the focus was on the most representative modelling of relevant sub-catchments. The methodology adopted for the disaggregation of lumped hydrology is described in **Section 2.1.4**.*

*The resolution of the WRPM configuration does not allow for the explicit modelling of the additional biophysical nodes described in **Section 2.2**. Although natural hydrology could be derived for these nodes, it will not be possible to simulate present day conditions at these sites. An alternative strategy will be followed for the assessment of current development conditions. Land use information to be obtained from the Validation and Verification studies will be used for this purpose.*

*The WRPM database includes growing water requirements up to the year 2030. Since the Integrated Vaal River System (IVRS) is analysed on an annual basis, the water requirement projections of the major bulk water suppliers (Rand Water, Midvaal Water Company and Sedibeng Water), the strategic water user Eskom, as well as large industries such as Sasol and Mittal Steel (previously known as Iscor), are also updated annually. The most recent water requirement projections of the above-mentioned users (revised as part of the 2011/2012 Annual Operating Analysis) will be used for the scenario analyses to be undertaken as part of this study and are summarised in **Table F-1** of **Appendix F**.*

6. *PROCESS TO DETERMINE THE ECOLOGICAL STATUS QUO: ECOCLASSIFICATION*

EcoClassification includes a range of analysis relevant to EWR sites and nodes. Relevant to this report is the identification of the Present Ecological State (PES) and the reasons for the PES which in essence provides the ecological status quo of the catchment. Additional analysis was undertaken to assess the Ecological, Socio-Cultural and Environmental Importance. This information, as well as considering the PES and the reasons for the PES, provides guidance to derive the Recommended Ecological Category which is set either to maintain or improve the PES.

The EWR sites were assessed during the recent and historic Reserve studies and the EcoClassification Level 4 method was used. This report focuses on the desktop biophysical nodes and the Desktop EcoClassification approach (Kleynhans and Louw, 2007) that was used. A current ongoing DWA/WRC PES and Ecological Importance-Ecological Sensitivity also provided some useful information specifically regarding the sub-quaternary (SQ) reaches of extensive river coverage of the area. All the information generated during the assessment is available in Excel spreadsheets.

7. SOCIO-ECONOMIC ASSESSMENT

The economic modelling systems used are the Water Impact Model (WIM) as well as the Production Industry Model (PIM), based on the SAFRIM model, to make it more WMA friendly. All three of the models are underpinned by a Social Accounting Matrix (SAM) to determine the different economic impacts on the applicable IUAs. Details of the procedure to be followed and the applied Scoring System for the classification of the rivers are discussed in ***Section 2.4*** *and is summarised below.*

The purpose of the Scoring System is to develop an objective evaluation system to reflect changes in water volumes on the classification of the river system, be it positive or negative. The elements used are: Ecological Condition, Economic Impact and Social Impact.

Approach to the Scoring System

- *The eventual choice of the different eco-system values will be based on a matrix that allows attaining the maximum value for both users, in and out of stream.*
- *The matrix to be developed listing all the values and then involve a group of knowledgeable people from in and out of stream to populate the matrix.*
- *The original concept was developed in a pilot project in the Olifants-Doorn River. For this study the concept is adapted for a highly industrialised Basin.*
- *The methodology proposed, is the Delphi approach where a number of specialists populate "Matrix 1" with approximate values.*
- *In "Matrix 2" weights are allocated to the different items which are then multiplied with the first matrix to get "Matrix 3" with answers.*

Water reallocation situational analysis

The evaluation of the results of the three different sets of analysis, namely ecological, goods and services and socio – economic is to establish the baseline per individual section of the main stem or tributary. If during the analysis it appears that the ecological situation of certain river zones have deteriorated to a point where corrective action is necessary, it might involve an increase in water in the specific river section. There is a possibility that a negative economic impact or a cost increase might occur, should it involve a water availability curtailment due to another activity.

In this regard the following assumptions have been developed and applied in the calculation of the possible socio – economic costs:

- *Main Stem: If in any zone problems arise the water will be augmented.*
- *Tributary: If any tributary a shortage of water is experienced it will be reallocated from the irrigation sector.*

If in a section of the main stem of the river more water is necessary to maintain or improve the status of the ecology of a specific the river section, the water will be supplied from the present available sources. However the possibility exists that this could influence the implementation date of the next augmentation scheme to supply the Vaal River system. The implementation date of the next dam in the Lesotho Highlands scheme, Polihali, is fixed and the project team has accepted that if a scheme must be brought forward it will be the proposed Tugela scheme.

The proposed approach to the estimation of the costs of bringing the project forward will rest on the principle of "time is money". The estimated cost of the Tugela scheme is available based on 2009 pricing, for implementation at a certain date in future, if that date is brought forward it will result in the money being spent earlier and the impact on the consumer in increased rates will be payable earlier.

This cost will be calculated, if necessary, should the analysis by the hydrology team indicate an earlier implementation date. This will assist the decision makers in arriving at a rational decision. The calculation per zone will be done by multiplying the necessary volume of water with the cost of augmentation per unit, expressed in 2011 prices.

Tributary - Economic Impact

The assumption governing the situation in a tributary rests on the supposition that the augmentation option will not be available and if more water is necessary for the ecology it will be provided from present sources, if there is a shortage it will be reallocated from the irrigation sector. The water reallocation volumes will be determined by the hydrology team. The macro – economic impact of the reallocation impact will be calculated to assist the decision makers in arriving at a rational decision.

Water Quality

Undesirable levels of water quality not only impact negatively on irrigation crop yields and quality, but also have an adverse impact on industrial water use. For example, should there be a deterioration of the water

quality within the Grootdraai Dam Sub-system more water has to be provided to Eskom through the VRESAP pipeline to ensure effective utilisation of the cooling systems of their power stations which receive water from this sub-system. Furthermore, extra costs might be necessitated by bulk water suppliers such as Rand Water that provides water to urban centres for domestic and industrial use. The costs associated with bringing the quality of the water to acceptable levels will be sourced from previous studies, where the specific option is not available the cost to the user will be used as the ball park figure.

The costs of these processes will be sourced from previous studies and indicated where necessary.

8. PROCESS TO DETERMINE THE GOODS & SERVICES STATUS QUO

Information on the Goods and Services (G&S) of the Vaal River is available and has been used as a basis for this purpose. It should be noted that the objective in describing and valuing the use of aquatic ecosystems is to determine the way in which aquatic ecosystems are currently being used in each socio-economic zone, and to estimate the value generated by that use. This provides the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared.

The most important Goods and Services associated with the overall system and likely to be impacted by changes in operational and management scenarios are the following:

- *Recreational fishing*
- *Subsistence fishing*
- *Other recreational aspects associated with the rivers*
- *Riparian vegetation usage*
- *Waste water dilutions*
- *Floodplain agricultural usage of subsistence purposes.*

Furthermore, each quaternary catchment of the Vaal has been examined in detail via the analysis of Socio-Cultural Importance. The Socio-Cultural Importance (SCI) was determined from:

- *A site visit that covered points along the river, and*
- *extrapolation to sites not visited by reference to available literature as well as to exiting mapping.*

9. STATUS OF WATER RESOURCES

The Vaal River System is the most important bulk water supply system in the country supplying water to 60% of the country's economy and 45% of its population. In addition to supplying water to other sub-systems (such as the Crocodile West through Rand Water) the system also receives water from the Usutu, Thukela and Senqu sub-systems. The Vaal River System is a very complex system consisting of many large dams,

pumping stations, pipelines and tunnels transferring water over long distances. The inter-basin transfer and system operating rules (which includes the dilution rule downstream of Vaal Barrage) have impacted on the natural flow regime of the system. This has resulted in elevated flows being observed in many of the tributaries as well as the main stem of the Vaal River. Water quality issues have also been identified.

10. ECOLOGICAL STATUS

Two of the major impacts dominating the Vaal Catchment are water quality impacts and changes in the flow regime. Changes in the flow regime range from too little flow but the most severe impacts are from too much flow and changes in seasonality which mainly relate to transfers, releases, irrigation return flows, mining and urban runoff.

Areas of highest water quality impact across the Vaal River catchments are as follows:

- *Rietspruit (C1Riet-Amers): The quality is a D category, largely due to extensive agricultural activities with highly elevated nutrients and salts.*
- *The condition of the lower Klip River (north-west flowing Klip River) catchment is poor, with sites ranging from a D to a D/E category. The main land use is still agriculture, although there are discharges around certain urban areas (e.g. Vrede) which reduce the water quality category.*
- *Rietspruit and Klip rivers (Gauteng) - Note that the water quality state of this portion of the Upper Vaal catchment is severely impacted and improvements in present state cannot occur without addressing water quality related problems, e.g. through implementation of the Integrated Water Quality Management Plan set up for the Vaal (DWAF, 2009).*
- *Lower Suikerbosrand and Blesbokspruit – The quality of the Suikerbosrand River is driven by the poor quality of the Blesbokspruit River. Impacts include mine water decants, diffuse runoff, urban runoff and point source discharges.*
- *Waterval catchment - Land use in the upper part of the catchment includes agricultural activities; Sasol petrochemical industry; Secunda town; coal mining in the Bethal to Secunda area (C11 and C12 tertiary catchments); and gold mining in the upper Waterval catchment. Impacts include elevated salts and nutrients, particularly phosphate. Some irrigation takes place in the lower part of the catchment, with issues related to elevated salts and nutrients, particularly phosphate. Water quality is poor across the area (D category) due to impacts of Sasol and Secunda and pivot irrigation.*
- *EWR 5 downstream of the Vaal Barrage – The salinity and nutrient impacts from the Klip, Riet, Suikerbosrand and Waterval rivers are combined in the Vaal Barrage and released downstream to this site on the Vaal River.*
- *The impact of Grootvlei Mine results in water quality deterioration to a D on the Molspruit tributary of the Vaal River.*
- *Mooi River (Upper Vaal catchment) - The main impact in the area is the uranium-laden effluent from the Wonderfonteinspruit. Impacts across the area are due to agricultural activities, urban runoff and the discharge of mining effluent.*

- *Middle Vaal River: EWR 12 at Vermaasdrift – Elevated nutrients and salts contribute to the poor water quality state.*
- *Tributaries of the Middle Vaal - Water quality is poor across this area, i.e. a D/E on the Koekemoerspruit to an E category elsewhere. Impacts are largely due to agriculture and urban / mining impacts. The Schoonspruit also runs through the urban areas of Klerksdorp and Kanana as well as the gold mining impacted areas (AngloGold Ashanti Vaal River Operations and Harmony).*
- *Vaal River (EWR 13) downstream of the Schoonspruit, Koekemoerspruit, Renoster and Vierfonteinspruit confluences in the Middle Vaal catchment.*
- *Lower Sand catchment - Water quality in the area is worst where mining impacts around Welkom and Virginia dominate. Here water quality is assumed to be a D category.*
- *Harts River (EWR 17 at Lloyds weir) – High salt and toxic concentrations due to agriculture and diamond mining impacts.*
- *Riet River – Impacts are high salts and high nutrient levels.*

Due to the economic importance of this area and the important role the Vaal System plays in conveying and supplying the water resource to this economic hub, it is understandable that most of the system is in a C EC or poorer condition.

*The biophysical nodes that scored a high Environmental Importance are listed in **Table 1** below.*

Table 1**: **Summary of the desktop biophysical nodes and EWR sites with a High Environmental Importance

IUA	VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC
UV-A	8VF5	C11A-01460	B/C		Yes	MODERATE	HIGH	B
UV-A	EWR 1	C11J-01838	B/C	Yes	Yes	HIGH	HIGH	B/C
UV-B	UV Uklip	C13C-02550	B		Yes	HIGH	HIGH	B
UV-B	C13C	C13D-02416	B/C		Yes	HIGH	HIGH	B
UV-B	C1KLIP-UNSPE1	C13D-02284	B/C	Yes	Yes	MODERATE	HIGH	B
UV-B	C13E	C13E-02228	B/C	Yes	Yes	MODERATE	HIGH	B
UV-C1	EWR 7	C81A-02790	A/B		Yes	HIGH	HIGH	A/B
UV-C1	8WF1	C81A-02790	B		Yes	MODERATE	HIGH	B
UV-C1	UV25	C81L-02594	B		Yes	MODERATE	HIGH	B
UV-C2	GG	C81G-02882	B		Yes	MODERATE	HIGH	B
UV-D	VC16	C83G-02364	B/C		Yes	MODERATE	HIGH	B
UV-D	VC17	C23H-02395	B/C		Yes	MODERATE	HIGH	B
UV-H	C21A	C12A-01567	B/C	Yes	Yes	MODERATE	HIGH	B
UV-H	EWR 9	C21C-01675	C	Yes	Yes	HIGH	HIGH	B/C
UV M	EWR 4	C22F-01737	C	Yes	Yes	HIGH	HIGH	B/C
UV M	EWR 5	C22L-01792	C/D	Yes	Yes	HIGH	HIGH	C
LV A4	VC59	C91D-02838	A/B		Yes	MODERATE	HIGH	A/B
LV B	VC60	C91D-02838	A/B		Yes	MODERATE	HIGH	A/B

*As can be seen from **Table 1**, most of the High EI nodes lie in the Upper Vaal, none in the Middle Vaal and two ephemeral small river reaches within the Lower Vaal. Apart from EWR 4, 5, and 9, all these sites are in a reasonable to good PES and the majority of those in a B/C EC (that should improve to a B EC) will require non-flow related intervention to achieve the required improvements.*

In summary, the following can be noted:

- *Some of the biggest water quality problems in South Africa occur within the study area.*
- *Many areas in the Vaal System (especially the Upper Vaal) are dominated by more flow than the natural flow regime (elevated flows).*
- *Although this river system is so heavily utilised (generally in a C category or worse condition) some features warrant protection and improvements are required where at all possible.*
- *The Vaal River is one of the few large rivers in South Africa; this fact on its own makes the Vaal River important.*
- *Protection of the Vredefort Dome. The Vaal River is a key feature within the Vredefort Dome especially around the town of Parys. Water quality issues are a serious concern – especially from the human use perspective and all the recreational activities.*
- *The presence of the Red Data listed Barbus kimberleynsis (yellow fish) and various riparian vegetation species.*
- *Endangered bird species are found within the study area, especially in upper reaches of Vaal and Wilge river catchments which are dominated by oxbows and wetland features.*
- *Seekoeivlei RAMSAR wetland in the Klip River.*
- *Blesbokspruit RAMSAR wetland in the Blesbokspruit.*
- *Barbers- and Leeu Pans RAMSAR Convention accredited wetland in the Harts River catchment.*
- *Wolwespruit Provincial (North West Province) Nature Reserve which includes the Vaal River.*

All of the above-mentioned features result in an extremely complicated set of challenges to be dealt with in the Vaal Catchment. The scope for considering a varied set of scenarios to deal with in the Classification System and the possibilities of trade-offs are limited.

11. SOCIO-ECONOMIC STATUS

***Tables 2**, **3** and **4** summarise the socio-economic impacts for the different IUAs as determined by the modelling processes.*

*As shown in **Table 2**, the economic indicators such as Gross Domestic Product (GDP), employment and household income percentage magnitudes of the Upper Vaal River IUAs generally compare well. A large concentration of the main economic activities is found in the UV-E: Waterval River area due to the mining, power generation and petro-chemical industries contributing 25.2% GDP, 26.3% employment opportunities and 22.5% of the household income.*

Table 2: Results for Upper Vaal WMA (2010)

IUA Reference	Description of resources	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
UV-A	Vaal River Upstream of Grootdraai Dam	38 217	9.9%	45 004	3.5%	14 744	6.7%
UV-B	Klip River (Free State)	1 529	0.4%	5 113	0.4%	721	0.3%
UVC1-UVC3	Wilge Rivier	1 476	0.4%	9 253	0.7%	849	0.4%
UV-D	Liebenbergsvlei River	1 829	0.5%	14 582	1.1%	1 073	0.5%
UV-E	Waterval River	97 244	25.2%	337 424	26.3%	49 744	22.5%
UV-F	Krop and Klip flowing into Vaal Dam	2 334	0.6%	10 395	0.8%	1 496	0.7%
UV-G	Vaal River reach upstream of Vaal Dam and Downstream of Grootdraai Dam	62 900	16.3%	169 766	13.2%	37 141	16.8%
UV-H and UV-I: C21D-C21G	Suikerbosrand River upstream of confluence with Blesbokspruit	51 705	13.4%	225 936	17.6%	33 616	15.2%
Partly UV-I: C22A-C22E; C22H & C22J	Klip Rivier (GT)	53 849	13.9%	239 066	18.7%	37 794	17.1%
UV-L	Mooi River up to confluence with Vaal River	12 606	3.3%	55 900	4.4%	7 111	3.2%
UV-M incl. UV-J, UV-K	Vaal Dam to Middle Vaal	62 818	16.3%	169 158	13.2%	37 109	16.8%
Total		**386 507**	**100%**	**1 281 597**	**100.0%**	**221 398**	**100.0%**

*The economic indicators such as GDP, employment and household income percentage magnitudes of the Middle Vaal River IUAs generally compare well (refer to **Table 3**). A large concentration of the main economic activities is found in the MV-C: Schoonspruit and Koekemoerspruit area with industries contributing 43.6% GDP, 43.6% employment opportunities and 35% of the household income.*

Table 3: Results for Middle Vaal WMA (2010)

IUA Reference	Description of Resources in MV WMA	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
MV-A	Renoster River	160	0.6%	1 256	0.8%	112	0.8%
MV-B	Vals River	3 533	14.3%	20 686	13.8%	2 033	14.6%
MV-C	Schoonspruit River and Koekemoerspruit	10 780	43.6%	65 226	43.6%	4 958	35.6%
MV-D1 & MV-D2	Sand	3 213	13.0%	20 000	13.4%	1 988	14.3%
MV-E1	Upper Vet River	3 309	13.4%	19 977	13.3%	2 262	16.2%
MV-E2	Lower Vet River	2 160	8.7%	12 906	8.6%	1 548	11.1%
MV-F	Vaal River main stem from C24B to Bloemhof Dam	1 574	6.4%	9 662	6.5%	1 035	7.4%
Total		**24 729**	**100.0%**	**149 712**	**100.0%**	**13 937**	**100.0%**

*As indicated in **Table 4**, the economic indicators such as GDP, employment and household income percentage magnitudes of the Lower Vaal River IUAs generally also compare well. The area accommodates vast irrigation agriculture enterprises. The main economic activities are found in the LV-B: Vaal River from the Bloemhof Dam to the Douglas Weir area contributing 51% GDP, 55% employment opportunities and 54% of the household income.*

Table 4: Results for Lower Vaal WMA (2010)

IUA Reference	Description of Resources in Lower Vaal WMA	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
LV-A1 to LV-A4	Harts	6 994	49%	42 721	45%	3 960	46%
LV-B incl. Vaalharts	Vaal River from Downstream of Bloemhof Dam to Douglas Weir	7 322	51%	52 957	55%	4 676	54%
Total		**14 315**	**100%**	**95 677**	**100%**	**8 636**	**100%**

12. STATUS OF GOODS AND SERVICES

While the Vaal System is important in terms of its extent, this is tempered by the nature of settlement in the area. In terms of utilisation and dependence on Goods and Services, the area is home to few communities for whom these resources would be important. The urbanised nature of the catchment and the fact that the bulk of the residents live in settings where livelihoods are linked to economic modes of production that are not linked to direct resource dependence is evident. Outside of the urban centres, the areas are dominated by relatively low population densities and given over to commercial farming enterprises (typically the upper parts of the catchment) as well as portions of the middle and lower catchments. These areas also tend to score relatively low in terms of dependence on Goods and Services.

As indicated, the nature of the Vaal River system and the typology of communities in the area mean that the

direct dependence on Goods and Services for livelihoods is restricted. There are however some forms of utilisation of goods and services that are important. These are:

- *Recreational fishing (specifically fly fishing targeting yellow fish);*
- *Subsistence fishing;*
- *Other recreational aspects associated with the rivers such as white water rafting, house boats, swimming;*
- *Riparian vegetation usage;*
- *Waste water dilutions; and*
- *Floodplain agricultural usage of subsistence purposes.*

Of these it is probably the recreational aspects associated with the river system and in particular fishing that is most important. Particular areas of importance include most of the Vaal river main stem and in particular areas around the Vredefort Dome. There are scattered areas in which the utilisation of riparian and other associated livelihood resources may be of some restricted importance, particularly to farm workers. However, these are highly unlikely to react to implementation of possible management and operational scenarios.

Another recreational activity that is important is bird watching which is associated with the various RAMSAR convention wetlands in the study area. These are Seekoeivlei, Barbers Pan, Leeu Pan and the Blesbokspruit wetland.

Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10

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ABBREVIATIONS

Acronym	Meaning
AOA	Annual Operating Analysis
BBM	Building Block Methodology
COMBUD	Computer Based Budgets
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CV	Coefficient of Variability
DC	Demand Centre
D: NWRP	Directorate: National Water Resource Planning
D: WRPS	Directorate: Water Resource Planning Systems
D: RDM	Directorate: Resource Directed Measures
DRM	Desktop Reserve Model
DSC	Dead Storage Capacity
DWA	Department of Water Affairs
EC	Ecological Category
EGSA	Ecosystem Goods, Services and Attributes
EI	Environmental Importance
EIS	Ecological Importance and Sensitivity
ER	Ecological Reserve
ESBC	Ecological Sustainability Base Configuration
ESKOM	Electricity Supply Commission
EWR	Ecological Water Requirements
FSL	Full Supply Level
GDP	Gross Domestic Product
GFSC	Gross Full Supply Capacity
GGP	Gross Geographic Product
HFSR	Habitat Flow Stressor Response
HFY	Historic Firm Yield
ISP	Internal Strategic Perspective
IUA	Integrated Unit of Analysis
IVRS	Integrated Vaal River System
IWQMP	Integrated Water Quality Management Plan
IWRM	Integrated Water Resource Management
LIM	Limnophilic Fish Species
LHDA	Lesotho Highlands Development Authority
LHWP	Lesotho Highlands Water Project
LSR	Large Semi-rheophilic Fish Species
LV	Lower Vaal
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbgl	Metres below ground level
MC	Management Class
MD	Municipal District
MOL	Minimum Operating Level
MVI	Marginal Vegetation Macroinvertebrate
MV	Middle Vaal
NFEPA	National Freshwater Ecological Priority Areas
NFSC	Net Full Supply Capacity
NWA	National Water Act

Acronym	Meaning
NWRS	National Water Resources Strategy
PES	Present Ecological State
PIM	Production Industry Model
REC	Recommended Ecological Category
RU	Resource Unit
RWQO	Resource Water Quality Objectives
SAFRIM	South African Inter-industry Model
SAM	Social Accounting Matrix
SCI	Socio-Cultural Importance
SD	Standard Deviation
SQ	Sub-Quaternary
TDS	Total Dissolved Solids
UV	Upper Vaal
VRESAP	Vaal River Eastern Sub-system Augmentation Project
VRESS	Vaal River Eastern Sub-system
VRSAU	Vaal River System Analysis Update
WDM	Water Demand Management
WC	Water Conservation
WIM	Water Impact Model
WMA	Water Management Area
WRC	Water Research Commission
WRCS	Water Resource Classification System
WRPM	Water Resource Planning Model
WRSAS	Water Resource Situation Assessment Study
WRSM2000	Water Resources Simulation Model 2000
WRYM	Water Resource Yield Model
WUA	Water User Association

Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8, 9, 10

Status Quo Report

1 INTRODUCTION

1.1 PURPOSE OF THE STUDY

This report describes the status quo assessments carried out by the appointed Professional Service Provider (PSP) for undertaking the Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8,9,10 Study. The study was commissioned by the Chief Directorate: Resource Directed Measures of the Department of Water Affairs (DWA) in October 2010 and the main objective of the study is to determine the Management Class (MC) of the significant water resources in the three Vaal WMAs over a period of 24 months.

The Water Resources Classification System (WRCS), which is required by the National Water Act (Act 36 of 1998), provides a set of guidelines and procedures for determining different classes of water resources. The WRCS prescribes a consultative process to classify water resources (Classification Process) to help facilitate a balance between the protection and use of the nation's water resources. The outcome of the Classification Process will be the approval of the Management Class (MC) by the Minister or her delegated authority for every significant water resource (river, estuary, wetland and aquifer) which will be binding on all authorities or institutions when exercising any power, or performing any duty under the National Water Act (NWA). The MC outlines those attributes that the Department and society require of different water resources. The 7 step process proposed by the WRCS (**DWAF, 2007**) is described in **Figure D-1** of **Appendix D**. The determination of the status quo, which is the subject of this document, was addressed in Steps 1, 2 and 3a.

As the project area includes the most important economic region of the country, data are collected and analysed in terms of the three Vaal Water Management Areas as well as the tributaries and main stem areas in the project area. The description of the study area is given in **Section 1.2**, which includes a synopsis of the water quality situation.

1.2 STUDY AREA

The study area comprises of the water resource of the Vaal River System which includes the catchments of the Upper, Middle and the Lower Vaal Water Management Areas (see **Figures A-1 to A-3** of **Appendix A)**. Other sub-systems that are linked to the Vaal River System are shown in **Figure 1.1** on **Page 4**. The supporting sub-systems will form part of the water resource system analysis (either directly or indirectly) to ensure the Management Class is determined in an integrated manner. A detailed description of the Integrated Vaal River System (IVRS) is provided in **Appendix E**. It is important to note that the Riet-Modder catchment, which forms part of the Orange River WMA, is not included in the study area.

The Vaal River is one of the most highly utilised rivers in the country and this has resulted in a moderate to severe degradation of the ecological state in most sections of the main river and its tributaries. Isolated important areas do occur however centered around, for example, reserves, wetlands and less disturbed areas. The Vaal River is one of South Africa's largest rivers, and due to the scarceness of such river types in SA, this makes it important in its own right, irrespective of its state. Protection of these resources in some acceptable form, even as a heavily utilised river, is important. It must also be noted that Barbus kimberleyensis, the largemouth yellow fish, occurs in the Vaal River. This fish is Red Data listed (IUCN 2010) and is also a very popular fly fishing target. South Africa, as a signatory of the Convention of Biodiversity (**CBD, 1992**), is obliged to determine strategies to maintain and protect its biodiversity. Furthermore, the Vaal River forms a centre part of one of South Africa's few World Heritage sites, the Vredefort Dome (UNESCO 2005). Pollution of the Vaal River and unstructured development might affect the status of the World Heritage site which could result in severe socio-economic problems (job losses amongst others).

Water quality problems, decreased flows (lower Vaal River) and increased flows (higher than natural especially in the dry season resulting in an aseasonal flow regime) are the major problems threatening the health of the Vaal System.

Water quality status in the Upper Vaal catchment is impacted on by discharges from gold mines, seepages from tailings dams, discharges from industry directly to the river, urban runoff and discharges from the large number of sewage treatment plants located in the urban areas. The return flows from sewage treatment plants have resulted in the flows in many of the river systems exceeding the natural flows. Coal mining is located in the Waterval and Grootdraai Dam catchments in the upper reaches of the Vaal River, and along the banks of the Vaal Barrage below Vaal Dam (ORASECOM, 2007; cited in Scherman, 2010).

Although the Middle Vaal is less urbanized, discharges from mining operations and sewage treatment facilities have a notable influence on the water balance. The predominant land use in the Lower Vaal is agriculture, with extensive irrigation schemes located on the Vaal River and along the Harts River (ORASECOM, 2007; cited in Scherman 2010). The following points summarize water quality status of the Vaal River (Scherman, 2010):

- The usage of water in the Vaal River is impacted by high levels of salinity and related macro-ions particularly downstream of Vaal Dam.
- Eutrophication due to high nutrient levels is a key issue in the Vaal River, resulting in algal blooms and growth of water hyacinth. The algae resulting from eutrophication has led to odour and colour problems

in the intake water to water treatment plants which are not geared for dealing with eutrophic waters.

- Microbiological pollution is an emerging concern.
- While sections of the upper part of the Vaal catchment have water of a good quality, the areas of concern include the Vaal Barrage and Lower Vaal River downstream of Harts River confluence.
- Discharges from coal and gold mining, industrial discharges and decant from mines post closure, cause water quality problems in the Vaal system.
- Along the main stem of the Vaal organics has been raised as an issue by the water boards, with monitoring programmes identifying increases in Dissolved Organic Carbon (DOC) in raw intake water to the water treatment plants.
- Although broad, this overview is congruent with that of the Vaal Integrated Water Quality Management Plan produced in 2009 (**DWAF, 2009e**), the Reserve studies recently undertaken and the findings of the Planning Level Review of Water Quality in South Africa currently being completed (Jay, DWA, pers. comm., July 2011).

1.3 PURPOSE AND LAYOUT OF THE REPORT

The purpose of the Status Quo Report is to define the current status of the water resources in the study area in terms of the water resource systems, the ecological characteristics, the socio-economic conditions and the community well-being. **Section 2** of the report describes the multi-disciplinary methodologies adopted for the status quo assessments. **Section 3** provides information on the delineated Integrated Units of Analysis (IUAs). The findings of the status quo assessments for the Upper, Middle and Lower Vaal WMAs are described in **Sections 4, 5** and **6** respectively for each IUA. The status quo results are summarised in **Section 7**, while the references are listed in **Section 8**.

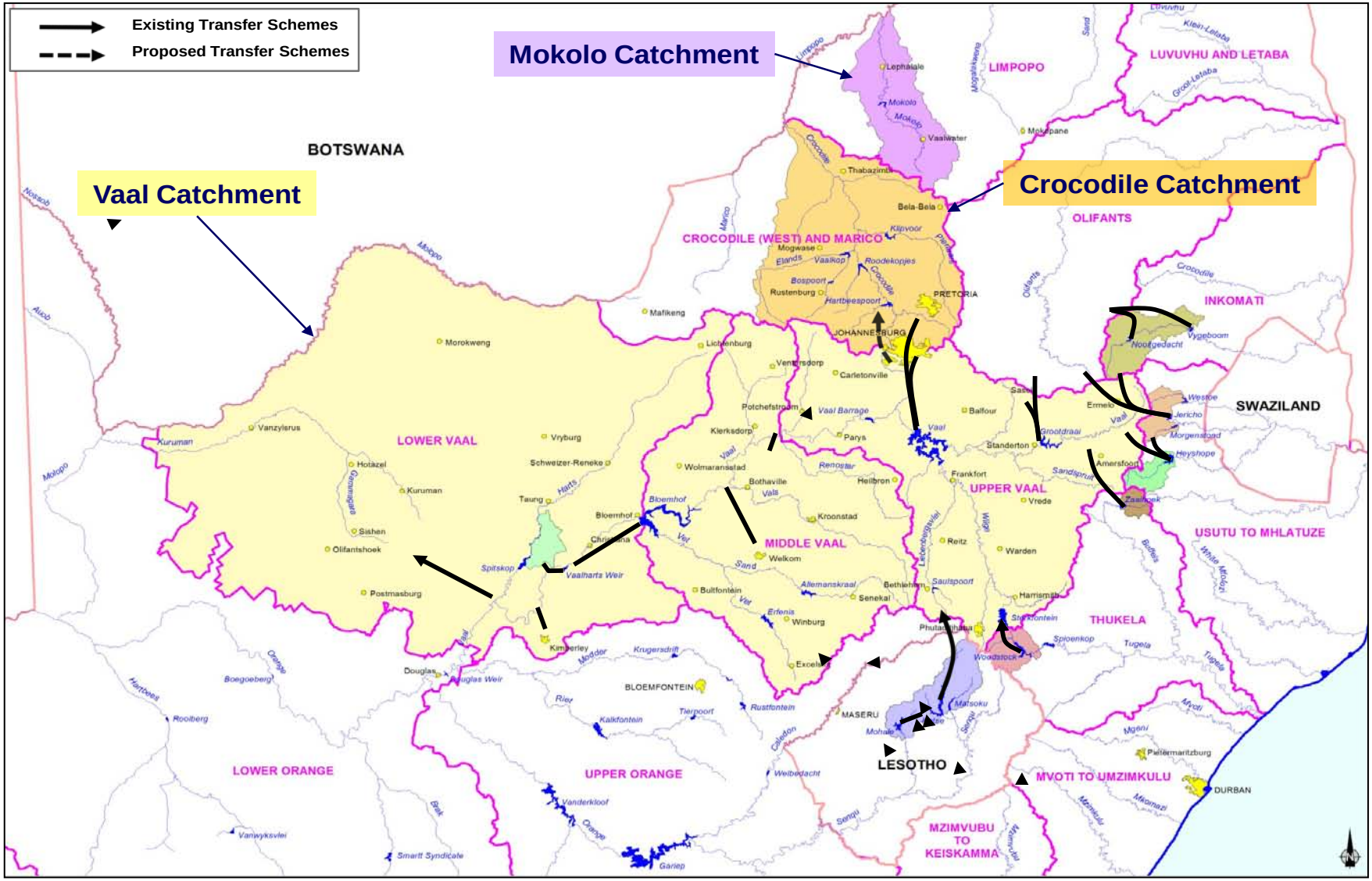


Figure 1.1: Location Map of the Vaal River System and linked sub-systems

2 METHODOLOGY ADOPTED FOR STATUS QUO ASSESSMENT

2.1 WATER RESOURCES ASSESSMENT

2.1.1 Decision support system (DSS) for Integrated Vaal River System

Due to the highly developed nature of the Integrated Vaal River System (IVRS) and the various inter-basin transfers that exist in the system, operating rules were developed that regulate when and how much water is transferred. Salinity (Total Dissolved Solids (TDS)) is an important driver of the operation of the Vaal River System affecting the flow in the river reach downstream of Vaal Dam. In the past the application of an operating rule has been implemented to dilute the saline water (discharged from the mines, returned by the numerous waste water treatment works and washed off from the highly developed urbanized catchments) through releases from Vaal Dam. The management and implementation of the operating rules of the inter-basin transfers and the dilution rule are undertaken by the application of the Water Resource Planning Model (WRPM). The WRPM will subsequently be used as the Decision Support System (DSS) for this study. The WRPM schematic representation of the IVRS is included in **Appendix C** (**Figures C-1** to **C-13**).

2.1.2 System components

As mentioned in **Section 1.2** the Vaal River is one of the most highly utilised rivers in the country. The Vaal River System is also a very complex system consisting of many large dams, pumping stations, pipelines and tunnels transferring water over long distances. The WRPM configuration of the IVRS includes the modelling of the following system components:

- 205 incremental catchments each with its own natural hydrology time series record (*.INC file) and representative catchment rainfall time series record (*.RAN file);
- 40 major storage dams;
- 179 minor dams (also referred to as dummy dams with each dummy dam representing a group of small dams within a specified incremental catchment);
- 14 major transfer links;
- 358 Demand Centres (DC) representing the water requirements of urban, industrial and irrigation users. Sasol and Eskom are considered as strategic water users and they require that water be supplied to them at a very high assurance level (a 99.5% exceedance probability level or 0.5% risk of failure is associated with these users). Sasol's Secunda and Sasolburg complexes receive water from the Vaal River System. The IVRS also supplies water to thirteen Eskom Power Stations (PSs) which include the new Kusile PS which is currently being constructed. Bulk water suppliers Rand Water, Midvaal Water Company and Sedibeng Water supply water to numerous towns, industries and mines. Irrigation water

users were grouped together based on their location and source of water supply. Approximately 126 irrigation areas are being modelled as DCs within the IVRS.

2.1.3 Hydrological database

The WRPM configuration of the IVRS includes the hydrological database resulting from the Vaal River System Analysis Update (VRSAU) Study (**DWA, 1999**). The hydrology for sub-catchments within the Komati, Usutu, Thukela and Senqu river basins was also updated as part of the VRSAU study. The VRSAU hydrology covers the period October 1920 to September 1995 (i.e. a period of 75 years). It is important to note that the hydrological analyses of the VRSAU study were not necessarily undertaken at quaternary catchment level as the focus was on the most representative modelling of relevant sub-catchments. The strategy adopted for the Annual Operating Analysis (AOA) of the IVRS is to continuously update and enhance the WRPM configuration and database as new information becomes available. Updated hydrology of the Thukela and Schoonspruit River catchments were subsequently included in the WRPM database. The updated hydrology of the Upper Waterval catchment resulting from the most recent BKS study undertaken for the DWA (**DWAF, 2005a**) was included in the WRPM database as part of the Comprehensive Reserve Determination Study (**DWA, 2010d**).

2.1.4 Hydrology for biophysical nodes

As mentioned in **Section 2.1.2** the hydrological analyses of the VRSAU study were not necessarily undertaken at quaternary catchment level as the focus was on the most representative modelling of specific sub-catchments of interest. Various catchment development components (e.g. small dams, diffuse and controlled water use) within these larger sub-catchments were also grouped together to simplify the WRPM configuration.

As part of the Comprehensive Reserve Determination Study (**DWA, 2010d**) it was necessary to derive natural runoff time series data for each quaternary catchment located in the Vaal River catchment upstream of Douglas Weir. Natural runoff information was also required for each of the selected Ecological Water Requirement (EWR) sites. It was, therefore, firstly necessary to disaggregate all the lumped catchment runoff data to obtain incremental quaternary catchment information. Secondly relevant incremental quaternary catchment information had to be combined to provide a natural Mean Annual Runoff (MAR) and natural runoff time series that are representative of each selected EWR site. To this end, it was necessary to establish an acceptable disaggregation methodology utilising the available sources of quaternary catchment information as benchmarks.

The WR90 (Water Resources 1990) study was the first national study initiated by the Water Research Commission (WRC) which provided comprehensive hydrological information at quaternary catchment level for the entire country. Since the WR90 study (**WRC, 1990**) only included information up to the year 1989, the need for updating this database was identified and culminated in the commissioning of the WR2005 study. The final results of the WR2005 Study were not available at the time when assessments were done for the Reserve Study and it was decided to use the WR90 database as source of information at quaternary catchment level.

The following methodology was adopted for the disaggregation process:

- The quaternary catchments which are situated within the lumped catchment were identified;
- The total natural WR90 MAR was calculated for the lumped catchment by adding up all the incremental natural WR90 MARs of the relevant quaternary catchments;
- The incremental natural WR90 MARs of the relevant quaternary catchments were then expressed as a ratio of the calculated total natural WR90 MAR;
- The calculated WR90 MAR ratios were applied to the lumped catchment's natural MAR resulting from the VRSAU study to obtain incremental natural VRSAU MARs for each of the relevant quaternary catchments;
- The VRSAU study's natural runoff time series for the lumped catchment was subsequently scaled by applying the calculated WR90 MAR ratios to obtain an incremental natural runoff time series for each of the relevant quaternary catchments.

The following approach was adopted for the determination of a natural VRSAU MAR and a total natural runoff time series at each of the selected EWR sites:

- The catchment area of the EWR site was determined;
- The quaternary catchments upstream of the EWR site were identified;
- The incremental natural VRSAU MARs and incremental natural VRSAU runoff time series of the relevant quaternary catchments were then added to obtain information that is representative of the EWR site;
- In the event where the location of the EWR site was not at the outlet of a quaternary catchment, the portion of the quaternary catchment area located upstream of the EWR site was determined and the incremental natural VRSAU runoff time series of the quaternary catchment was scaled according to the catchment area ratio.

In addition to the key biophysical nodes (comprising of the EWR sites selected as part of the Reserve Study), the ecological team identified biophysical nodes within the project area where no or limited ecological data existed (refer to **Section 2.2** below). Since hydrological data were required for these additional nodes, the methodology described above was applied for the determination of the natural MAR and corresponding time series data for each of the biophysical nodes.

The gross catchment areas and natural MARs of all the biophysical nodes (including the EWR sites selected as part of the Reserve Study) are summarised in **Table G-1** of **Appendix G**.

2.1.5 Catchment development and water use

The system configuration of the IVRS, as defined in the data files of the WRPM model, are presented as schematic diagrams in **Appendix C**. The land use information currently included in the WRPM configuration is mostly based on data obtained as part of the VRSAU Study. As mentioned in **Section 2.1.4** the various catchment development components (e.g. small dams, diffuse and controlled water use) were also grouped together to represent activities occurring within the larger sub-catchments modelled as part of the simplified WRPM configuration. Refinements were, however, made to the system configuration to enable modelling of the selected EWR sites for the purposes of the Comprehensive Reserve Determination Study (**DWA, 2010d**). It is important to note that various assumptions had to be made in view of these refinements which may impact on the accuracy of simulation results. The locations of the selected EWR sites are shown on the schematic diagrams presented in **Appendix C**.

The resolution of the WRPM configuration does not allow for the explicit modelling of the additional biophysical nodes described in **Section 2.2**. Although natural hydrology could be derived for these nodes, it will not be possible to simulate present day conditions at these sites. An alternative strategy will be followed for the assessment of current development conditions. Land use information to be obtained from the Validation and Verification studies will be used for this purpose.

The WRPM database includes growing water requirements up to the year 2030. Since the Integrated Vaal River System (IVRS) is analysed on an annual basis, the water requirement projections of the major bulk water suppliers (Rand Water, Midvaal Water Company and Sedibeng Water), the strategic water user Eskom, as well as large industrial users such as Sasol and Mittal Steel (previously known as Iscor), are also updated annually. The most recent water requirement projections of the above-mentioned users (revised as part of the 2011/2012 Annual Operating Analysis) will be used for the scenario analyses to be undertaken as part of this study and are summarised in **Table F-1** of **Appendix F**.

The following is a brief description of the sources of information adopted for the water requirement components included in **Table F-1:**

- **Rand Water Supply Area**: The adopted water requirement scenario for the Rand Water (RW) supply area was compiled based on the Phase 2 Reconciliation Strategy High Population Demand Projection without Water Conservation and Water Demand Management (WC/WDM) initiatives as revised in October 2010.

- **Eskom**: Eskom provided three alternative water requirement scenarios for each existing and planned power station in April 2011. The Base Demand scenario was recommended for planning purposes.

- **Sasol Secunda**: The April 2011 projections provided by Sasol were adopted.

- **Sasol Sasolburg**: The May 2011 projections provided by Sasol were adopted.

- **Mittal Steel**: A revised water requirement projection was obtained from Mittal Steel on 20 July 2010 and was adopted for analysis.

- **Sedibeng Water**: Updated information was received in June 2011 from Sedibeng.

- **Midvaal Water Company (WC)**: The April 2011 projection provided by Midvaal WC was adopted.

- **Other users**: Water requirements for most towns were based on the NWRS projections and in cases where data were available the All Town Reconciliation Strategy Study scenarios were adopted.

- **Irrigation**: The irrigation water requirements of the Vaal River System that were adopted for the 2011/2012 Annual Operating Analysis were applied. These estimates and the portion deemed to be unlawful originated from the Vaal River System: Large Bulk Water Supply Reconciliation Strategy Study (**DWAF, 2008a**).

Table F-2 included in **Appendix F** provides detailed information on individual water users and the information is presented within the context of the various sub-systems of the IVRS. The detailed water requirement information can be referenced as part of the status quo assessments of the identified Integrated Units of Analysis (refer to **Sections 4**, **5** and **6**).

2.2 SELECTION OF BIOPHYSICAL NODES

The key biophysical nodes are the Ecological Water Requirement (EWR) sites and the selection process of these sites is documented in the recent Reserve studies (**DWAF, 2008e**; **DWAF 2009a** and **b**). The location of the EWR sites however were focussed on the main stem and key tributaries, i.e. the areas where there are water resource issues and where operational management of the system can be implemented. However, this leaves large sections of the catchment unaccounted for.

The process described in the Classification guideline (which refers to the Desktop EcoClassification and the identification of hotspots (**Louw & Huggins, 2007**) was used as an initial step to identify additional nodes within the project area where no or limited ecological data existed. Biophysical nodes were selected at the outlet of any area with a High or Very High Environmental Importance (EI). During the Desktop EcoClassification process of the Reserve studies for the Upper (**DWAF, 2008f**), Middle (**DWAF, 2009c**) and Lower (**DWAF, 2009d**) Vaal WMAs, the Ecological Importance (EI) was evaluated by means of using a matrix to determine the rating, and as interpretation can be subjective, this was not necessarily consistent. To ensure consistency during the evaluation of these nodes the Desktop EcoClassification results produced during the Reserve studies for the Upper, Middle and Lower Vaal WMAs were summarised in Excel format and formulas were used to consistently recalculate the EI for all quaternary catchments.

Furthermore, the very recent National Freshwater Ecological Priority Areas (NFEPA) (**CSIR, 2010**) identified in the project area were incorporated and a node was placed in every NFEPA area.

After the above-mentioned information was mapped, the following became obvious:

- The Desktop EcoClassification approach was relevant for the main rivers in the quaternary catchments. Many of the biophysical nodes selected were not on the main rivers and the PES and Ecological Importance and Sensitivity (EIS) allocated to the quaternary catchment was not relevant for sub-quaternary (SQ) reaches.

- The use of the Environmental Importance evaluations can lead to a selection of only the ecological important areas, thereby leaving large sections of the catchment unaccounted for. Another approach could be to use the Water Resource Use Importance evaluation but the scale of this assessment is even larger than quaternary catchment level and information on sub-quaternary level was not available.

- NFEPA: No specific information is yet available on the reasoning for the selection of NFEPAs in the study area. DWA therefore indicated that the NFEPAs should be considered and used only where appropriate (Naidoo, personal commmunication). Initial attempts to verify the NFEPAs using DWA methodologies showed that many of the NFEPAs result in a low or moderate EIS. All NFEPAs would, therefore, have to be verified according to Department of Water Affairs (DWA) approaches to determine whether these additional nodes are warranted.

Therefore, prior to the final selection of biophysical nodes, the following was undertaken:

- Nodes were included in areas not covered by the original nodes to ensure a realistic spread of the nodes. This follows the principles set out in the guideline (Brown *et al* 2006) where nodes where required at the end of every tributary and at end of any change in operation of the system. This approach can however not be followed as exactly recommended due to the cost associated with this. Also, results of developments since 2006 (such as the current study on PES and EI-ES) will also impact on the 2006 recommended approach and allow one to streamline the approach.
- NFEPAs that did not coincide with any of the existing selected nodes based on the Desktop EcoClassification, or selected to represent unaccounted catchment areas, were verified (see **Section 2.1.4** for method description). Reasoning obtained from the verification process is provided in all accompanying data.

The outcome of this process was the selection of 115 biophysical nodes in the project area which include the EWR sites.

A very important lesson learnt during this process was that due cognisance to a fair (nodes representative of all Ecological Categories and ensuring that High importance areas were included) selection of biophysical nodes cannot be made without the results of the current ongoing PES and Ecological Importance (EI) – Ecological Sensitivity (ES) DWA/WRC study being undertaken for the whole country. During this study, SQ reaches will be identified and the PES and EI-ES identified for each SQ reach. To give an idea of the number of SQ reaches – the Vaal catchment has 9 secondary catchments and one of those (C1) has 270 SQ reaches, i.e. a requirement of 270 assessments. This would ensure excellent coverage of the catchment. Within the PES and EI-ES study, the Vaal assessment has not been initiated and is last on the priority list. This information was therefore not

available.

All the biophysical nodes, as initially selected, were plotted on the maps including SQ reaches. SQ reaches are delineated on the basis of hydrological changes, i.e. at tributary confluences and was provided by DWA, RQS (these are the same reaches that would be utilised for the Vaal assessment of the PES and EI ES study when it is initiated). Each of the SQ reaches represents a Resource Unit, i.e. the length of river for which a status assessment and EWR assessment will be valid for.

The naming of the biophysical nodes did not follow a consistent process. The reason for this was that many nodes are actual sites that already exist in various databases and it would be preferably for purposes of cross-referencing not to change the names. Any new node that does not exist in any other database was called VC (Vaal Classification) and a number. It must also be noted that some nodes are named after a quaternary catchment, e.g. C13B. This node represents a point in that catchment which is not representative of the quaternary catchment area but of the sub-quaternary reach area within which the actual node is placed.

Information on the physical characteristics and locality of the nodes is provided in **Table G-1** of **Appendix G**.

2.3 ECOCLASSIFICATION

This report focuses on the biophysical nodes (other than EWR sites) and the approach used. The results are provided in an Excel spreadsheet per Integrated Unit of Analysis (IUA). Every IUA spreadsheet contains the following worksheets:

- Fact sheet (**Table 2.1**): Basic information regarding impacts on the nodes within the IUA. There is a separate fact sheet for each node identified by the name of the node.
- PES: The PES results of all the nodes within the IUA.
- EIS: The EIS results of all the nodes within the IUA.
- REC: Essentially a summary of all the previous information generated in the spreadsheet and providing the REC.
- Goods and Services: Summarised for each node.

It must be noted that EcoClassification includes steps other than just the determination of the status quo (PES) and that the Ecological and Environmental Importance and Recommended Ecological Category have also already been determined and the results provided in this report.

The Desktop EcoClassification approach (**Kleynhans and Louw, 2007**) was used for all the biophysical nodes which are nodes other than the EWR sites. To distinguish, these biophysical nodes will be referred to as the desktop biophysical nodes. During the recent Reserve studies on the three Vaal Water Management Areas (WMA) (**DWA, 2010a-c**), the EcoClassification, Level 4 (**Kleynhans and Louw, 2007**) method was applied for all EWR sites. Additional to this, EWR studies at detailed level were also undertaken on the Schoonspruit (**DWAF, 2006**) and Waterval (**DWAF, 2005b**) Rivers.

For all the nodes, apart from those nodes selected ONLY because they were identified as a NFEPA, the following process was followed:

- A fact sheet (see **Table 2.1** on page 14) was completed which identified the impacts that are present in the area. This information is used to inform the assessment of the Present Ecological State. This information was mostly derived from Google Earth, as well as available information collected from personal and professional experience. The fact sheet is available as a worksheet in an Excel spreadsheet compiled for every IUA. There is a separate fact sheet for each node identified by the name of the node.
- Google Earth image extracts were made and inserted in the fact sheet. A description of each image is provided on the fact sheet. Representative images were selected of specific impacts (such as mines) or of areas that represent a certain portion of the SQ reach. Street view photos were also downloaded from Google Earth as well as photos taken during surveys and included in the fact sheet.
- The PES was determined using the basic EcoQuat model (**Kleynhans and Louw, 2007**) which requires the following minimum tools:

  Drivers: Quick Habitat Integrity: The metrics used are
  - bed modification,
  - flow modification,
  - inundation,
  - riparian bank condition, and
  - water quality modification.

  Each metric is rated between 0 – 5 with 5 indicating a severe change from natural.

  Responses: The response of the instream and riparian biota to the habitat changes are derived for
  - fish,
  - aquatic invertebrate and
  - riparian vegetation rating.

  These ratings are based on a 0 – 5 scale with 0 implying an A Ecological Category and 5 a F Ecological Category.

  - The model calculates the Instream Ecological Category and the EcoStatus. A confidence between 1 – 5 (5 = very high confidence) is also supplied.
  - The PES was assessed on one Excel worksheet for each node. The methods are well documented in Kleynhans and Louw (2007) and the model is imbedded in the Excel spreadsheet which will be made available as part of the final deliverable.
  - A desktop water quality assessment was therefore conducted by using all available information, e.g. the IWQMP and Vaal Reserve documents, and assessing the extent of land uses which would impact on water quality using Google Earth and knowledge of the catchment from the specialist team. The approach is therefore desktop and confidence ranges from low to high, pending information available. The 0-5 rating relate to the A-F Ecological Categories.
- The EIS was calculated using a refined (from **Kleynhans and Louw, 2007**) EIS model which was developed during 2010 by Dr Kleynhans. This refined model is better suited to address seasonal and

ephemeral systems and the following metrics (rated from 0 to 4 with 4 indicating Very High importance) are addressed:

Instream biota: Rare & endangered

Instream biota: Unique

Instream biota: Intolerant to no flow

Instream biota: Intolerant physico-chemical changes

Instream biota: Species/taxon richness

Instream habitat: Diversity of types and features

Instream habitat: Refugia and critical

Instream habitat: Sensitivity to flow changes

Instream habitat: Migration route

Riparian/wetland biota: Rare and endangered

Riparian/wetland biota: Unique

Riparian/wetland biota: Intolerant

Riparian/wetland biota: Species/taxon richness

Riparian/wetland habitat: Diversity of types and features

Riparian/wetland habitat: Refugia and critical

Riparian/wetland habitat: Sensitivity to flow changes

Riparian/wetland habitat: Migration corridor

National parks, wilderness areas, reserves, heritage sites, natural areas

Three additional columns were added to the EIS model. The first column indicated whether the node lies in a NFEPA (y or n). The second column indicates whether this assessment confirmed the NFEPA and a comment is provided in the last column. Note that although many of the NFEPA areas were not confirmed, they were still retained as a viable node if the NFEPA area represented a specific part of the catchment or physical surveys were undertaken in these areas and important information was available.

- REC worksheet is provided which includes the following:
  - Column C & D: PES score and Ecological Category copied from the PES sheet.
  - Column E: PES metric that score a three or higher. This is summarised from the PES sheet
  - Column F: Copy of the impacts from the fact sheet relevant for this SQ only
  - Column G & H: Indicates whether the key (dominating) impacts are flow or non-flow related. This is important as it informs the setting of objectives and whether improvement, if required, is possible with adjustments of flow.
  - Column I and J: Copy of the IES score and EIS evaluation.

- Column K: Provides the metrics which score a three or higher.
- Column L and M: Provides the Socio-Cultural score out of 5 and modified to be out of 4 so that it is comparable to the EIS.
- Column N: Important use of G&S. This will summarise any of the important identified G&S on the G&S work sheet. If there is none, the column stays blank.
- Column O – S: Hidden column that calculates the EI from the PES, EIS and SCI scores. The evaluation is provided in column T.
- Column T: Proved the EI evaluation in terms of Low to Very High.
- Column U: Provides the Recommended Ecological Category. This value is derived from all the other information provided on this worksheet and the basic rule followed to determine whether the REC should be an improvement of the PES is as follows:

  If the PES is below a D, then the REC should at least be a D. The restoration potential and attainability of this should be considered and should be commented on in the next column.

  If the EI is High or Very High, the REC should be improved if the PES is lower than a B EC. If the PES is a B or higher, it is in a good enough condition that improvement is not required.
- Column V: This summarises the actions that would be required to either maintain or improve the PES. These statements are derived from the information provided in this work sheet regarding the causes and sources of the deviation of the PES from natural. This column will not be discussed further in this document as it will be used later in the study.
- Column W & X: Using all the preceding information, it provides the EWR rule that should be used to estimate the EWR. Comments if applicable are provided in Column X.

- The last worksheet is the Goods and Services and the Goods and Services for each node and SQ reach is supplied. This work will be further explained in the appropriate sections.

For the nodes identified based on NFEPA status alone, Google images were downloaded and included in the fact sheet. Based on these images, and input from the riparian vegetation and instream specialists, a decision was made whether the NFEPA actually represents an important area. If it was decided that the node was superfluous, the node was not assessed further. The information is documented either on the Fact sheet next to the Google images, and/or on the EIS sheet (last columns).

Table 2.1: Example of the metrics used in the fact sheet

METRIC (1)	METRIC (2)	METRIC (3)
Abstraction (run-of river)/increased flows	Feedlots	Runoff/effluent: Industries
Agricultural lands	Forestry	Runoff/effluent: Irrigation
Algal growth	Inundation	Runoff/effluent: Mining
Bed stabilisation	Industries,	Runoff/effluent: Urban areas

METRIC (1)	METRIC (2)	METRIC (3)
Canalization	Inter-basin transfers	Sedimentation
Chicken farms	Irrigation	Small dams (farm)
Crossings low water	Large dams	trampling
Erosion	Mining	Urbanization
Exotic aquatic macrophytes	Natural areas/nature reserves	Vegetation removal
Exotic vegetation	Recreation	
Fire (rated if site is burnt)	Roads	

The following specialists provided input into the EcoQuat model:

- Delana Louw and Shael Koekemoer: Fact sheet, Google images, Bed modification, Flow modification, and summary.
- Piet Kotze and Rob Palmer: All instream biota metrics in the PES and EIS models.
- James Mackenzie: All riparian metrics in the PES and EIS models.
- Patsy Scherman: Water quality input in the PES model.
- Greg Huggins: SCI and Goods and Services input.

2.4 SOCIO-ECONOMIC ASSESSMENT

The socio-economic assessment includes two areas namely; the socio and the macro-economic fields. The macro-economic assessment which forms part of the "Classification of Significant Water Resources in the Upper, Middle and Lower Vaal WMAs" was performed to determine the present state of the economic situation in the Units of Analysis. The focus was on those sectors with high water usage, such as irrigation agriculture, mining, heavy industry and power generation. It is represented by means of an estimation of the gross domestic product (GDP) and the number of employment opportunities. These impacts are determined in respect of the direct, indirect and induced effects which sums the total impacts. Another indicator used, is the distribution of income which is provided by the economic activities. This was estimated for the high, medium and low income groups that sums the total household distribution. The GDP indicator represents the economic growth evolving from these user groups. The employment and the income distributor indicators signify the alleviation of poverty.

The modelling systems used are the Water Impact Model (WIM) (**Section 2.4.2**) as well as the Production Industry Model (PIM) (**Section 2.4.3**), which is based on the South African Inter-industry Model (SAFRIM), to make it more Water Management Area (WMA) friendly. Al three of the models is underpinned by a Social Accounting Matrix (SAM) to determine the different economic impacts on the applicable Units. The national SAM was originally compiled by Statistics South Africa, and was later development into provincial SAMs by Conningarth Economists in conjunction with the Development Bank of Southern Africa (DBSA), South African

Reserve Bank (SARB) and National Treasury. The procedure to be followed with the scoring system for the classification of the rivers is discussed in **Section 2.4.4**.

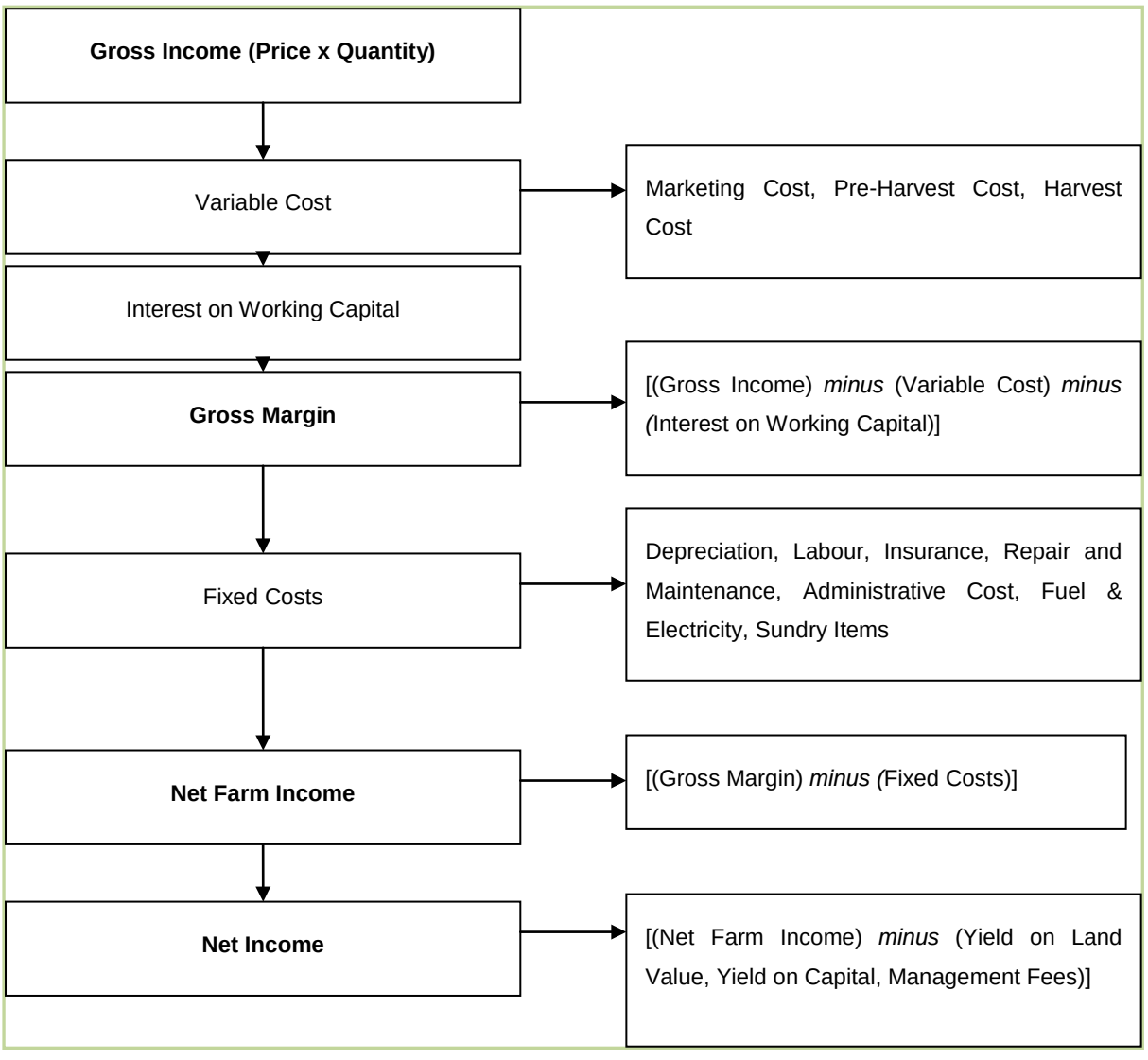
2.4.1 Preparation modelling for the WIM

2.4.1.1 Agricultural Production Budgets

The use of the WIM model is restricted to irrigation. A standard SAM is restricted to a maximum of seven agricultural products. The only irrigation crops included are the three most important fruit crops – citrus, deciduous and grapes. The WIM was therefore developed to accommodate up to ten irrigation crops.

To prepare the preliminary inputs required from irrigation agriculture, Computer Based Budgets (COMBUD) produced by the Department of Agriculture, now the Department of Agriculture, Forestry and Fisheries, were adapted and updated for the use of the WIM-model. **Figure 2.1** below shows its components.

Figure 2.1: Irrigation Budget Structure



In addition to the use of the macro-economic impacts determination, these costs in the budget are allocated to structures in such a way that it is assigned to the different sectors of the economy as reflected in **Table 2.2** below. These are applied to determine the direct, indirect and induced effects.

Table 2.2: Structure of Production Costs

Total costs (Intermediate inputs and labour requirements)
Agriculture
Mining
Manufacturing (Fuel, Fertilizer, Pharmaceuticals and Other)
Electricity
Water
Construction
Trade and accommodation
Transport and communication
Financial and business services
Community services
Salaries and wages: (Skilled, Semi-Skilled and Unskilled)

2.4.1.2 Secondary Inputs for WIM-model

The inputs identified as secondary inputs (refer to list in **Table 2.3**) were also prepared for the WIM.

Table 2.3: Secondary inputs for WIM

Items	Sources
Number of hectares	Schoeman and Partners, Loxton and Venn study
Water usage per hectare [m^3]	Water Resource Yield Model (WRYM)
Tons per hectare	Determine by crop budget
Labour requirements per hectare [Numbers]	Department of Agriculture
Annual capital requirements per hectare [Rands]	Adjusted by Mechanisation Guide, PK Le Roux 2011 and Conningarth Research

The number of hectare water volumes used in the WIM was sourced from measurements made by Schoeman and Partners in the Upper Vaal and for the Middle and Lower Vaal the Loxton and Venn study were used. It was provided by quaternary catchment level and allocated to the specific Units of Analysis (UA) provided by the project team members responsible for the classification of the eco-systems. For purposes of the model design and relevance for the analyses, the groups of crops listed in **Table 2.4** were used that totalled the irrigation

agriculture sector.

Table 2.4: Structure of Production Costs

Irrigated Crops	Reasons for allocation
Maize	Staple food planted in many of the units
Wheat	Staple food planted in many of the units
Lucerne	Crops planted for food stock for animals in large quantities in the units
Pastures	Vegetation for livestock and other animals
Ground Nuts	Prominent crop in especially the Middle and Lower Vaal
Fruit	Represent trees such as citrus and other related structures applicable
Summer Vegetables	Vegetables harvested in the summer months such as the Cucurbits group i.e. melons and pumpkins
Winter Vegetables	Vegetables harvested in the winter months such as the Brassica group i.e. broccoli and cabbages

2.4.1.3 Immersed Inputs for WIM-model

In addition to the Preliminary and Secondary Input Requirements, a further level of Immersed Inputs was also embedded in the modelling system. For this component the Social Accounting Matrix (SAM) was used as an application. These immersed inputs consist of an array of multipliers deduced from the appropriate provincial SAM and are crucial in calculating the macro-economic and socio-economic impacts emanating from water re-allocations across individual water users in the different sub-systems.

As this is a large land cover to be analysed in this study and as South Africa is a country with distinctly different economic spheres of activities, the representative SAMs were used for the different economic areas identified. The SAMs that were used for the purposes of this study were for Mpumalanga, Gauteng, Free-State and Northern Cape.

2.4.2 The Water Impact Model (WIM)

2.4.2.1 Description of the WIM

Although reduced water allocation and/or lowering assurances of supply will directly impact on water users, there are also broader macro-economic implications at a regional level. In order to assess the indirect impacts of re-allocation of water a WIM developed by the project team, was constructed for each tributary and main stem. This model is based on Input-Output analysis. The economic model is based on a social (i.e. low income household, employment and levels of income) and financial contribution made by water users with specific water allocations. Gross revenue, gross margins, cash returns and net profits calculated for the base case will be used to compare with the gross revenues and margins of the other allocation scenarios. One of the key inputs is the water allocation to each sector which is taken from the Water Resource Planning Model (WRPM) database as a basis.

The WIM was structured in economic zones and restructured into units of analysis in this main study which comprises the quaternary catchment in the specific tributary or catchment. It is structured to determine the implications of sectoral changes in water allocations to the social and economic well-being of the communities in the economic zone. In doing so, the impact of changes in water use patterns can be uniquely measured for each water user sector in the economic zone and comparative analyses between various user sectors can be performed in terms of the economic impacts emanating from each water re-allocation scenario.

2.4.2.2 Economic Multipliers

All economic models incorporate a number of "multipliers" which constitute the nucleus of the modelling system. The nature and extent of the impact of a change in a specific economic quantity (e.g. exports) on that of another economic quantity or quantities (e.g. production output or employment) is determined by a "multiplier".

A multiplier summarises the total impact that can be expected from any change in a given economic activity. **Figure 2.2** illustrates the multiplier concept which was used in assessing the change in an economic activity within a WMA for changes in the available water resources to the users in their undertaking of economic production.

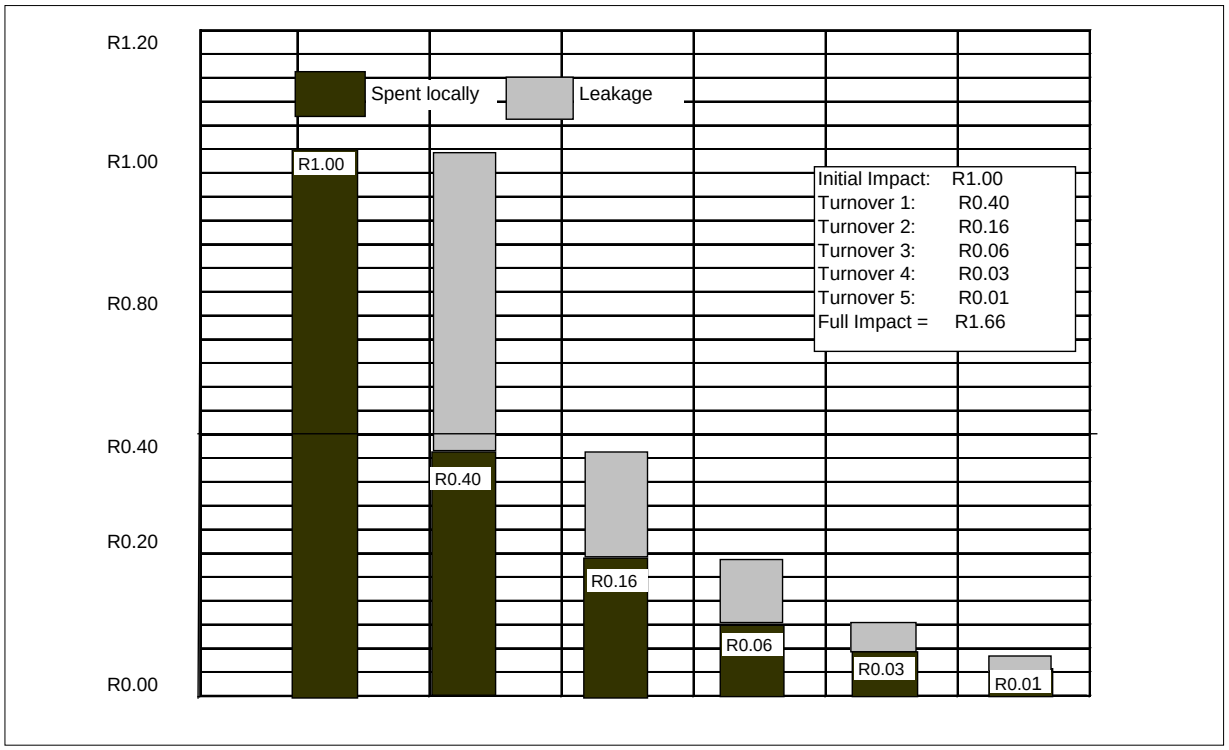


Figure 2.2: Multipliers and Turnover

One Rand is received into the local economy of a Water Management Area (WMA) from sales beyond the WMA borders. Of this one Rand, 40 cents is spent for goods and services within the WMA. The economic sectors and individuals who receive the 40 cents spend 16 cents within the WMA. Of the 16 cents, only six (6) cents is spent locally and so on. The total amount of money received by local firms and residents as a result of the initial

one Rand in added exported earnings is R1.66. Therefore the multiplier is R1.66.

The change in economic activity resulting from the change in one factor of production, such as water resources, is measured by different multipliers. Four multipliers are commonly used to assess the impacts of an initial increase in production resulting from an increase in sales, usually called final demand in a multiplier analysis. The four multipliers are: (1) Output, (2) Employment; (3) Income; and (4) Value Added Multipliers.

2.4.2.3 Calculation of Multipliers

Sectoral multipliers are calculated using information contained in the applicable Provincial Social Accounting Matrix (SAM), the National RSA SAM and data obtained from the Reserve Bank of South Africa and Statistics South Africa. These inverse matrices capture all of the direct and indirect relationships among the inputs and outputs of the various entities included in the applicable provincial SAM.

Direct GDP, labour and capital multipliers for each sector are calculated using the following formula:

$$\text{GDP multiplier} = \frac{\text{Value Added}}{\text{Production}}$$

$$\text{Labour multiplier} = \frac{\text{Employment}}{\text{Production}}$$

$$\text{Capital multiplier} = \frac{\text{Capital stock}}{\text{Production}}$$

These Multipliers were incorporated into the Water Impact Model and used to calculate the macro-economic impacts.

When using a SAM for the applicable unit of analysis, the above multipliers can be calculated. The multipliers that were used in this study to determine the economic impacts are as follows:

- Economic growth (i.e. the impact on GDP).
- Employment creation (i.e. the impact on labour requirements).
- Income distribution (i.e. the impact on low-income, poor households and the total income households).

A breakdown of the different effects of the agricultural sector multipliers used in this study is as follows:

- Direct Impacts: Refer to effects occurring directly in the agriculture sector.
- Indirect Impacts: Refer to those effects occurring in the different economic sectors that link backward to agriculture due to the supply of intermediate inputs, i.e. fertilisers, seeds, etc.
- Induced Impacts: Refer to the chain reaction triggered by the salaries and profits (less retained earnings) that are ploughed back into the economy in the form of private consumption expenditure.
- Total Impacts: Refer to the direct, indirect and induced summed effects.

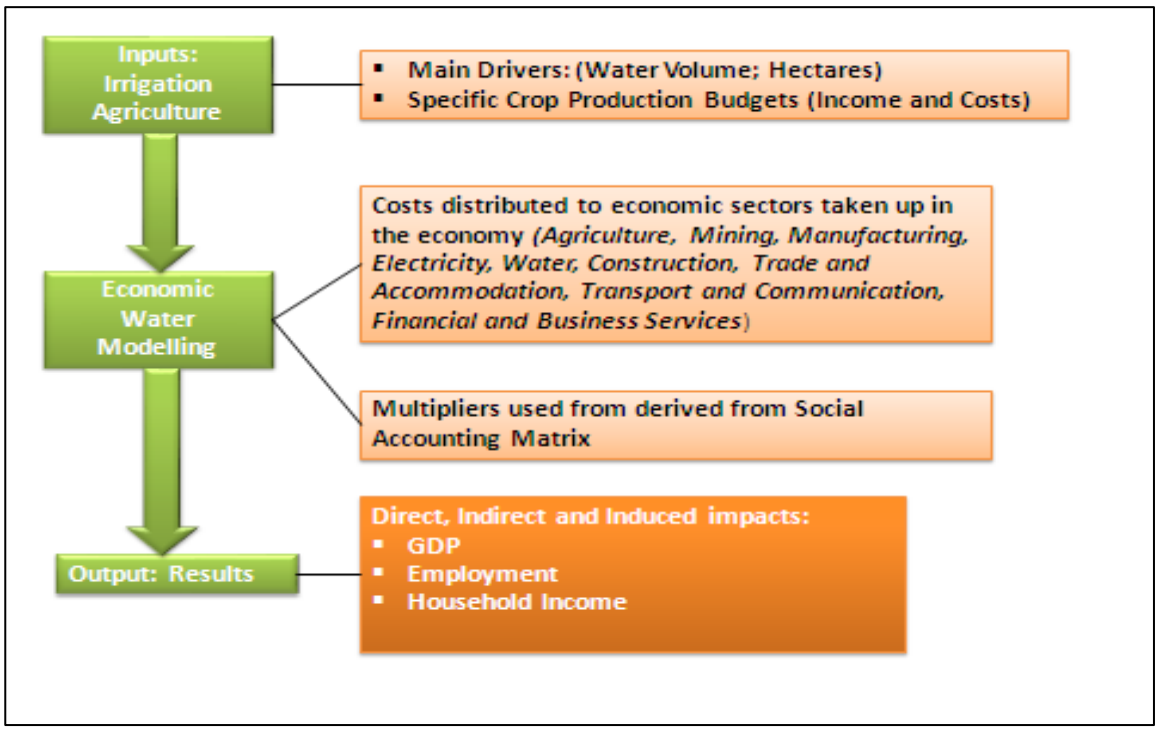


Figure 2.3: Schematic representation of the WIM

2.4.3 Approach for Production Inputs: Production Industry Model (PIM)

The Production Industry Model (PIM)[1], developed by Conningarth Economists from the SAFRIM model, used in this study identifies economic activity (measured as production output) for the national economy, as well as at the Magisterial District [2] level for the 2010.

The PIM captures the integrated nature of the South African economy in terms of the linkages that occur between economic sectors and households throughout the national economy and between geographical areas as represented by the Magisterial Districts. Furthermore, the model also captures the linkages that exist between the South African national economy and its international trading partners by incorporating imports and exports into the model. As such, the forecasts produced by the PIM are based on macro-economic data which provides a 'top-down' perspective on the broader national economy.

The output of the PIM was compared with that produced by the strategic socio-economic study undertaken by Conningarth Economists. In this way it was possible to compare the results of a bottom-up and a top-down approach to forecasting economic activity, and with the result of it being possible to produce more accurate and

[1] ESKOM: Thabile Engineering – 2008- Economic Modelling for the Load Forecast and Strategic Study of the Watershed Network Master Plan.

[2] It is important to note that the Magisterial Districts used in this study have been derived from Census 2001 data. As such, these Magisterial Districts reflect their old, original names and boundaries.

more reliable forecasts for the production demand.

The sectors to be focussed on in this study include mining, manufacturing, electricity and construction. The magisterial districts were superimposed on the Units of Analysis in the three areas of the Upper, Middle and Lower Vaal. In was further divided into the sub-units of each of the main units of analysis. In such cases of non-conformity, either a realistic percentage division was made of the municipal district as applicable to the sub-units.

A schematic representation of the PIM is shown below in **Figure 2.4**.

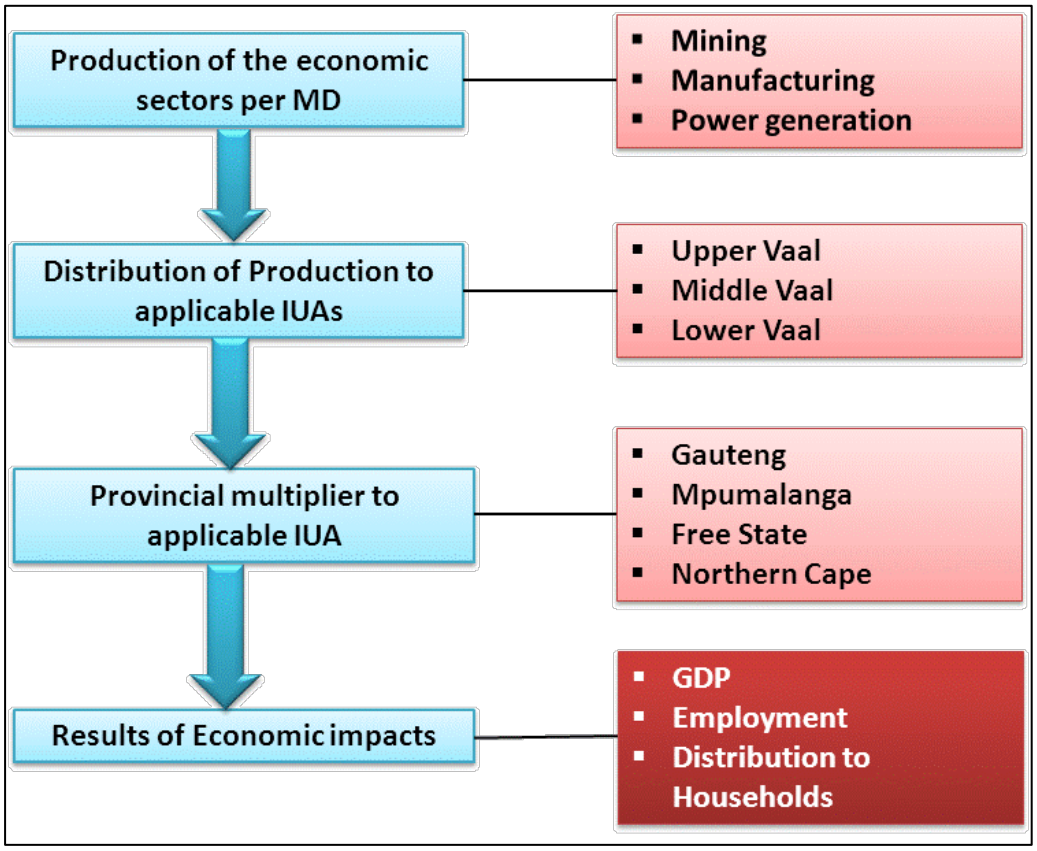


Figure 2.4: Schematic representation of the PIM

2.4.4 Scoring System

2.4.4.1 Purpose

The purpose of the Scoring System is to develop an objective evaluation system to reflect changes in water volumes on the classification of the river system, be it positive or negative.

The elements used are:

- Ecological condition.

- Economic Impact.
- Social Impact.

2.4.4.2 Approach to the Scoring System

- The eventual choice of the different eco-system values will be based on a matrix that allows attaining the maximum value for both users, inside and outside the river including the in stream ecological condition.

- The matrix to be developed will list all the values and then involve a group of knowledgeable people from both groups inside and outside the river to populate the matrix. All aspects that may have an effect on a change of a class that is analysed by each field studied in this project will be part of the evaluation criteria.

- The original concept was developed in a pilot project in the Olifants-Doorn River. For this study the concept is adapted for a highly industrialised Basin.

- The methodology proposed, is the Delphi approach where a number of specialists populate "Matrix 1" with approximate monetary values for the different environmental functions the water fulfils while in the river. As it is not always possible to quantify these values in monetary numbers an indirect approach will be followed. The monetary value of the water expressed in terms of the irrigation value at the EWR point will be used as proxy to estimate the value of the in river value of the water.

- In "Matrix 2" weights are allocated to the different items which represent the relative importance of the specific in river service provided by the water as assessed by the participants, which are then multiplied with the first matrix to get "Matrix 3" with answers.

The following is a short practical explanation of the above methodology. In the following table a description of the application of one of the main stem or tributary zones is given. **Table 2.5** presents the weights allocated for the different sections of a certain zone that will be converted to monetary values (note that the weights will differ from zone to zone).

Table 2.5: Allocated weights

Field of Analysis	Weight	Monetary Value
Irrigation	20%	R50 mil.
Goods and Services	10%	(50x(20/10)) = R25 mil.
Ecological	70%	(50x(70/20) = R175 mil.
Total:	**100%**	**R250 mil.**

The individual values for the Ecological Analysis are presented in **Table 2.6** below. The weight allocation is per EWR point and done by the ecological team, this is then used to distribute the monetary value estimated above between the fields of analysis.

Table 2.6: Weight allocation and associated monetary value

Ecological Service by the Water	Weight Allocation	Monetary Value
Instream Biota	20%	R35.00 mil.
Instream Habitat	15%	R26.25 mil
Riparian/wetland biota	25%	R43.75 mil.
Riparian/wetland habitat	30%	R52.50 mil.
National parks, wilderness areas, reserves, heritage sites, natural areas	10%	R17.50 mil.
Total:	**100%**	**R175.00 mil.**

These monetary values are then used together with the present volume of water in the macro – economic model to determine the macro parameters. The proposed scenario is expressed in terms of the new allocated volume of water which is then fed into the model. The model then provides a new set of indicators per field of analysis which is then used to determine a possible score change.

The calculation of a specific scenario, based on the weights allocated, is demonstrated in **Table 2.7**. Note that the field items would be updated for the Vaal system, as the table below is presented for demonstration purposes only.

Table 2.7: Example of the results calculation

Field	Field Items	% Change in Monetary Values
Ecological	Instream Biota	13.85%
	Instream Habitat	8.85%
	Riparian/wetland biota	9.97%
	Riparian/wetland habitat	12.23%
	National parks, wilderness areas, reserves, heritage sites, natural areas	11.50%
Goods and Services	Recreational Fishing	2.06%
	Subsistence Fishing	1.61%
	Other recreational aspects associated with the rivers	1.68%
	Riparian vegetation usage	2.58%
	Waste water dilutions	1.64%
	Floodplain agricultural usage of subsistence purposes	1.04%
Economics	Irrigation Agriculture	-14.93%

The above table only presents the results in monetary value while the final results will be presented in terms of macro – economic indicators, namely:

- Gross Domestic Product (GDP),
- Employment opportunities,
- Payments to Households.

In the final instance it will possible to compare possible gains from the environmental services with the possible losses that irrigation agriculture may suffer.

The present classification system makes provision for a class change every 10%, therefore, a 10% score change will necessitate a changed classification.

It must be kept in mind that Table 2.7 above table is an example and that the subdivisions is not finalised as yet.

2.4.4.3 Evaluation Criteria

The following criteria are to be considered:

- Detailed criteria per zone.
- Economic impacts.
- Water quality.
- Environment.
- Goods and services.
- Carbon sequestration.
- Flood attenuation.
- Waste treatment.

2.4.4.4 Result Interpretation

The interpretation of the results is based on the following:

- That each EZ has already been allocated an environmental classification (REC) – A-D and a Management class 1-3.
- The current scores to be converted to the allocated class.

Any change in water allocation to be converted by the model and interpreted in terms of a possible change in class.

2.5 GOODS AND SERVICES ASSESSMENT

2.5.1 Methods used to Assess Goods and Services

Information on the Goods and Services (G&S) of the Vaal River is available and has been used as a basis for this purpose. It should be noted that the objective in describing and valuing the use of aquatic ecosystems is to determine the way in which aquatic ecosystems are currently being used in each socio-economic zone, and to estimate the value generated by that use. This provides the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared.

By way of summary the most salient socio-economic characteristics for each of the three Water Management Areas (WMAs) is presented.

The Upper Vaal WMA is economically one of the most important in the country and nearly 22% of the GDP of South Africa originates from the Upper Vaal WMA. Only the adjacent Crocodile (West) and Marico WMA, with about 24%, contributes more to the Gross Domestic Product (GDP). The contribution of the different sectors to the Gross Geographic Product (GGP) in the Upper Vaal WMA reflects a diversified economy with a strong

industrial and financial base. Despite the large areas under cultivation, agriculture only contributes about 2% of the GGP. Agriculture, however, has important linkages to other sectors and provides livelihood to a large proportion of the rural population. The average income for the Upper Vaal WMA is in line with the national average of around R18 000 per capita per year. This is however highly skewed and the urban poor make up a large percentage of the WMA.

The demography of the WMA will be influenced by economic opportunities and potential. Projections are therefore for continued strong growth in urban population in the sub-area downstream of Vaal Dam where most of the economic activity is centred. A decline in population is projected for the Wilge sub-area due to the movement of people out of Phuthaditjaba and the former QwaQwa area. Overall the area is growing at a rate in excess of the national average. The potential for future growth in this WMA remains strong. Growth will largely be attracted to the already strong urban and industrial areas in the Johannesburg- Vereeniging-Vanderbijlpark complex. New mining developments will mainly replace worked out mines with a long term decline expected in this sector. There is however potential for further development of coal mining on the Eastern Highveld and in the Vereeniging area downstream of Vaal Dam.

Mining is critical to the WMA and products of the mining industry in the Upper Vaal WMA include coal, precious metals (gold, uranium, etc.), base metals, semi-precious stones and industrial minerals. The major impact of the mines on the water resource is the water pumped from the mines to dewater the underground workings mainly of the gold mines. The salinity loads associated with these mine discharges together with the sewage return flows contribute significantly to the salinity problems that are experienced in the Vaal Barrage and downstream river system. The mine dewatering and the diffuse salinity contributions from the highly developed urban and industrial areas in the Vaal Barrage catchment has resulted in the need for the currently applied blending and/or dilution operating rules applied downstream of Vaal Dam.

Major industries in this WMA include Sasol I (Sasolburg), Iscor, Sappi, AECI and Sasol Synthetic Fuels (SSF) (Secunda). Sasol 1 is located in the Free State province near Sasolburg and abstracts water from the Vaal Barrage. The production of petro-chemicals is the main activity. Iscor is located near Vanderbijlpark and is supplied with water from the Vaal Barrage. The production of iron and steel products is the main activity. SSF are located in Mpumalanga Province near the Secunda urban area. Water for SSF is supplied by pipeline from Grootdraai Dam. The production of petro-chemicals products is the main activity. Other important industries such as Sappi and AECI receive water from the urban centres where they are located. All these industries are economically important and provide significant employment. There are three operational coal fired power stations located in the WMA. The power stations are the Lethabo, Tutuka and Majuba Power Stations.

Irrigated farmlands are an important feature of the WMA. About 75% of the irrigation is upstream of major storage dams and are supplied from run-of-river or farm dams. These areas will be supplied at a lower assurance of supply than the irrigation areas located in the Mooi sub-catchment (Mooi Government Water Scheme, Klipdrift and Vyfhoek Schemes) and Barrage to Mooi sub-catchment (Rietpoort and Koppieskraal Irrigation Boards) which are supported by major dams and conveyance infrastructure.

Land use in the south and east is dominated by cultivated dry land agriculture with the main crops being maize and wheat. Beef and sheep farming is range extensive. The use of water for recreational purposes is important

in the WMA. The dams in the WMA, particularly the Vaal Dam are important recreational zones.

While the Vaal system is important in terms of its extent this is tempered by the nature of settlement in the area. In terms utilisation of and dependence on goods and services the area is home to few communities for whom these resources would be important. The urbanised nature of the catchment and the fact that the bulk of the residents live in settlements where livelihoods are linked to economic modes of production that are not linked to direct resource dependence is evident. Further the areas dominated by relatively low population densities and given over to commercial farming enterprises (typically the upper parts of the catchment) as well as portions of the middle catchment also tend to score relatively low in terms of dependence on goods and services. An obvious exception is recreational use. The dams as well as the settlement below the Vaal Barrage have important values associated with river linked recreational services. An additional benefit that of the service delivered by riverine systems in terms of pollutant dilution is also important in some areas. The single other marked exception to this rule in the WMA is that part of the Wilge River in the former homeland area of QwaQwa. Even here the altered nature of the environment and degree of residential development means that the bulk of people, arguably constituting a displaced working class, do not make as much use of goods and service delivered by the riverine system.

The Middle Vaal WMA is located downstream of the confluence of the Vaal and the Rietspruit Rivers and upstream of Bloemhof Dam. It extends to the Schoonspruit River in the north and the Vet River in the south, and covers a total catchment area of 52 563 km^2. The Middle Vaal WMA incorporates portions of the Free State and North-West Provinces and is, therefore, important to the regional economies of these provinces. Major rivers in the Middle Vaal Water Management Area include the Schoonspruit, Renoster, Vals, Vet and Vaal rivers.

Settlement patterns within the Middle Vaal WMA are dispersed and extensive dryland agricultural practices take place throughout this WMA. Major towns and urban areas in the Middle Vaal WMA include Klerksdorp, Kroonstad, Welkom and Virginia.

Primary sector activities such as mining and agriculture accounted for approximately 55% of the areas total GDP in 1997 (DWAF, 2002). Of this total, mining activities accounted for approximately 46%. Major mines in the area include Anglogold's Great Noligwa, Kopanang, Tau Lekoa and Moab Khotsong mines and Harmony's Tshepong and Virginia mines. According to Van Vuuren (2008), few of the gold mines within the Middle Vaal WMA have a secure future beyond 2010, although the resource base could potentially support mining up to 2030. Mine dewatering and the discharge into the river systems have a negative impact on water quality within this WMA.

The Lower Vaal WMA is located downstream of Bloemhof Dam and upstream of Douglas Weir. It extends to the headwaters of the Harts, Molopo and Kuruman River in the north and the Vaal River Downstream of Bloemhof in the south. It covers a catchment area of 51,543 km^2 and lies in the North West and Northern Cape Provinces, with the south-eastern corner in the Free State, and borders on Botswana in the north, as well as on the Crocodile (West) and Marico, Middle Vaal, Upper Orange and Lower Orange water management areas.

Primary agriculture is the major economic activity in the Lower Vaal WMA. Water is supplied from the Vaal River main stem via the Vaal-Harts Weir to the Taung and Vaalharts Irrigation schemes under which 6 000ha and 32 000ha of irrigated land are cultivated, respectively. Commonly produced crops include a mix of high and low

value crops such as maize, wheat, lucerne, table grapes, citrus and peaches. DWAF (2002) note that approximately 80% of the water released from the Upper Vaal WMA is used for irrigation purposes and that only irrigation return flows and flood flows reach the confluence with the Orange River. In terms of provincial context, the Middle and Lower Vaal WMAs also have an important role to play in the provincial economies. The Middle Vaal WMA extends from the Gauteng, North West and Free State Provinces whereas the Lower Vaal WMA extends over the North West and Northern Cape Provinces.

It is important to point out that while EGSAs will be identified and described in qualitative terms, a baseline value can often only be described for some of these, as the information required, is not available without investing in a costly survey. This is particularly so for the Vaal System that is densely populated and consists of a complex array of highly disparate social groupings but almost certainly relatively few communities or population groupings that are dependent on EGSA for their livelihoods. As such it is, therefore, more practical to measure changes in EGSA values relative to a reference point rather than computing a baseline value. For the purposes of this exercise the baseline value is described as a value of 1. The most important goods and services associated with the overall system and likely to be impacted by changes in operational and management scenarios are the following:

- Recreational fishing;
- Subsistence fishing;
- Other recreational aspects associated with the rivers;
- Riparian vegetation usage;
- Waste water dilutions; and
- Floodplain agricultural usage of subsistence purposes.

These have been identified from an analysis of the Reserve Determination reports available. The reports covering the Upper, Middle and Lower Vaal rivers included analysis of goods and services. The reports were supported with primary fieldwork to critical areas. In addition a second analysis based on the typology of settlements in the area and their likely associated dependence on Goods and Services for livelihoods was undertaken for this report. This was sourced from information available from Statistics South Africa and cross referenced with an examination of aerial photography, largely that provided by Google Earth. This allowed for an analysis of land use types associated with the settlement typology.

Furthermore, each quaternary catchment of the Vaal has been examined in detail via the analysis of Socio-Cultural Importance. The Socio-Cultural Importance (SCI) was determined from:

- a site visit that covered points long the river;
- extrapolation to sites not visited by reference to available literature as well as to exiting mapping.

Given the size of the budget and the geographical scope of the work most of the information used to influence the score was derived from direct observation and consideration of the literature available. A limited number of direct interviews were held with people who are resident proximate to the river. A key component of the SCI

model is the category "Resource Dependence". This refers to the Goods and Services delivered by the river system and people's dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. The categories "Recreational Use" and "Ritual Use" were also examined. The SCI model was compared to the evaluation of likely areas of importance with regard to Goods and Services. For the purposes of this report the analysis of Goods and Services at a quaternary level was aligned with the Integrated Unit of Analysis (IUA) approach adopted. Results are set out in **Sections 4**, **5** and **6**.

In addition recreational usage and in particular recreational fishing, that is not associated with settlement type and direct livelihood dependence was also identified as a key aspect of goods and services utilisation.

In the Upper Vaal the value of recreation associated with the dams is high. The Vaal Dam is a highly developed recreational area. Estimates are that the number of visitors attracted to the Vaal Dam area exceeds 300 000 per year. In addition the dam offers a high value residential opportunity. Equally important are the areas adjacent to the Vaal Barrage. This is also home to a number of properties that rely on the dam for their high value. Downstream of the Vaal Barrage and culminating in the town of Parys are residential, leisure and sporting developments that depend on the Vaal River and the operational parameters of the dam and barrage for their high value. Fishing is important as are boating and canoeing.

In the Middle and Lower Vaal WMA's recreational angling is an important ecosystem service supplied by the Vaal River System. Yellow fish (*Labeobarbus* spp.) is one of South Africa's most important angling and sport fishing species (**De Villiers, 2007a**; **2007b**) and is an indigenous South African fish species, widely distributed throughout the Orange-Vaal River system.

The two most common species of Yellow fish are the Orange-Vaal Small-mouth (Labeobarbus aeneus) and the Orange-Vaal Large-mouth (*Labeobarbus kimberleyensis*). According to Brand et al. (2009) Yellowfish are attractive, reach a large size, and are considered to be an excellent game fish. Their study on the economic and social use value of Yellow fish in the Vaal River found that Yellow fish were a targeted angling species for approximately 5,000 anglers. They estimated the total value of the Yellow fish dependent fishing industry in the Vaal River at R133 million per annum. This total value comprised the equipment sector (estimated expenditure of anglers on fishing and associated equipment) with R14.6 million, the travel sector (estimated expenditure of anglers on travel to and from fishing areas along the Vaal River) with R41.4 million, the accommodation sector (estimated expenditure of anglers on angling related accommodation) with R75.5 million.

The results of the study on the total economic value of Yellow fish in the Vaal River by Brand *et al*. (2009) showed that much of the total expenditure by anglers are on accommodation, equipment and travel. Little of the total cost is spent on memberships and other activities. The study also suggested that a link between the social and economic benefits of Yellow fish conservation in terms of improved livelihoods and local economies from Yellow fish angling and related activities exists.

It should be noted that only the Goods and Services that are deemed likely to be impacted by mooted operational scenarios will be costed and analysed. Analysis of goods and services not deemed to be at risk would be pointless.

2.5.2 Delineation of the Units of Analysis and Description of the Status Quo

The zone (delineation) that was applied in the Vaal River System in the Reserve Determination study consisted of the following components:

- Vaal River main stem representing all water users receiving water from the Vaal River and supporting systems.
- Vaal River Eastern Sub-system (Grootdraai Dam and linked water resources).
- Tributary river catchments including: Sand–Vet, Vals, Mooi, Schoonspruit, Renoster and Harts river catchments.

Two approaches could be considered with respect to a delineation and analysis of the socio-economic units that make up the three WMAs. The first was to divide society into relatively homogenous communities through delineating socio-economic zones and describing community wellbeing within each zone. The objective of the catchment socio-economic zones would then be to estimate and report on the implications of different catchment configuration scenarios on social wellbeing, economic prosperity and ecosystem health at an appropriate spatial scale. The second was, in accordance with the concept of Integrated Units of Analysis (IUA's) to divide the WMAs into zones that reflect the IUAs as developed by the overall team approach.

From the perspective of ensuring greater harmonization of approach and making analysis more consistent this second approach has been followed with respect to the goods and services. Results are discussed in **Sections 4**, **5** and **6** below. The first approach has been restricted to analysis at the level of recreational use with respect to **Step 1(g)**.

2.5.3 Present Status of the Goods and Services in the Catchment

Data as captured in the reports for the Comprehensive Reserve Determination Studies undertaken for the Upper, Middle and Lower Vaal River systems has been used as a basis for this section. The profiles presented in these reports have been summarised and updated where relevant. In terms of updating the reporting the most important step was to generate more detailed an integrated assessment of the current population of all three areas. This was deemed necessary as much of the data included in the comprehensive reports relied on population analysis undertaken in 2006/2007. The population data was also re-analysed to generate an overview of the populations most likely to be inside the overall catchment area and be dependent on the goods and services. This analysis becomes important for some of the subsequent steps in the analysis. Analysis was undertaken using the following three primary tools:

- The 2001 census as adjusted.
- Geographic Information System (GIS) overlays of quaternary catchments and the census "sub place name" data. "Sub place name" data fields are the most detailed subsets of data released by Statistic

South Africa. This allows for the population for each quaternary to be calculated and a profile of the population for each unit to be analysed. Data was analysed to select areas in which populations likely to be dependent on riverine goods and services were possibly or probably present.

- Cross check of the GIS data sets with available mapping to determine likely livelihood styles and profiles.

Although the 2001 census remains the most recent national population data set it is now out-dated. In order to compensate for this data is adjusted using derived population growth rates. These rates were used to update the data. It should be noted that local drivers, usually economic, cannot always be built into these extrapolated calculation. The overall population for the catchment areas (end 2010) was deemed to be around 11 750 000. This is about 23% of the overall population of the country. Of these the vast majority (87%) are resident in urban centres and either resides in formal or informal settlement.

The Vaal River System, because of its extent, plays an important role in maintaining important Ecosystems goods and services to both on-site as well as other users. An ecosystem service is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. Natural capital and associated ecosystem services are now becoming scarce and the Millennium Ecosystems Assessment (MEA) partitions ecosystems services into four broad categories:

- Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, biochemicals, medicine, and genetic material, that are in many cases: directly consumed; subject to reasonably well-defined property rights (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are priced in the market.
- Cultural services are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (non-consumptive uses); that have poorly-developed markets (with the exception of ecotourism); and poorly-defined property rights (most cultural services are regulated by traditional customs, rights and obligations); but are still used directly by people and are therefore open to valuation.
- Regulating services are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (**Perrings, 2006**); and arethus frequently undervalued in economic markets; many of these are indirectly used being intermediate in the provision of cultural or provisioning services.
- Supporting services are an additional set of ecosystem services referred to in the MEA, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (indirectly used); and are not evaluated separately (**Mander et al., 2007**).

2.5.4 Description of the Present-day Community Wellbeing within each IUA

This is described in **Sections 4**, **5** and **6**.

2.6 WATER REALLOCATION SITUATIONAL ANALYSIS

The evaluation of the results of the three different sets of analysis, namely ecological, goods and services and socio – economic is to establish the baseline per individual section of the main stem or tributary. During the analysis it might appear that the ecological situation of certain river zones has deteriorated to a point where corrective action is necessary, e.g. actions involving an increase in water in the specific river section. The possibility arises that a negative economic impact or a cost increase might result, particularly if corrective action involves curtailing water availability to another activity.

In this regard the following assumptions have been developed and applied in the calculation of the possible socio – economic costs[3]:

- Main Stem: If in any zone problems arise the water will be augmented.
- Tributary: If in any tributary a shortage of water is experienced, it will be reallocated from the irrigation sector.

In the next two sections the implications of the two assumptions are explained in more detail.

2.6.1 Main stem – Augmentation

If in a section of the main stem of the river more water is necessary to maintain or improve the status of the ecology and water quality of a specific river section, the water will be supplied from the present available sources. However the possibility exists that this could influence the implementation date of the next augmentation scheme to supply the Vaal River system. The implementation date of the next dam in the Lesotho Highlands scheme, Polihali, is fixed and the project team has accepted that if a scheme must be brought forward, it will be the proposed Thukela scheme (refer to the Vaal River WRDP: Comparative Study Between LHWP Phase II and Thukela Water Project (**DWAF, 2008g**) for details).

The proposed approach to the estimation of the costs of bringing the augmentation project forward will rest on the principle of “time is money”. The estimated cost of the Thukela scheme is available in 2009 prices, for implementation at a certain date in future. If that date is brought forward it means money will be spent earlier and the impact on the consumer in increased rates will be payable earlier.

This cost will be calculated if the water resource analysis’ results indicate that an earlier implementation date is

[3] **RDM/WMA8C000/01/CON/0210: Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: Socio Economic Consequences of Various Operational Scenarios.**

required. The calculation per zone will be done by multiplying the necessary volume of water with the cost of augmentation per unit, expressed in 2011 prices.

2.6.2 Tributary – Economic Impact

The assumption governing tributaries is that the augmentation option will not be available and if more water is required to maintain the ecological state it will be provided from present sources. If there is a shortage, water will be reallocated from the irrigation sector. The water reallocation volumes will be determined by the water resources team. The macro – economic impact of the reallocation of water will be calculated to assist the decision making process.

2.6.3 Water Quality

Undesirable levels of water quality not only impact negatively on irrigation crop yields and quality, but also have an adverse impact on industrial water use and ecological state. For example, should there be a deterioration of the water quality within the Grootdraai Dam Sub-system more water has to be provided to Eskom through the VRESAP pipeline to ensure effective utilisation of the cooling systems of their power stations which receive water from this sub-system. Furthermore, extra costs might be necessitated by bulk water suppliers such as Rand Water which provides water to urban centres for domestic and industrial use. The costs associated with providing water of acceptable levels will be sourced from previous studies and presented where necessary. Where specific options have not previously been assessed, the cost to the user will be used as an estimate.

3 INTEGRATED UNITS OF ANALYSIS (IUAS)

3.1 APPROACH IN IDENTIFICATION OF IUAS

The identification and selection of the Integrated Units of Analysis (IUAs) were based on the following considerations:

- The resolution of the hydrological analysis and available water resource network configurations currently being modelled.
- Location of significant water resource infrastructure.
- Distinctive functions of the catchments in context of the larger system.
- Available budget for refinement of the existing network and undertaking scenario analysis of each IUA.
- The biophysical nodes and the Present Ecological State (PES) and Recommended Ecological Category (REC) for each node were also considered.

In an ideal situation it would have been preferred to have a properly calibrated higher resolution network water resource model available for use in the classification process. Such models have been developed for other systems in the country as part of Water Availability Assessment Studies where the focus was to develop installed modelling systems to support the licensing of water use. Such detailed work requires significant human resources and were not included in the scope of work to be undertaken for this study.

It has been recognised that the characteristics of individual small tributaries can significantly differ from the larger rivers and may warrant a different management class. The constraint is however that if the same intensity of investigation has to be applied for all tributaries (that is to satisfy scientific sound practice) much more time and money would be required to undertake the classification of the water resources. It was therefore proposed in the Inception Report that a practical qualitative evaluation method be applied which will only consider the ecological aspects as well as likely implications on goods and services in a qualitative manner. The identification of the tributary catchments formed part of the delineation of the IUAs (**Task 3a**).

As already described in the approach to select biophysical nodes, the results (if available) of the current PES and Environmental Importance-Environmental Sensitivity (EI-ES) would also have contributed largely to the delineation of the IUA as the proportions of the different Ecological Categories for all the river reaches could play a vital role in the delineation.

The identified Integrated Units of Analysis (IUAs) for the three Vaal Water Management Areas are shown in **Figures A-1**, **A-2** and **A-3** of **Appendix A** and are discussed in the subsequent sections.

3.2 UPPER VAAL IUAS

Figure A-1 presents the sixteen identified Integrated Units of Analysis (IUA) of which three IUAs (consisting of quaternaries C83K, C83L, C23A, C23B and C22G) as well as a portion of a fourth IUA (comprising of quaternary catchments C22H and C22J) cannot be explicitly analysed due to modelling network constraints. The remaining thirteen IUAs form the sub-catchments according to which analysis will be carried out. The above-mentioned three IUAs, as well as the tributary rivers within each of the remaining thirteen IUA, will be evaluated in a qualitative manner only.

The significant resources of the IUAs are summarised in **Table 3.1**.

Table 3.1: Summary of IUAs in Upper Vaal WMA

IUA Reference	Description of resources	Major impoundments	Quaternary catchments
UV-A	Vaal River Upstream of Grootdraai Dam	Grootdraai Dam	C11A – C11L
UV-B	Klip River (Free State)	-	C13A – C13H
UV-C1	Upper Wilge River and tributaries (Meul and Cornelius)	-	C81A, C81B, C81L, C81M, C82A, C82B
UV-C2	Wilge River and tributaries (Nuwejaarspruit and Namahadi - Elands)	Sterkfontein Dam	C81C – C81K, C82C & C82D
UV-C3	Lower Wilge River		C82E – C82H
UV-D	Liebenbergsvlei River	Saulspoort Dam	C83A – C83J
UV-E	Waterval River	-	C12D – C12G
UV-F	Krom (C83K) and Klip (C83L) flowing into Vaal Dam	-	C83K & C83L
UV-G	Vaal River reach upstream of Vaal Dam and Downstream of Grootdraai Dam	-	C11M – C12L & C83M
UV-H	Suikerbosrand River upstream of confluence with Blesbokspruit	Balfour Dam	C21A - C21C
UV-I	Blesbokspruit, Riet and Klip River (Gauteng)	-	C21D – C21G, C22A – C22E, C22H & C22J
UV-J	Taaibosspruit	-	C22G
UV-K	Kromelmboogspruit	-	C23A & C23B
UV-L	Mooi River up to confluence with Vaal River	Klerkskraal, Boskop, Lakeside and Klipdrift dams-	C23D – C23L(42%)
UV-M	Vaal River from downstream of Vaal Dam to	Vaal Dam	C22F, C22K, C23C,

IUA Reference	Description of resources	Major impoundments	Quaternary catchments
	outlet of C23L		C23L(58%)
UV-N	Groundwater: dolomite aquifers supporting the abstractions by Rand Water (Zuurbekom wells)	-	-

Figure A-1 shows the different types of EWR sites or nodes that were analysed as part of the Upper Vaal Reserve Determination Study, as well as the biophysical nodes identified as part of this study. From **Figure A-1** it is clear that there was sufficient coverage of extrapolation EWR nodes already available in the Upper Vaal.

3.3 MIDDLE VAAL IUAS

Figure A-2 presents a map of the Middle Vaal WMA and there are nine proposed IUAs which include the Schoonspruit groundwater resource (Schoonspruit Eye).

The significant resources of the IUAs are summarised in **Table 3.2**.

Table 3.2: Summary of IUAs in Middle Vaal WMA

IUA Reference	Description of resources	Major impoundments	Quaternary catchments
MV-A	Renoster River	Koppies Dam	C70A – C70K
MV-B	Vals River	-	C60A – C60J
MV-C	Schoonspruit River and Koekemoerspruit	Rietspruit and Johan Neser dams	C24C – C24H & C24A
MV-D1	Upper Sand River	Allemanskraal Dam	C42A – C42E
MV-D2	Lower Sand River	-	C42F – C42L
MV-E1	Upper Vet River	Erfenis Dam	C41A – C41E
MV-E2	Lower Vet	-	C41F– C41J & C43A – C43D
MV-F	Vaal River main stem from C24B to Bloemhof Dam	Bloemhof Dam	C24B, C24J, C25A – C25F
MV-G	Groundwater: dolomite aquifer (feeding the Schoonspruit Eye) supporting the irrigation abstractions in the Schoonspruit. (Simulation analysis will be carried out on the dolomites.)	-	-

3.4 LOWER VAAL IUAS

Figure A-3 presents a map of the Lower Vaal WMA and there are five selected IUAs. The Molopo River Catchment was not part of the Vaal River Comprehensive Reserve Determination Study. The Molopo and its tributary rivers are ephemeral and therefore cannot be evaluated with ease by following the standard reserve determination methods. The Molopo catchment will, therefore, not been assessed in the same quantitative way as all the other identified IUAs. Some work regarding ecological water requirements has recently been carried out in this area through the ORASECOM study. Information from the latter study will be evaluated in terms of its usefulness regarding the qualitative assessment of the catchment.

The significant resources of the five IUAs are summarised in **Table 3.3**.

Table 3.3: Summary of IUAs in Lower Vaal WMA

IUA Reference	Description of resources	Major impoundments	Quaternary catchments
LV-A1	Upper Harts River	Barberspan	C31A – C31D
LV-A2	Middle Harts River	Wentzel Dam	C31E
LV-A3	Dry Harts River	-	C32A – C32D
LV-A4	Lower Harts River	Taung and Spitskop dams	C31F, C33A – C33C
LV-B	Vaal River from downstream of Bloemhof Dam to Douglas Weir	Vaalharts Weir	C91A– C91E, C92A – C92C
LV-C	Groundwater: dolomite aquifer in the Lichtenburg area (simulation analysis will be carried out on the dolomites).	-	-

4 STATUS QUO OF UPPER VAAL WMA

4.1 GENERAL

The Upper Vaal WMA includes the economic hub of the country. The strategic water user Eskom, as well as Sasol, are supplied from the water resources located within this WMA. Bulk water supplier Rand Water abstracts water from Vaal Dam and supplies water to a large number of municipalities located in the Upper Vaal and Crocodile West Marico WMAs. Most of the inter-basin transfers into the Vaal River system take place within this WMA. The water quality of tributaries within the Vaal Barrage incremental catchment as well as the main stem of the Vaal downstream of the Vaal Barrage is influenced by mine dewatering/decanting and urban effluent discharges.

Results from the Vaal River Reconciliation Strategy study (**DWAF, 2008a**) indicated that there is a significant amount of unlawful irrigation water use (net use of approximately 180 million m^3/a) in the Upper Vaal. The DWA is in the process of putting legal measures in place for the eradication of the unlawful water use. Detailed information on the water requirements and return flows of individual user groups (as included in the WRPM configuration) is listed in **Table F-2** of **Appendix F**. The information in **Table F-2** is provided within the context of the sub-systems identified as part of the VRSAU study.

Information on the water reconciliation status of small towns upstream of the biophysical nodes was obtained from the All Towns Reconciliation Strategy Study (**DWA, 2011**). This information was integrated with the biophysical node catchments (refer to summarised results presented in **Table G-2** of **Appendix G**) and will be used as a qualitative indication of the water supply situation in the relevant urban areas.

4.2 UV-A: VAAL RIVER UPSTREAM OF GROOTDRAAI

4.2.1 Water Resources Assessment

The Grootdraai Dam catchment (as shown in **Figure C-1** of **Appendix C**) forms part of the Vaal River Eastern Sub-system. Tutuka Power Station (PS) is supplied with water from Grootdraai Dam and water from the dam is also supplied (through the Vlakfontein Canal) to the Sasol Secunda Complex as well as the Eskom Power Stations located in the Upper Olifants River Catchment. Grootdraai Dam is supported by transfers from the Heyshope and Zaaihoek Sub-systems as described below.

Little Vaal River (C11C)

Water is transferred from Heyshope Dam into the Little Vaal River (i.e. into the lower part of quaternary C11C) downstream of the selected EWR site referred to as RE-EWR1. The normal operating rule is to transfer water to the Vaal River system if Grootdraai Dam's storage decreases below 90%. The maximum transfer rate is 4.28 m^3/s. There may be limited flexibility in the transfer rate (lower than the maximum) if one or two of the three pump sets are used.

Skulpspruit River (C11E)

The transfer from Zaaihoek Dam discharges water into the Perdewaterspruit, which is a tributary of the

Skulpspruit (C11E). The water is released in the river system upstream of Amersfoort Dam, which is a small storage dam providing water to the town. The transfer from Zaaihoek Dam is mainly for the purpose of supplying water to Majuba Power Station and the release to Grootdraai Dam (into Perdewaterspruit) is only the excess yield that is available in Zaaihoek Dam after Majuba's water requirement has been supplied. The water transferred into Grootdraai Dam has decreased over time due to the increasing usage from Majuba Power Station, and as the different power generation units were commissioned. The maximum capacity of the supply infrastructure from Zaaihoek Dam is 2.79 m^3/s.

Rietspruit River (C11F)

Msukaligwa Local Municipality (former Ermelo TLC) is situated within this catchment. There are two dams, Willem Brummer and Douglas dams, in this river system supplying water to Msukaligwa (based on information received from Trevor Coleman). There are also coal mining activities in the catchment upstream of these dams. These dams are small storage structures and it is unlikely that they have any release capabilities. The town of Msukaligwa uses all the available water from these dams and in dry periods the dams are frequently depleted. Msukaligwa also receives water from the Rietspruit-Davel pipeline (i.e. the pipeline from Jericho Dam providing water to the Usutu-Vaal Eskom Power Stations).

4.2.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.1**. The results are also provided in **Figure B-1** of **Appendix B**.

Table 4.1: PES, EIS and REC for UV-A

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
8VF5	C11A-01460	B/C		Mostly non-flow related activities related to agricultural encroachment of grassland floodplains and trampling of wetlands, also wattle present in lower reaches.	MODERATE	HIGH	B	Non flow related: Improvement of agricultural practices. Removal of alien vegetation.
C1VAAL-KVAAL	C11B-01770	C		Mostly non-flow related activities related to agricultural encroachment of grassland floodplains and trampling of wetlands, also wattle present in lower reaches.	MODERATE	MODERATE	C	Present flow will maintain PES/ REC.
RE EWR 1 KLEINVAAL	C11C-01846	C		Grazing and trampling pressure	MODERATE	MODERATE	C	Present flow will maintain PES/ REC. Increased grazing and trampling could impact on the PES – especially on the high instream EC of an A/B.
UV9	C11E-01985	C	Abstraction for agriculture.	Mostly non-flow related activities related to agricultural encroachment of grassland floodplains and trampling of wetlands, also	LOW	LOW	C	Present flow will maintain PES/ REC.

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
				wattle in lower reaches.				
C1RIET-AMERS	C11E-01895	C		Agricultural activities.	LOW	MODERATE	C	No actions required as the assumption is that flow is available. Current problems are mostly related to water quality and farming activities.
C1KVAA-UNSPE	C11C-01846	C/D	Increased flows from inter-basin transfer		MODERATE	LOW	C/D	Major problems are associated with the transfer. Any INCREASE in flow or more frequent transfers will further degrade the system.
EWR 1	C11J-01838	B/C	Mainly due to inter-basin transfers (Heyshope and Zaaihoek dams).	Mining and agricultural activities in area has caused water quality deterioration and erosion.	HIGH	HIGH	B/C	EI is **HIGH** and the PES warrants improvement. An improvement in the PES would mean that fish and macroinvertebrates must improve from a C to a B EC. No improvement in riparian vegetation is needed as the current EC is an A/B. An improvement in the biotic component EC is dependent on **water quality** changes and not flow related issues. To improve the EC therefore, the water quality problems must be identified to determine how it can be addressed.
UV17	C11G-01799	C/D	Abstraction.	Agricultural activities	LOW	LOW	C/D	Present flow will maintain PES/ REC.
C1BLES-UNSPE	C11J-01821	C/D		Agricultural activities	MODERATE	LOW	C/D	Present flow will maintain PES/ REC.
VC4	C11L-01945	B/C		Agricultural activities	MODERATE	MODERATE	B/C	Present flow will maintain the PES/REC.
VC5	C11K-01824	C		Agricultural activities	MODERATE	MODERATE	C	Present flow will maintain the PES/REC.

The PES varies from a C/D (3 desktop nodes) to a B/C (2 nodes and one EWR site). Most of the impacts associated in this reach are due to agricultural activities with abstraction or flow modification only being an issue in some of the reaches. The water quality state across UV-A is generally a C category, with the worst state being in the Rietspruit River. Here the quality drops to a D category, largely due to extensive agricultural activities with highly elevated nutrients and salts.

The only node with a high IE is 8VF5 (in the Vaal River) and the recommendation is made at this node to improve the B/C PES to a B REC. To achieve this, non-flow related improvements such as improved agricultural practices and removal of alien vegetation will be required. It must be noted that the instream EC at RE-EWR1 is an A/B. This is linked to the fact that the hydrology is only minimally impacted and the low EcoStatus is linked to the riparian EC of a D.

4.2.3 Socio-economic Assessment

This area is part of the integrated system of water supply to most of the Eskom Power Stations and the Sasol Secunda Complex and is, therefore, strategically critical to the county's economy. The area includes the urban centres of Bethal, Ermelo, Amersfoort and Morgenzon. The main contributor to GDP in the area is power

generation with R24 331.3 million and income to households at R8 872.8 and manufacturing the main contributor to employment opportunities of 8 566. The economic impacts are summarised in **Table 4.2**.

Table 4.2: **Economic Impacts on Vaal River upstream of Grootdraai (2010)**

Description	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	58.3	142.7	1 304	2 133	49.3	169.5
Mining	4 698.6	8 241.9	7 172	12 580	333.4	2 619.6
Manufacturing	2 497.3	5 500.9	9 862	21 724	374.7	3 081.8
Power Generation	11 886.6	24 331.3	4 185	8 566	1 129.7	8 872.8
Total	**19 140.8**	**38 216.8**	**22 523**	**45 004**	**1 887.1**	**14 743.6**

4.2.4 Goods and Services Assessment

Usage of Ecological Goods and Services are limited in this area. The area is sparsely populated with some concentration in urban areas. Overall there are very few people present who would be reliant on goods and services for livelihoods and subsistence. There is some recreational fishing and some other additional recreational use but by and large the area is dominated by mixed farming of a commercial nature with access to the land for those without requisite rights tightly controlled. Although much of the farming appears to be dry land there are some pockets of significant irrigation. The towns of Amersfoort and Morgenzon are two urban centres that have some marginal and informal settlement that surround them. These would include population that might be dependent on the riverine goods and services but this will be sporadic and highly locational. Identified Goods and Services likely to be relevant were identified as follows:

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farmworkers and some usage from the dams.
- Other Recreational Opportunities: The area offers a limited set of recreational opportunities associated with the riverine system but some bird watching is important in areas associated with wetlands.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural run-off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

4.2.5 Proposed Action

If the proposed action involves corrective action, which could lead to the need for extra volumes of water, it will be supplied by increased transfers and additional augmentation. The economic impact of the classification scenarios will, therefore, be assessed based on the costs of the additional transfers.

4.3 UV-B: KLIP RIVER (FREE STATE)

4.3.1 Water Resources Assessment

Sandspruit River (C13A and C13B)

The Sandspruit, which is a tributary of the Klip River, should be mostly natural without any regulating storage and only minor water abstractions.

Klip River (including and upstream of C13H)

The Klip River is largely natural and there is no large regulating storage in the catchment. The yield balance of the river system is positive. This catchment is contributing a large portion of the incremental runoff to Vaal Dam and is an important tributary of the Vaal River, in terms of providing natural variable flow downstream of Grootdraai Dam. There is a possibility (has been investigated in past studies) of constructing a dam on the Klip River. The most feasible option was found to be a dam in quaternary catchment C13F (just downstream of the tributary from quaternary C13E) from where water will be transferred (pumped) to Grootdraai Dam.

4.3.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.3**. The results are also provided in **Figure B-2** of **Appendix B**.

Table 4.3: PES, EIS and REC for UV-B

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
UV Uklip	C13C-02550	B		Mostly non-flow related activities related to agriculture.	HIGH	HIGH	B	Removal of exotic vegetation, preventing a general increase in these species which impact on the EIS.
C13C	C13D-02416	B/C		Mostly non-flow related activities related to agriculture and some urbanization.	HIGH	HIGH	B	Remove alien vegetation along channel. Agricultural activities in wetland should not be allowed.
C1KLIP-UNSPE1	C13D-02284	B/C	Abstraction for agriculture.	Mostly non-flow related activities related to agriculture, some abstraction.	MODERATE	HIGH	B	See above and improvement of flow. Whole wetland should be managed as a unit at a B EC.
C13A	C13B-02175	C	Abstraction for agriculture.	Agricultural activities and some abstraction. Alien vegetation.	MODERATE	MODERATE	C	Assuming that flow is present in the system to maintain the PES/REC.
EWR 6	C13D-02226	B/C	Severely reduced base flows and moderate floods due to weirs and farm dams (many illegal).	Agriculture, cattle grazing, and alien vegetation.	MODERATE	MOERATE	B/C	Present flow will maintain PES/REC.

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
C1SAND-UNSPE	C13B-02135	C	Abstraction for agriculture.	Agricultural activities and some abstraction. Alien vegetation.	MODERATE	MODERATE	C	Assuming that flow is present in the system to maintain the PES/REC.
C13E	C13E-02228	B/C	Abstraction for agriculture.	Agricultural activities and some abstraction. Alien vegetation.	MODERATE	HIGH	B	Increased flow and addressing agricultural activities.
C1KLIP-UNSPE2	C13H-02118	C/D	Abstraction for agriculture.	Alien vegetation.	MODERATE	MODERATE	C/D	To improve this section, increased flows will be required and the illegal dams will have to be addressed. To maintain the PES/REC there should be sufficient flow. It must be noted that EWR 6 results should probably be extrapolated to this point as it has a higher requirement.
C13G	C13H-02156	C	Abstraction for agriculture.		MODERATE	MODERATE	C	Assume that flow is present in the system to maintain the PES/REC.
C13H	C13H-02077	C/D	Abstraction for agriculture.	Alien vegetation.	MODERATE	MODERATE	C/D	Assume that flow is present in the system to maintain the PES/REC.

The PES varies from a C/D (2 nodes) to a B (1 node). Most of the impacts associated in this reach are due to flow modification related to agricultural abstraction and a number of illegal dams in the catchment. This IUA includes the Seekoei Vlei Wetland which is a RAMSAR site and of which a section is protected in the Seekoei Vlei Nature Reserve. As such, the SQ reaches of the upstream river and the reaches including the wetland are of High importance. This situation leads to the REC being an improvement of the PES where the PES is lower than a B. Most of the improvements would require non-flow related measures such as removal of alien vegetation as well as the prevention of agriculture in the wetland. Further downstream in the wetland, a decrease in flow also becomes an issue. The other node which also has a high importance is C13E (Kommandospruit). Improvement in flow and improvement in agricultural practices will be required to achieve the improvement to the REC. In terms of water quality, the Sand River sites are in a better condition than the Klip River sites, with the average water quality category being a B/C and main land use being agricultural. The condition in the Klip River catchment is much poorer, with sites ranging from a C to a C/D category. The main land use is still agricultural, although there are discharges around certain urban areas (e.g. Vrede) which reduce the water quality category.

4.3.3 Socio-economic Assessment

Table 4.4: Economic Impacts on Klip River (Free State) (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	16.8	58.6	340	706	7.0	37.4
Mining	329.1	577.3	502	881	23.4	183.5
Manufacturing	405.3	892.9	1 601	3 526	60.8	500.2
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**751.3**	**1 528.8**	**2 443**	**5 113**	**91.2**	**721.1**

The area is mainly rural with the urban centre, Memel. The main contributor to GDP, employment and household income is the manufacturing sector with a GDP of R892.9 million, employment opportunities of 3 526 and a household income of R500.2 million respectively.

4.3.4 Goods and Services Assessment

In many respects this is similar to UV-A. Use of goods and services are limited. The area is also sparsely populated with some concentration in urban areas. Again, and overall there are very few people present who would be reliant on goods and services for livelihoods and subsistence. Some of the upper parts of the area include a series of remote and aesthetically pleasing scenery and wetlands but these are not major recreational resources. In terms of the G&S the following should be noted for this IUA:

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farm workers and some usage from the dams.
- Other Recreational Opportunities: The area offers an important set of recreational opportunities associated with the riverine system with bird watching is important in areas associated with wetlands. The upper reaches of the IUA offer important recreational opportunities as it is of a pleasing aesthetic nature. Usage is however relatively low.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. In the main it is agricultural run-off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

4.3.5 Proposed Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.4 UV-C1: UPPER WILGE RIVER

4.4.1 Water Resources Assessment

In terms of the water resources modelling resolution it is not feasible to comment on individual sections of the

Wilge River. Comments provided, are therefore relevant to the entire Wilge River System (upstream of quaternary catchment C82H). The WRPM configuration of the Wilge River catchment is shown in **Figure C-1** of **Appendix C**.

This river system has Sterkfontein Dam (located in C81D) as the only regulating storage. Sterkfontein Dam has a very small incremental catchment of its own and receives water from the Thukela-Vaal Transfer Scheme (maximum transfer capacity of 20 m^3/s). Sterkfontein Dam contains the "reserve" water for the Integrated Vaal River System. The operating rule of Sterkfontein Dam is such that water is only released from the dam when Vaal Dam is at low levels.

Eskom is planning the Braamhoek Pump-storage Scheme that will result in the construction of a dam in the upper part of quaternary C81A. According to available information, there was Reserve Determination study done for this proposed dam. The existing WRPM configuration does not allow for the explicit modelling of this scheme.

In the upper portion of quaternary C81F water is abstracted from Fika Patso and Metsi Matso dams to supply the Phuthaditjhaba area. Currently there are plans to further support the Phuthaditjhaba area with water from Sterkfontein Dam, which is an indication that the water resources of the above-mentioned two dams are fully utilised.

The remainder of the Wilge River System is largely unregulated with only small dams for water supply to local users. Water users within this catchment comprise of both urban and irrigation user groups. Results from the Vaal River Reconciliation Strategy study (**DWAF, 2008a**) indicated that there is unlawful irrigation water use in this river system. The available network models simulate the Wilge River System as a unit and it is therefore not possible to give yield balances for the individual tributary catchments.

The Wilge River may in future be the transfer conduit to convey water from the proposed Thukela Water Project (TWP) to Vaal Dam. This proposed transfer scheme is an alternative to a possible further phase of the Lesotho Highlands Water Project.

4.4.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.5**. The results are also provided in **Figure B-2** of **Appendix B**.

Table 4.5: PES, EIS and REC for UV-C1

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 7	C81A-02790	A/B		Small dams for agriculture and exotic fish species (*Micropterus salmoides*).	HIGH	HIGH	A/B	Assuming present flows will maintain the PES/REC.
8WF1	C81A-02790	B		Agricultural activities, small farm dams.	MODERATE	HIGH	B	Removal of exotic vegetation, preventing a general increase in these species that result in the deterioration of the PES/REC.

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
8WF3	C81B-02864	C		Agricultural activities.	MODERATE	LOW	C	Removal of exotic vegetation, preventing a general increase in these species that result in the deterioration of the PES/REC.
UV25	C81L-02594	B		Agricultural activities, small farm dams and abstraction, alien vegetation.	MODERATE	HIGH	B	Removal of exotic vegetation, preventing a general increase in these species that result in the deterioration of the PES/REC.
UV28	C81M-02609	C	Abstraction	Agricultural activities, small farm dams, alien vegetation.	MODERATE	MODERATE	C	Assuming maintaining present flows will maintain the PES - removal of aliens will prevent the degradation of the PES/REC.
UV Cor	C82A-02542	C	Abstraction	Barrier effect of instream dams.	MODERATE	MODERATE	C	Assuming present flows will maintain the PES/REC.
C82B	C82B-02540	C	Abstraction		MODERATE	LOW	C	Assuming present flows will maintain the PES/REC.

The PES is in a B and C state apart from EWR 7 (in the Upper Wilge wetlands) which is in an A/B PES. Most of the impacts associated in this reach are due to agricultural activities with abstraction or flow modification being an issue in the Cornelis River and the lower Meul River. The nodes with a High EI are:

- 8WF1 (in the Wilge River) which is a result of the high PES (B) and as such, do not require any improvements to achieve a higher EC. Alien vegetation should however be removed to prevent further infestation and a potential lowering in the EC.
- UV25 (in the upper Meul River) which is a result of the high PES (B) and as such, do not require any improvements to achieve a higher EC. Alien vegetation should however be removed to prevent further infestation and a potential lowering in the EC.
- EWR 7 (Wilge wetlands). The presence of alien fish species is impossible to eradicate, but some control over the grazing and agricultural practices within the wetland should be installed.

The water quality state is a B to B/C category across the catchment, with agricultural activities dominating.

4.4.3 Socio-economic Assessment

As it is impractical to do the socio-economic assessment of the individual integrated units of analyses UV-C1 to UV-C3 separately, it has been included in the Socio-Economic Assessment of the combined UV-C1 to UV-C3: Wilge River.

The area is to a large extent rural and includes the urban centres of Witsieshoek, Harrismith and Kestell. The main contributor to GDP, employment and household income is the manufacturing sector with a GDP of R1 198.7 million, employment opportunities of 4 734 and a household income of R671.5 million respectively.

Irrigation agriculture offers the highest direct employment opportunities in the area.

Table 4.6: Economic Impacts on Wilge River UV-C1 to UV-C3 (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	79.6	277.1	2 799	4 519	34.6	177.9
Mining	-	-	-	-	-	-
Manufacturing	544.2	1 198.7	2 149	4 734	81.7	671.5
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**623.8**	**1 475.8**	**4 948**	**9 253**	**116.2**	**849.4**

4.4.4 Goods and Services Assessment

The area is sparsely populated with some concentration in urban areas, notably Harrismith and Warden. However, overall there are very few people present who would be reliant on goods and services for livelihoods and subsistence. There is some recreational fishing and some other additional recreational use of the riverine resources but by and large the area is dominated by mixed farming of a commercial nature. Some of the upper parts of the area include a series of remote and aesthetically pleasing scenery and wetlands but these are not major recreational resources. In summary, the following should be noted:

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farm workers and some usage from the dams
- Other Recreational Opportunities: The area offers an important set of recreational opportunities associated with the riverine system with bird watching is important in areas associated with wetlands. The upper reaches of the IUA offer important recreational opportunities as it is of a pleasing aesthetic nature. Usage is however relatively low
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural runoff that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

4.4.5 Proposed Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts

of the action will be calculated.

4.5 UV-C2: WILGE RIVER AND TRIBUTARIES

4.5.1 Water Resources Assessment

Refer to **Section 4.4.1** for general comments on water resources of the Wilge River catchment.

4.5.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.7**. The results are also provided in **Figure B-2** of **Appendix B**.

Water quality is a B category across most of the catchment, although it drops to a C on most of the Wilge River, with a C/D category on the Elands River due to urban impacts from the upstream Phuthaditjhaba. Agricultural activities are widespread across the catchment.

Table 4.7: PES, EIS and REC for UV-C2

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
8EF4	C81F-02995	C/D	Abstraction for towns.	Urbanisation, and water quality problems relating to urbanisation.	LOW	MODERATE	C/D	Resource dependence is very high in SQ. An improvement of the situation to ensure better utilisation of the G&S, includes: Fish - more water of better quality would be required. Overgrazing and erosion should be addressed, but this is unlikely to happen due huge pressure on the area. It is possible that the WWTW is non-compliant and this issue needs to be addressed.
C81G	C81G-02882	C		Mostly impacts associated with agriculture.	MODERATE	MODERATE	C	Assuming present day flow will maintain the PES/REC.
GG	C81G-02882	B		Old dam present.	MODERATE	HIGH	B	Assuming present day flow will maintain the PES/REC.
C81J	C81K-02710	C	Abstraction.	Agricultural activities.	LOW	LOW	C	Assuming present day flow will maintain the PES/REC.
C81C	C81C-02978	B/C	Abstraction.	Agricultural activities.	MODERATE	MODERATE	B/C	Removal of exotic vegetation, preventing a general increase in these species that result in the deterioration of the PES/REC. Assuming present day flow will maintain the PES/REC.
C8NUWE-CONFL	C81E-02930	C	Transfer: Sterkfontein Dam.	Barrier effect of Sterkfontein Dam.	LOW	LOW	C	Any increase in the transfer has the potential to impact on the PES/REC.
EWR 8	C82C-2505	C	Alteration of hydrological regime due to inter-basin transfers from Sterkfontein Dam, abstraction for agriculture.	Water quality problems, erosion and exotic species invasion as well as agriculture.	MODERATE	MODERATE	C	Assuming present day flow will maintain the PES/REC.
C82D	C82D-02490	C	Abstraction.	Agricultural activities.	LOW	MODERATE	C	Maintaining present day flows will maintain the PES/REC.

The PES ranges from a C/D to a B state. The impacts in this reach are varied with abstraction and agriculture dominating in most areas. C8Nuwe-confl is dominated by the transfer from Sterkfontein Dam. Rivers in the vicinity of Harrysmith and downstream of Phuthaditjhaba have water quality problems. The node with a High EI is GG which is a new node to represent only the Golden Gate section of C81C-02882. As the PES is already in a B, no action is required to maintain/achieve the REC. The only impact in this reach is an old dam which of which the wall has been breached. It seems as it this dam has created an artificial wetland in the backup zone.

4.5.3 Socio-economic Assessment

See the Socio-Economic Assessment in **Section 4.4.3** above.

4.5.4 Goods and Services Assessment

From the perspective of the Upper Vaal WMA this is an important area with respect to reliance on resources as a part of livelihoods. Goods and services are particularly important in the upper part of the catchment as this is made up of the areas that were the former homeland of Qwa-Qwa around the town of Phuthaditjhaba. This includes some of the most marginal areas of the country. People were largely forcibly settled into the area as displaced farmworkers and continue to be a marginal community displaced from the economic centres of the country. The importance of the goods and services to provide part of livelihoods, even within the now dense closer settlement of the area should not be overlooked. Golden Gate is also part of this IUA and provides an important recreational resource of which the river is an important component. The remainder of the IUA is similar to the previous area and dominated by commercial and mixed farming. Some recreational fishing is important. The following should be noted for this IUA:

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams and the Golden Gate area.

- Fishing (Subsistence): Important with respect to resident of the Phuthaditjhaba. Also some more limited use by farmworkers and some usage from the dams.

- Other Recreational Opportunities: The area offers an important set of recreational opportunities associated with the riverine system with bird watching is important in areas associated with wetlands and with the Golden Gate area. The upper reaches of the IUA offer important recreational opportunities as it is of a pleasing aesthetic nature. Usage is more pronounced than the other IUAs considered so far.

- Riparian vegetation: This is an important component of the livelihoods strategies of people in the Phuthaditjhaba area. Resources are however highly utilised and sustainability of utilisation is questionable.

- Waste Water Dilution and Assimilation: Waste water dilution from Phuthaditjhaba is important. Also given that land use is primarily commercial agriculture the function of the river in this regard is of importance.

4.5.5 Proposed Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.6 UV-C3: LOWER WILGE RIVER

4.6.1 Water Resources Assessment

Refer to **Section 4.4.1** for general comments on water resources of the Wilge River catchment.

4.6.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.8**. The results are also provided in **Figure B-2** of **Appendix B**.

Table 4.8: PES, EIS and REC for UV-C3

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
UV31	C82E-02418	C	Abstraction.	Trampling, erosion and bank slumping.	MODERATE	MODERATE	C	Maintaining present flows will maintain PES/REC.
VC8	C82G-02415	B/C		Grazing.	LOW	MODERATE	B/C	Maintaining present flows will maintain PES/REC.
UV35	C82F-02326	C		Grazing.	MODERATE	MODERATE	C	Maintaining present flows will maintain PES/REC.
VC9	C82H-02200	C/D	Abstraction.	Exotic vegetation species - willows.	MODERATE	LOW	C/D	Maintaining present flows will maintain PES/REC.

The PES varies from a C/D to a B/C. Most of the impacts associated in this reach are due to agricultural activities, alien vegetation and abstraction in some areas. Water quality impacts in the Grootspruit and Wilge River are expected to be slightly higher.

There are no nodes with a High importance so the REC reflects in all cases the maintenance of the PES.

4.6.3 Socio-economic Assessment

See the Socio-Economic Assessment in **Section 4.4.3** above.

4.6.4 Goods and Services Assessment

This IUA is the Lower Wilge and surrounds. The area is sparsely populated with scattered mixed farming. Some irrigation is visible. There is negligible livelihood usage but fishing may be important, particularly closer to the area around Frankfort. Other small-scale recreation is probably important upstream of Frankfort:

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams.

- Fishing (Subsistence): Limited to farm workers with some usage from the dams.
- Other Recreational Opportunities: The area offers a relatively limited set of recreational opportunities.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural run-off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

4.6.5 Proposed Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.7 UV-D: LIEBENBERGSVLEI RIVER

4.7.1 Water Resources Assessment

The flow in the Liebenbergsvlei River (including and upstream of C83H) is dominated by the transfer from the Lesotho Highlands Water Project (LHWP). The LHWP water is discharged into the river system upstream of Saulspoort Dam (located in quaternary catchment C83A). Saulspoort Dam supplies water to the town of Bethlehem as well as to irrigation farmers. There are significant irrigation abstractions along the Liebenbergsvlei River, of which a significant portion is considered to be unlawful (refer to **Table F-2** of **Appendix F** for details). The WRPM configuration of this IUA is shown in **Figure C-1** of **Appendix C**.

4.7.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.9**. The results are also provided in **Figure B-2** of **Appendix B**.

Table 4.9: PES, EIS and REC for UV-D

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC15	C83A-02863	C		Erosion and incision.	MODERATE	LOW	C	Maintain present flow to maintain PES/REC.
C83D	C83E-02588	C		Agriculture and irrigation.	MODERATE	MODERATE	C	Maintain present flow to maintain PES/REC.

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
C83E	C83E-02579	C	Abstraction.	Agriculture and irrigation.	MODERATE	MODERATE	C	Maintain present flow to maintain PES/REC.
VC16	C83G-02364	B/C		Grazing and dryland agriculture.	MODERATE	HIGH	B	Improvement will be related to addressing agricultural practices which is unlikely to happen. Increased flows will not address the current problem.
VC17	C23H-02395	B/C		Activities relating to grazing and dryland agriculture.	MODERATE	HIGH	B	Improvement will be related to addressing agricultural practices which is unlikely to happen. Increased flows will not address the current problem.

The land use is dominated by agriculture and the PES varies from a C to a B/C. This is, however, not representative of this catchment as no nodes have been placed in the Liebenbergsvlei River and the Ash River which are both impacted on by the transfer from Lesotho. The PES will probably be a F in these rivers. The reason that no nodes are placed in the river is that it is known that the demand for the water and operational constraints will not allow for mitigation of the impacts. Conveying the water by pipeline (to prevent the theft of water) has been raised; however the impact to the river channel will probably be so severe that it would be difficult to re-establish an ecologically healthy system. A large wetland in the Ash River has also been destroyed by the transfer. These aspects need to be kept in mind when setting a Management Class. The water quality category across the area is in a B in the upper Liebenbergsvlei, to a B/C in the lower sections.

VC-16 and VC-17 in small tributaries are both in a B/C state and of a high EI (due to the high PES). Improvement to a B would require non-flow related measures related to agricultural activities. Increased flows will not achieve the desired effect.

4.7.3 Socio-economic Assessment

The area is to a large extent rural and includes the urban centres of Bethlehem and Reitz. The manufacturing sector is the biggest contributor in the area to GDP with R1 063.2 million and to household incomes with R595.6 million. Irrigation agriculture is by far the biggest employment generator in the area with 10 355 employment opportunities offered.

Table 4.10: Economic Impacts on Liebenbergsvlei River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	218.2	747.1	5 713	10 355	89.4	471.3
Mining	10.6	18.5	16	28	0.7	5.9
Manufacturing	482.7	1 063.2	1 906	4 199	72.4	595.6
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**711.5**	**1 828.8**	**7 635**	**14 582**	**162.5**	**1 072.8**

4.7.4 Goods and Services Assessment

The area is sparsely populated with scattered mixed farming enterprises the dominant land form. Some irrigation is visible. There is negligible livelihood usage but fishing may be important. Some of the higher flows from the transfer may promote other recreational aspects such as canoeing. Livelihood usage is almost zero.

- Fishing (Recreational): Important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farm workers and some usage from the dams.
- Other Recreational Opportunities: The area offers a relatively limited set of recreational opportunities bar that downstream of the transfer where some white water canoeing appears to be of importance.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural run off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

4.7.5 Corrective Action

This tributary carries the water from the Lesotho Highlands Scheme from the point of release above Bethlehem and no corrective action involving volumes of water is foreseen in the tributary.

4.8 UV-E: WATERVAL RIVER

4.8.1 Water Resources Assessment

The Waterval River receives discharges from the Sasol Secunda Complex as well as treated urban wastewater. From the salinity balance done by Chris Herold as part of the Vaal River System Analysis Update (VRSAU) study, there is also evidence of mine water seepage and runoff from the paved urbanised areas contributing to the flow in the river. There are irrigators situated downstream of the above-mentioned discharges. The WRPM configuration of the Waterval catchment (refer to **Figure C-1** of **Appendix C**) was refined for the purposes of the Comprehensive Reserve Determination Study (DWA, 2010d) to allow for the explicit modelling of the two EWR sites resulting from the most recent Reserve study undertaken by BKS. Results from the Validation and Verification Study indicated that unlawful irrigation water use occurs in this catchment.

4.8.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.11**. The

results are also provided in **Figure B-1** of **Appendix B**.

Table 4.11: PES, EIS and REC for UV-E

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC6	C12D-01576	C		Deteriorated water quality relating to mining, urban areas and agriculture.	LOW	LOW	C	Maintain present flow to maintain PES/REC.
WA1	C12F-01722	D	Increased flows.	Deteriorated water quality relating to industry, mining, urban areas and agriculture as well as Evander WWTW.	LOW	LOW	D	Maintain present flow to maintain PES/REC.
VC7	C12F-01728	C	Barrier effect and flow modification due to farm dams.	Grazing.	LOW	MODERATE	C	Maintain present flow to maintain PES/REC.
WA2	C12G-01896	D	Abstraction with centre pivots.	Agriculture and upstream water quality.	LOW	LOW	D	Maintain present flow to maintain PES/REC.
UV WV	C12G-01963	D	Abstraction with centre pivots.	Upstream water quality.	MODERATE	MODERATE	D	Maintain present flow to maintain PES/REC.

The PES varies from a D to a C. Most of the impacts associated in this reach are due to water quality problems from mining, industry, urban, sewage and agriculture. The area includes Secunda and the industrial effects of SASOL. Although abstraction is an issue in some areas without addressing water quality, there can be no improvement in most of the SQ reaches.

There are no nodes with a High importance so the REC reflects in all cases the maintenance of the PES.

4.8.3 Socio-economic Assessment

Table 4.12: Economic Impacts on Waterval River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	21.5	74.9	592	1 069	8.9	47.6
Mining	11 150.1	19 558.7	17 019	29 854	791.1	6 216.4
Manufacturing	35 233.7	77 610.8	139 145	306 501	5 287.0	43 479.9
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**46 405.3**	**97 244.4**	**156 756**	**337 424**	**6 087.0**	**49 744.0**

The area includes the industrial centres of Secunda, Evander and Kinross. The main contributor to GDP, employment and household income in the area is manufacturing with a GDP at R77 610.8 million, employment numbers of 306 501 and a contribution to household income of R43 479.9 million.

4.8.4 Goods and Services Assessment

Sasolburg and the upper area of the IUA ensure that there is an industrial element evident. Other parts of the IUA are more agricultural but aside from the urban nodes the population is sparse and usage in terms of goods and services is highly limited. Although there is negligible livelihood usage some fishing may be important in the areas abutting the Vaal confluence.

- Fishing (Recreational): Limited to lower reaches close to the Vaal confluence.
- Fishing (Subsistence): Limited but some use is made by people in and around the urban areas of Sasolburg.
- Other Recreational Opportunities: Usage is relatively low bar some use of the lower reaches close to the Vaal confluence.
- Riparian vegetation: The utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural runoff that will be diluted.
- Floodplain cultivation: This is negligible.

4.8.5 Corrective Action

Although this is tributary water supplied via a pipeline from the main stem to the Secunda complex, if more water is necessary to improve the ecological status of the tributary it will be augmented and the cost of the augmentation calculated.

4.9 UV-F: KROM AND KLIP RIVERS

4.9.1 Water Resources Assessment

These two river systems were included in the lumped modelling of the Frankfort sub-system which also included the Wilge and Liebenbergsvlei River systems.

4.9.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.13**. The results are also provided in **Figure B-2** of **Appendix B**.

Table 4.13: PES, EIS and REC for UV-F

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
UV45	C83K-02204	C	Abstraction	Agricultural activities.	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.
C8KLIP-VAALD	C83L-02057	C		Agricultural activities.	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.

The PES varies from a C/D to a B/C. Most of the impacts associated in this reach are due to agricultural activities, alien vegetation and abstraction in some areas. Water quality state is good across the catchment, with water quality category being a B to B/C due to dryland agriculture being the dominant land use activity.

There are no nodes with a High importance so the REC reflects in all cases the maintenance of the PES.

4.9.3 Socio-economic Assessment

Table 4.14: Economic Impacts on Krom and Klip flowing into Vaal Dam Rivers (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	3.5	14.2	251	357	1.2	10.9
Mining	346.6	813.2	1 461	3 428	11.9	371.8
Manufacturing	636.1	1 506.6	2 790	6 609	32.7	1 112.9
Power Generation						
Total	**986.1**	**2 334.0**	**4 502**	**10 395**	**45.8**	**1 495.5**

The area includes no main centres to mention. The main contributor to GDP, employment and household income in the area is manufacturing with GDP at R1 506.6 million, employment numbers of 6 609 and a contribution to household incomes of R1 112.9 million.

4.9.4 Goods and Services Assessment

These are minor tributaries upstream of the Vaal River and are generally sparsely populated with commercial agriculture the dominant land use. Some fishing may take place upstream of the Vaal Dam but this is not likely to be a major attraction.

- Fishing (Recreational): Largely limited to lower reaches close to the Vaal Dam confluence.
- Fishing (Subsistence): Limited but may be utilised by some farm workers.
- Other Recreational Opportunities: Usage is relatively low bar some use of the lower reaches close to the Vaal Dam confluence.
- Riparian vegetation: The utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural run off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.
- Floodplain cultivation: This is negligible in this reach.

4.9.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.10 UV-G: VAAL RIVER REACH UPSTREAM OF VAAL DAM

4.10.1 Water Resources Assessment

Vaal River reach between C11M and Grootdraai Dam

The Vaal River reach upstream of Vaal Dam and downstream of Grootdraai Dam (see **Figure C-1**) receives compensation water from Grootdraai Dam. This is a variable flow release (dependant on the inflow to the dam) and this water is used by Lekwa LM (former Standerton TLC) as well as downstream irrigators. The yield balance of Grootdraai Dam is such that all available water is used to supply Sasol (Secunda Complex) and Eskom Power Stations. Any additional water released from the dam would result is a negative yield balance and will have an impact on the Eastern Sub-system of the Integrated Vaal River System.

4.10.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.15**. The results are also provided in **Figure B-3** of **Appendix B**.

Table 4.15: PES, EIS and REC for UV-G

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 2	C11M-01894	C	Changes in flow regime due to Grootdraai Dam, abstraction.	Agricultural and livestock farming activities. WWTW in Bethal, Tukukani, New Denmark Colliery and coal mining.	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.
8VF3	C11M-01901	C	Abstraction.	Barrier effect of farm dams, agriculture and water quality.	LOW	LOW	C	Maintaining present day flows will maintain the PES/REC.
C12A	C12B-02028	C		Agriculture and grazing.	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.
EWR 3	C12C-01997	C	Impacts mostly related to changes in flow regime due to Grootdraai Dam and unlawful irrigation.	Livestock farming and vegetation removal. Agricultural runoff and as a result increased nutrients from point and diffuse sources (e.g. agriculture, Standerton WWTW, industrial and residential runoff).	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.
C12K	C12L-01881	C	Abstraction.	Water quality related impacts and barrier effect of dams.	MODERATE	LOW	C	Maintaining present day flows will maintain the PES/REC.
C12J	C12J-02091	C	Abstraction.	Water quality related impacts and barrier effect of dams.	MODERATE	MODERATE	C	Maintaining present day flows will maintain the PES/REC.

Dominant land use is agriculture with the PES in a C and water quality across the area being a C category. The impact of Grootvlei Mine drops the water quality category to a D on the Molspruit. Most of the impacts associated in this reach are due to agricultural and abstraction.

There are no nodes with a High importance so the REC reflects in all cases the maintenance of the PES.

4.10.3 Socio-economic Assessment

The area is mainly a rural area and includes the main centres of Standerton and Villiers. The main contributor to GDP, employment and household income in the area is irrigation agriculture with GDP at R273.5 million, employment numbers of 3 285 and contribution to household incomes of R172.6 million.

Table 4.16: Economic Impacts on Vaal River reach upstream of Vaal Dam and downstream of Groot Draai Dam (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	78.2	273.5	1 513	3 285	31.1	172.6
Mining	-	-	-	-	-	-
Manufacturing	105.9	233.2	418	921	15.9	130.7
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**184.1**	**506.8**	**1 931**	**4 206**	**47.0**	**303.3**

4.10.4 Goods and Services Assessment

As with UV G these are areas feeding into the Vaal Dam, and sparsely populated with commercial agriculture the dominant land use. Fishing takes place upstream of the Vaal Dam and this is relatively important attraction downstream of Villiers. Floodplain usage is important but this is restricted to commercial utilisation.

- Fishing (Recreational): Important in reaches close to the Vaal Dam confluence.
- Fishing (Subsistence): Relatively important given the town of Villiers and its population, some of whom rely on fish for part of their diet.
- Other Recreational Opportunities: Usage is relatively low bar some use of the lower reaches close to the Vaal Dam confluence. Here picnic spots are of importance.
- Riparian vegetation. The utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance. It is mainly agricultural run-off that will be diluted but the comment was made that nutrients do not react particularly well to dilution influences of this nature.

- Floodplain cultivation: This is negligible from a livelihood perspective but important in terms of commercial agriculture.

4.10.5 Corrective Action

If the proposed action involves corrective action, which could lead to the need for extra volumes of water, it will be supplied by additional augmentation and the augmentation costs calculated.

4.11 UV-H: SUIKERBOSRAND RIVER UPSTREAM OF BLESBOKSPRUIT CONFLUENCE

4.11.1 Water Resources Assessment

Suikerbosrand River (C21C, C21B and C21A)

This portion of the Suikerbosrand River catchment is largely natural and there are no significant abstractions or discharges influencing the river flow. Balfour Dam, situated on the main stem of the Suikerbosrand River, regulates the flow to some extent and is used for supplying water to the town of Balfour. For the purposes of the Comprehensive Reserve Determination Study (DWA, 2010d) it was assumed that releases can be made from the dam in support of the Reserve (the site EWR9 is situated downstream of Balfour Dam). The WRPM configuration of this IUA is shown in **Figure C-4** of **Appendix C**.

4.11.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.17**. The results are also provided in **Figure B-3** of **Appendix B**.

Table 4.17: PES, EIS and REC for UV-H

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
C21A	C12A-01567	B/C	Flow modification.	Agricultural activities.	MODERATE	HIGH	B	Instream: Increase flow and prevent overgrazing. Vegetation: Increase in flow will not improve the EC. Prevent overgrazing and trampling of banks.
EWR 9	C21C-01675	C	Altered flow regime due to Balfour and Haarhoff Dams.	Deteriorated water quality due to WWTW and agriculture, erosion, alien fish and vegetation.	HIGH	HIGH	B/C	An improvement is based on increased base flows (released from upstream dams) as well as erosion control measures in the tributaries to address erosion and increased sediment loads in the reach and alien woody vegetation control.

This reach covers the upper reaches of the Suikerbosrand River. Water quality impacting issues include agricultural activities and erosion. The water quality category is a B/C. The PES is in a B/C for the node which is upstream of the large dams and a C for EWR 9 downstream of the dams. The REC is set to improve the REC

at both nodes. Improved flow conditions will improve the instream EC. To improve vegetation, overgrazing and trampling of banks should be prevented.

4.11.3 Socio-economic Assessment

Table 4.18: Economic Impacts on Suikerbosrand River upstream of Blesbokspruit Confluence (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	29.4	117.8	1 468	2 409	9.0	88.5
Mining	6 932.7	16 266.0	29 228	68 576	239.0	7 437.1
Manufacturing	14 911.9	35 321.5	65 417	154 951	765.8	26 090.5
Power Generation						
Total	**21 874.0**	**51 705.2**	**96 112**	**225 936**	**1 013.7**	**33 616.2**

The area includes the industrial centres of Nigel and Heidelberg. The main contributor to GDP, employment and household income in the area is manufacturing with GDP at R35 321.5 million, offering employment opportunities of 154 951 and a contribution to household incomes of R26 090.5 million.

4.11.4 Goods and Services Assessment

The Suikerbosrand catchment is sparsely populated with commercial agriculture the dominant land use. Goods and service utilisation is negligible.

- Fishing (Recreational): Of limited importance.
- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and usage is relatively low.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance.
- Floodplain cultivation: Negligible.

4.11.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.12 UV-I: BLESBOKSPRUIT, RIET AND KLIP RIVER (GAUTENG)

4.12.1 Water Resources Assessment

Suikerbosrand and Blesbokspruit rivers (including C21G, C21F, C21E and C21D)

About 50 million m^3/annum of treated urban wastewater is discharged into this river system as well as mine water discharges from Grootvlei Mine (now referred to as Petrex). Furthermore, runoff from the paved urbanised areas within the Suikerbosrand catchment also contributes to the flow in the river. There is no storage structure that can regulate the flow in this river reach (refer to **Figure C-4** for WRPM configuration).

Klip River (including and upstream of C22E)

This river reach receives about 200 million m^3/annum of treated urban wastewater which significantly changed the flow pattern from natural conditions. There is also significant runoff from the paved urbanised areas contributing to the flow in the Klip River and discharges from the mines are estimated at approximately 10 million m^3/annum. There is no storage structure that can regulate the flow in this river reach.

Rietspruit (including and upstream of C22J)

This river system receives in the order of 35 million m^3/annum treated urban wastewater with the result that high base flows are present in the river. Discharges from the Far West Basin Mines that are in the order of 18 million m^3/annum are made to the Rietspruit and runoff from the paved urbanised areas also contributes to the flow in the river.

4.12.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.19**. The results are also provided in **Figure B-3** of **Appendix B**.

Table 4.19: PES, EIS and REC for UV-I

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC11	C22C-01509	E		WQ problems relating to upstream activities, especially from industry mining and urban activities.	LOW	LOW	D (but not possible)	Will have to improve the water quality significantly and this is unlikely to happen. Any changes of flow will not improve the situation.
VC12	C22A-01315	E		WQ problems relating to upstream activities, especially from industry mining and urban activities.	LOW	MODERATE	D (but not possible)	Will have to improve the water quality significantly and this is unlikely to happen. Any changes of flow will not improve the situation, however, if some of the sewage flows are removed and do not end up in the river, then some improvement in fish could be possible.
VC13	C22E-01619	E		WQ problems relating to upstream activities, especially from industry mining and urban activities.	LOW	LOW	D (but not possible)	Will have to improve the water quality significantly and this is unlikely to happen. Any changes of flow will not improve the situation, however, if some of the sewage flows are removed and do not end up in the

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
								river, then some improvement in fish could be possible.
VC14	C22K-01765	D/E		WQ problems relating to upstream activities, especially from industry mining and urban activities.	LOW	MODERATE	D (but not possible)	Water quality major problems

This IUA covers the Rietspruit and Klip rivers (Gauteng). Note that the water quality state of UV-I is severely impacted and improvements in present state cannot happen without addressing water quality problems. Implementation of the Integrated Water Quality Management Plan set up for the Vaal (DWAF, 2009) will be required. DWA is currently implementing a phased approach to improving water quality across the catchment. The following information is taken from the DWA Feedback Meeting in October 2010 for the Comprehensive Vaal Reserve Study.

The three studies undertaken for the Vaal system are (i) the development of an Integrated Water Quality Management Plan for the Vaal system to either maintain or improve the water quality of the system, (ii) Implementation of Water Conservation and Demand Management (WC/WD) strategies and (iii) Development of a reconciliation strategy for the Vaal system.

The main focus areas of the reconciliation strategy are:

- *Unlawful use of water;*
- *Implementation of a 15% savings in the dams using WC/WD strategies;*
- *Re-use of effluent (e.g. Acid Mine Drainage (AMD)), including the setting of RWQOs;*
- *Impacts of the future planned augmentation to the Vaal (Polihali Dam); and*
- *Institution of a Strategy Steering Committee (SSC).*

Part of the reconciliation strategy is to determine the impact of the Receiving Water Quality Objectives (RWQOs) on water availability in the system for the short to medium term, due to releases for dilution and the subsequent higher flows than natural in the system. The longer term strategy is to re-use return flows (e.g. AMD) after treatment to a potable state.

Water quality category across the area is a D on the upper Klip River, which deteriorates to a D/E category at all other sites. Impacts include pollution from gold mining slimes dams, industrial effluent run-off, run-off from urban areas, leaking sewers, effluent from WWTW, and agricultural return flows.

All the sites have a PES lower than a D and, in theory, require improvement to at least a D. However, it must be noted that, as mentioned above, all problems here are associated with water quality. Prior to water quality being addressed one would not achieve any improvement by improving flow conditions. Most of this area also suffers from 'too much flow' due to increased runoff which is more than the natural flow regime. Improvement would normally be associated with decreasing flows; however in this case that would not achieve any improvement as the water quality conditions will worsen. Increasing flows are very likely to further degrade the system, even through some of the water quality impacts may be diluted.

4.12.3 Socio-economic Assessment

Table 4.20: Economic Impacts on Blesbokspruit and Klip River (Gauteng)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	57.7	232.4	3 292	5 064	18.4	175.5
Mining	3 007.6	7 056.6	12 680	29 750	103.7	3 226.4
Manufacturing	19 656.5	46 559.7	86 231	204 252	1 009.5	34 391.8
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**22 721.8**	**53 848.7**	**102 202**	**239 066**	**1 131.5**	**37 793.6**

The area includes the industrial centres and densely populated area of Johannesburg, Soweto, Boksburg, Brakpan, Benoni, Springs and Sebokeng. The main contributor to GDP, employment opportunities and household income in the area is manufacturing with GDP at R46 599.7 million, employment opportunities of 204 252 and a contribution to household incomes of R37 793.6 million.

4.12.4 Goods and Services Assessment

The Rietspruit has some developed smallholdings abutting irrigated agricultural lands. The Klip River portion goes through industrial and built up areas. There are a broad range of communities present but most are urbanised and dependence on the goods and services is likely to be limited. Having said this, there are a number of poor urban and informal communities that have been observed as making use of the fish and living in the vegetation in areas around the river banks. The “other Rietspruit” is similar in profile to the Klip River areas although this is adjacent to higher value Vaal river properties.

- Fishing (Recreational): Important in certain areas.
- Fishing (Subsistence): Despite poor water quality this aspect is important given the nature of the population and access to the river.
- Other Recreational Opportunities: The area offers a relatively limited set of recreational opportunities but the nature of the area means that these are utilised. Use is mostly picnicking closer to the river.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area. However there is a population of people living “rough” in the area for whom the shelter offered by riverine trees is important.
- Waste Water Dilution and Assimilation: Waste water dilution from the urban conglomerate is important. Also given that land use is primarily commercial agriculture the function of the river in this regard is of importance
- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the

commercial agricultural utilisation sector rather than direct use for livelihoods.

4.12.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.13 UV-J: TAAIBOSSPRUIT

4.13.1 Water Resources Assessment

Taaibosspruit River (C22K and C22G)

These catchments contain the Sasolburg industrial complex including coal-mining areas. There is no regulating storage structure and water quality is a concern in this river system. More detailed information on these catchments should be available from Catchment Management Strategy studies or detailed water quality studies.

4.13.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.21**. The results are also provided in **Figure B-3** of **Appendix B**.

Table 4.21: PES, EIS and REC for UV-J

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
C22G	C22K-01795	D	Flow modification.	Urbanization and water quality related problems.	LOW	LOW	D	Possibility that upper reaches are in better condition. However, as long as present flow is maintained, the PES/REC will be maintained.

This reach is the Taaibosspruit downstream of Vaal Dam. Extensive agricultural activities occur (dryland and pivots), with highly elevated levels of nutrients and salts. The river runs relatively close to Sasolburg's industrial area and alongside Zamdela. The water quality (wq) category is a C category and the PES is in a D. The EI is low and the REC therefore is set to maintain the PES.

4.13.3 Socio-economic Assessment

As it is impractical to do a socio-economic assessment of the individual integrated unit of UV-J: Taaibosspruit on its own, it has been included in the Socio-Economic Assessment of UV-M: Vaal River from Downstream of Vaal Dam to Outlet of C23L, see **Section 4.16.3** below.

4.13.4 Goods and Services Assessment

This is the Taaibosspruit near Vaal Park. Goods and Services utilisation is likely to be practically non-existent.

- Fishing (Recreational): Of limited importance.
- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and .usage is relatively low.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance.
- Floodplain cultivation: Negligible.

4.13.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.14 UV-K: KROMELMBOOGSPRUIT

4.14.1 Water Resources Assessment

Kromdraai River – (C23A and part of C23B)

The Kromdraai River catchment down to its confluence with the Vaal River is largely natural. With the exception of relatively small irrigation water use, there are no significant abstractions or discharges influencing the river flow. There is no storage structure that can regulate the flow in this river reach.

4.14.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.22**. The results are also provided in **Figure B-4** of **Appendix B**.

Table 4.22: PES, EIS and REC for UV-K

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
UV53	C23A-01811	C	Abstraction	Agricultural activities	MODERATE	LOW	C	Present flows will maintain PES/REC.

This reach covers the entire Kromelmboogspruit, a tributary of the Vaal River entering the Vaal upstream of Parys and downstream of Vaal Barrage. Catchment development in the area is mostly agricultural, with numerous road crossings and pivots in the lower reaches. Elevated salts, nutrients and toxics are expected. The water quality category and the PES is a C. The EI is low and there is, therefore, no motivation to improve the PES.

4.14.3 Socio-economic Assessment

As it is impractical to do a socio-economic assessment of the individual integrated unit of UV-K (Kromelmboogspruit) on its own, it has been included in the Socio-Economic Assessment of UV-M (Vaal River from Downstream of Vaal Dam to Outlet of C23L), see **Section 4.16.3** below.

4.14.4 Goods and Services Assessment

This is the Kromelmboogspruit with commercial farming the dominant landform. Goods and Services utilisation is likely to be negligible to virtually non-existent.

- Fishing (Recreational): Of limited importance.
- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and .usage is relatively low.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance.
- Floodplain cultivation: Negligible.

4.14.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.15 UV-L: MOOI RIVER UP TO CONFLUENCE WITH VAAL

4.15.1 Water Resources Assessment

Mooi River– (C23H, Boskop and Klerkskraal dams)

The WRPM configuration of this sub-system is shown in **Figure C-5** of **Appendix C**. Boskop Dam is located

upstream of this river reach and has currently limited excess water available. This is due to significant mine

water discharges into the river system. The catchment upstream of Boskop Dam is partly underlain by dolomite. The Wonderfonteinspruit is the most significant tributary of the Mooi River. Water from the Gerhard Minnebron eye is used for irrigation purposes. Urban return flows from the Flip Human Wastewater Treatment Works are also discharged into the Mooi River upstream of Boskop Dam. Potchefstroom Town is supplied from a small storage dam, Lakeside Dam, which is supported from Boskop Dam. Boskop Dam also supplies water to the Mooi River Irrigation Scheme. Klerkskraal Dam is located upstream of Boskop Dam in quaternary catchment C23F. There are irrigation water users supplied directly from Klerkskraal Dam. Under certain conditions, water is released from Klerkskraal Dam to support Boskop Dam. In order to minimise river losses these releases are, however, made via the concrete lined Klerkskraal canal system. Portions of the natural spills from Klerkskraal Dam are also routed through the right bank canal that spills into Boskop Dam.

There is currently an application for additional irrigation to supply resource poor farmers. It should be noted that there is a significant canal and pipe infrastructure conveying the urban return flows, mine discharges and irrigation water supply in this area.

Loopspruit River – (C23K, Klipdrift Dam)

Klipdrift Dam (see **Figure C-5**) is located upstream of this river reach and provides water to irrigators. There is significant mine dewatering entering the river system upstream of the dam. The yield balance indicates that the water available and the water requirements are in balance (this is with the mine discharges included).

4.15.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.23**. The results are also provided in **Figure B-4** of **Appendix B**.

Table 4.23: PES, EIS and REC for UV-L

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
RE-EWR 2 MOOI	C23G-01250	D		Agricultural activities, alien vegetation.	LOW	LOW	D	Maintain present flows to maintain PES/REC.
C23F	C23G-01250	C/D	Abstraction.	Agriculture and barrier effect of dams.	LOW	LOW	C/D	Maintain present flows to maintain PES/REC.
VC19	C23G-01406	E		WQ related problems relating to industry, urbanization and mining.	LOW	LOW	D	This will not happen unless the issues regarding the presence of Uranium are addressed. Waste water return flows entering the system need to be addressed.
M2	C23K-01579	E	Abstraction.	Impacts relating to irrigation.	LOW	LOW	D	Increased flows from Klipdrift Dam, could address some of the problems downstream of the dam, however, water quality might be of such a state that it does not help. Upstream of the dam, water quality problems are severe due to mining and sewage (have record of 100% sewage discharge).
VC20	C23L-01827	D	Abstraction.	Impacts relating to irrigation. Upstream urbanization and industrialization.	LOW	LOW	D	Maintain present flows to maintain PES/REC.

The main impact in the area is the uranium-laden effluent from the Wonderfonteinspruit, which drops the water

quality category to a F category. Water quality EC across the rest of the catchment are a C/D to D, with impacts being related to agriculture, urban runoff and mining effluent.

The PES of the upper Mooi River is in a C/D due to abstraction and barrier effects of the dams. The Mooi at the confluence of the Vaal is in a D with most of the impacts associated with abstraction and upstream urbanisation and industrialisation.

The Wonderfonteinspruit and the Loopspruit are both in a E PES. The Wonderfonteinspruit's issues relate to the uranium issues and are addressed above. No improvement by any flow manipulation is possible without addressing these issues.

The Loopspruit issues are varied and differ upstream and downstream of Klipdrift Dam. The upstream issues are water quality related again the improvement cannot be achieved without improving the water quality situation. Downstream of Klipdrift Dam, improved flows would be required. Flows that would be released from the dam can however be of such bad quality, that it would serve no purpose.

4.15.3 Socio-economic Assessment

The area includes the mining areas of Westonaria, Carltonville and Potchefstroom. The main contributor to GDP, employment opportunities and household income in the area is the mining industry with GDP at R7 814.7 million, employment opportunities of 32 946 and a contribution to household incomes of R3 573.1 million. The area also has a strong manufacturing sector.

Table 4.24: Economic Impacts on Mooi River up to Confluence with Vaal River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	48.9	187.8	1 164	2 760	12.5	137.8
Mining	3 330.7	7 814.7	14 042	32 946	114.8	3 573.1
Manufacturing	1 943.4	4 603.4	8 526	20 194	99.8	3 400.3
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**5 323.1**	**12 605.9**	**23 732**	**55 900**	**227.1**	**7 111.2**

4.15.4 Goods and Services Assessment

This is the area that includes the Mooi River and tributaries. There are numerous developed towns with a variety of industrial communities in the area. Water quality is major issue in much of the area. Given the industrial nature as well as the water quality issues there are few opportunities for communities to make use of goods and services. As such any utilisation is negligible.

- Fishing (Recreational): Of limited importance.
- Fishing (Subsistence): Limited.

- Other Recreational Opportunities: The area offers few opportunities for recreational use and usage is relatively low.
- Riparian vegetation: Usage is limited but there may be some ad hoc usage from poorer urban centres.
- Waste Water Dilution and Assimilation: Although this would be important the nature of the pollutants has probably overwhelmed the ability of the river to cope in this regard.
- Floodplain cultivation: Negligible.

4.15.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

4.16 UV-M: VAAL RIVER REACH FROM VAAL DAM TO C23L

4.16.1 Water Resources Assessment

Vaal River reach between Vaal Dam and the Vaal Barrage (C22K)

Water is released from Vaal Dam for abstraction by Rand Water at Lethabo Weir. The water body created by the Vaal Barrage dam wall dominates the river reach between Vaal Dam and Vaal Barrage. Management of the flow into this reach is from Vaal Dam and is influenced by the water users in and downstream of the Vaal Barrage, the urban return flows and mine dewatering discharges as well as the releases form Vaal Dam to maintain the TDS concentration at 600 mg/l. The three main tributaries (Suikerbosrand, Klip and Rietspruit rivers) discharging into the Vaal Barrage, each convey significant volumes of treated wastewater and mine discharge water.

Vaal River reach between the Vaal Barrage (C22K) and the boundary of the Upper Vaal WMA

The main flow regulating capability for this reach is from Vaal Barrage with support from Vaal Dam. There are contributing flows from the Mooi tributary river. The flow in this river reach is influenced by various factors as listed below:

- Return flows from mine dewatering and treated urban wastewater into this reach and upstream of the Vaal Barrage contribute to the flow in this river reach.
- In the past years a flow dilution operating rule has been applied where water is released from Vaal Dam to maintain the Total Dissolved Solids (TDS) concentration in the Vaal Barrage not to exceed 600 mg/l. This result in “spills” from Vaal Barrage and in some years it can be as much as 200 million m^3/annum.

4.16.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 4.25**. The results are also provided in **Figure B-4** of **Appendix B**.

Table 4.25: PES, EIS and REC for UV-L

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 4	C22F-01737	C	Impacts are mostly due to the presence of Vaal Dam and lack of flow variability. Increased base flows (dry season) occur as well as reduced frequencies of moderate floods due to releases from the Vaal Dam to maintain a target TDS concentration of 600 mg/l downstream of Vaal Barrage.	Agricultural activities, alien vegetation. Deteriorated water quality, alien fish species, and vegetation removal.	HIGH	HIGH	B/C	Improvement is limited due to the limited operational possibilities from the Vaal Dam. Improvement of seasonal variability (decreased base flows during the dry season and increased wet season flows above the current base flows).
EWR 5	C22L-01792	C/D	Increased base flows and reduced frequency of moderate floods due to Vaal Dam and Barrage and releases to regulated TDS levels. Non-flow related impacts include	Agriculture, and urban sewage and industrial waste and the occurrence of gauges, weirs and dams in the system.	HIGH	HIGH	C	Improvement is limited due to the limited operational possibilities from the Vaal Dam. Improvement of decreased base flows for 3 days (during winter) (to improve macroinvertebrates EC) and increased moderate floods in the wet season.

There are no other nodes than the EWR sites in this IUA. The main impacts are due to the increased and aseasonal flows as well as water quality impacts. Alien fish and vegetation also occur.

4.16.3 Socio-economic Assessment

As mentioned above in paragraphs 4.13.3 and 4.14.3 both UV-J: Taaibosspruit and UV-K: Kromelmboogspruit has been included in UV-M: Vaal River from Downstream of Vaal Dam to Outlet of C23L as it is economically impractical to further sub-divide the Unit. This section of the Upper Vaal River is therefore analysed as one economic unit as the economic sectors are similar.

Table 4.26: Economic Impacts on Vaal River from Downstream of Vaal Dam to Outlet of C23L (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	78.2	273.5	1 513	3 285	31.1	172.6
Mining	3 172.5	7 443.6	13 375	31 381	109.4	3 403.4
Manufacturing	11 982.0	28 381.4	52 564	124 506	615.4	20 964.2
Power Generation	27 836.4	26 801.7	5 175	10 593	366.2	12 601.0
Total	**43 069.1**	**62 900.2**	**72 627**	**169 766**	**1 122.0**	**37 141.2**

The area includes the manufacturing areas of Vereeniging, Vanderbijl Park, Sasolburg and Parys. The main contributor to GDP, employment opportunities and household income in the area is the manufacturing sector with a GDP of R28 381.4 million, employment opportunities of 124 506 and a contribution to household incomes of R20 964.2 million.

4.16.4 Goods and Services Assessment

This IUA includes the Vaal River all the way from the Vaal Dam to the end of the Upper Vaal WMA. The towns of Vereeniging, Vanderbijlpark, Roodia, Parys and a myriad of high value residential estate developments about the river are located in this area. Industrial development and some mining are also evident in the area. Below Parys the area is dominated by commercial farms. Also included are areas such as the Lesotho Spruit. Goods and Services utilisation is likely to be practically non-existent on the tributaries but of high importance, particularly recreation in the main Vaal stem. The area includes the Vredefort Dome, a World Heritage site.

- Fishing (Recreational): Highly important and it includes some of the prime yellow fish and carp fishing areas in the country.
- Fishing (Subsistence): Relatively important given the towns and their population, some of whom rely on fish for part of their diet.
- Other Recreational Opportunities: Usage is of high importance. Boating, canoeing and utilisation of the area as an aesthetic resource is of prime importance.
- Riparian vegetation. The utilisation is of moderate importance given the towns and their population, some of whom rely on firewood from trees close to the river for their fuel.
- Waste Water Dilution and Assimilation: Given that land use is urban industrial and commercial agriculture the function of the river in this regard is of high to moderate importance.
- Floodplain cultivation: This is negligible from a livelihood perspective but important in terms of commercial agriculture.

4.16.5 Correction Action

If the proposed action involves corrective action, which could lead to the need for extra volumes of water, it will be supplied by increased augmentation and the augmentation costs calculated.

4.17 UV-N: GROUNDWATER (ABSTRACTION FROM ZUURBEKOM WELLS)

The Zuurbekom dolomitic area (as shown in **Figure 4.1**) straddles quaternary catchments C22A and C23D. The principal aquifer is the dolomitic aquifer of the Malmani group. Mean water levels are between 10-50 mbgl and

have not been significantly affected by mine dewatering. Water levels have been constant since the early 1960s. The Malmani Subgroup is composed of dark grey dolomite with variable proportions of interbedded chert and quartzite.

Major syenite dykes of Pilansberg feature compartmentalise the Zuurbekom. It is separated from the Gemsbokfontein compartment by the Panvlakte dyke in the south, from the Venterspost Compartment by the Gemsbokfontein dyke in the west, and from the Upper Kliprivier compartment by the Kliprivier dyke in the east.

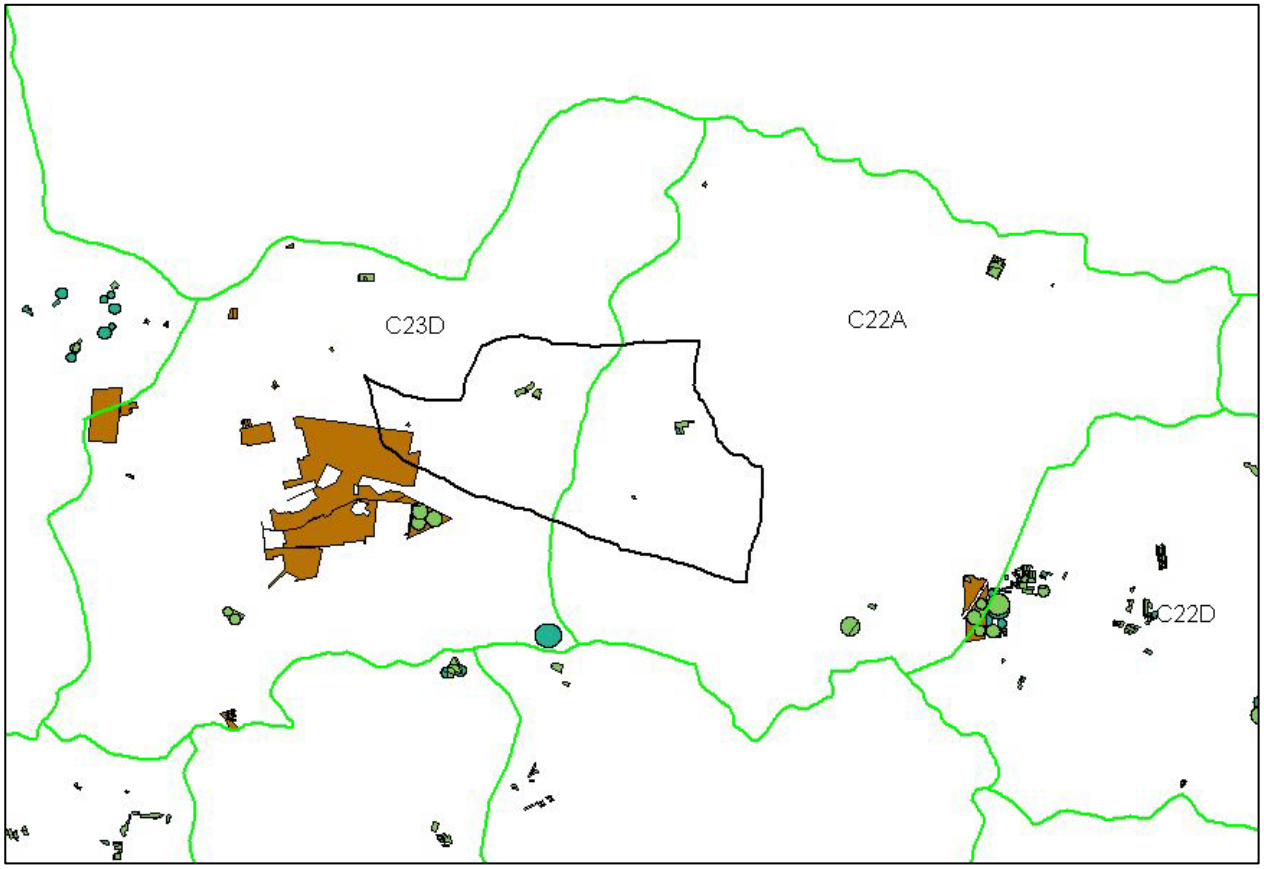


Figure 4.1: Location of Zuurbekom dolomitic aquifer

Surface and subsurface water flow is from north to south. Under natural conditions, the subsurface flow was arrested by the dykes and forced to emanate as springs into the Kliprivier. Enslin (1967) estimated the original Klipriver eye flow to be 13 689 m^3/d before abstraction by Rand Water began in 1896. In 1980 the flow from this eye varied between 7 200 and 12 000 m^3/day, but has since dried up. Recharge has been calculated to be between 27 379 - 35 600 m^3/day, or 15% of the rainfall. Additional inflows are believed to occur from percolation from surface sources and mine effluents. Transmissivity can range from very low in unweathered dolomite to extreme in the karst. Storage coefficients for the compartment are estimated at 3%.

The abstraction of groundwater from the Zuurbekom Wells commenced in 1896. Rand Water has been abstracting water out of the Zuurbekom Wells since 1903 when the Rand Water Board was established. Since 1985 Rand Water has been abstracting 10 Ml/d raw water from the wells and is not planning to increase the water abstraction volumes. Rand Water is currently operating only one borehole. The abstraction well is

situated on the South-western boundary of the Farm Zuurbekom 297 IQ near the Lenasia urban area (26° 17.9634' S, 27° 48.8382' E).

Currently, the Zuurbekom Wells are registered under the National Register of Water Use Certificate 20001409. The registered abstraction volume is 357 7000 m^3/a. A great deal of confusion regarding total water abstraction exists. Some reports cite a total water use of 17.6 million m^3/a, which is 48000 m^3/d, however, this value can be traced back to an original DWA investigation in 1981. Of this volume, only 10 000 m^3/d is attributable to Rand Water. The extent to which this irrigation is currently present needs to be investigated. WARMS lists only 1.8 million m^3/a of irrigation for both the Gemsbokfontein and Zuurbekom Compartments. Validation studies indicate that irrigation within the Zuurbekom compartment is only about 50 ha, or 423 000 m^3/a at the present day development level. **Figure 4.2** shows the Google Earth image of the Zuurbekom area.

Figure 4.2: Google Earth image of Zuurbekom area

5 STATUS QUO OF MIDDLE VAAL WMA

5.1 GENERAL

The Integrated Units of Analysis (IUA) defined within the Middle Vaal WMA are shown in **Figure A-2** of **Appendix A**. Major tributaries of the Vaal River in this WMA are the Renoster, Vals, Schoonspruit and the Sand-Vet. Midvaal Water Company and Sedibeng Water are two bulk water suppliers abstracting water from the Vaal River. Irrigation is the largest water user group in this WMA. There are also significant losses along the main stem of the Vaal River. The water requirements and return flows included in the WRPM configuration are listed in **Table F-2** of **Appendix F**. The WRPM configurations of the Middle Vaal IUAs are shown in **Figure C-5**.

5.2 MV-A: RENOSTER RIVER

5.2.1 Water Resources Assessment

Flow in the upper Renoster River is regulated by Koppies Dam. Irrigation water use in the catchment upstream of Koppies Dam is supplied from run-of-river abstractions as well as from farm dams. Rand Water supplies water to the town Heilbron. Heilbron's effluent discharges are made to the river upstream of Koppies Dam and it was assumed that about 50% of the discharge will result as inflow to the dam. The yield balance situation is such that the water available from the dam is fully utilised. There is also significant water use from the river downstream of the dam to the extent that there is not excess water available. The Voorspoed Mine has recently purchased water rights from irrigators that were supplied from Koppies Dam as part of the Koppies Government Water Scheme.

5.2.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.1**. The results are also provided in **Figure B-5** of **Appendix B**.

Table 5.1: PES, EIS and REC for MV-A

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC24	C70B-02323	C		Agricultural activities.	MODERATE	MODERATE	C	Maintain present conditions to maintain PES/REC.
VC25	C70B-02297	B/C		Agricultural activities.	MODERATE	MODERATE	B/C	Maintain present conditions to maintain PES/REC.
VC26	C70C-02233	C		Agriculture.	MODERATE	MODERATE	C	Maintain present conditions to maintain PES/REC.
R1	C70D-02182	C	Abstraction.		LOW	LOW	C	Maintain present conditions to maintain PES/REC.
VC27	C70D-02215	C/D	Abstraction.	Agricultural activities, small farm dams.	LOW	LOW	C/D	Maintain present conditions to maintain PES/REC.
R2	C70J-02163	C		Agricultural activities.	LOW	LOW	C	Maintain present conditions to maintain PES/REC.
VC29	C70H-02208	C	Abstraction.	Agricultural activities.	LOW	MODERATE	C	Maintain present conditions to maintain PES/REC.
VC30	C70J-01955	C	Abstraction.	Agricultural activities.	LOW	LOW	C	Maintain present conditions to maintain PES/REC.

The predominant land use is agriculture and the impacts are abstraction and other non-flow related agricultural activities. The water quality category across the area is in a B/C to C category. The PES varies from a C/D (1 node) to a B/C (1 node) with all the other nodes being in a C.

There are no nodes with a High importance so the REC in all cases reflects the maintenance of the PES.

5.2.3 Socio-economic Assessment

Table 5.2: Economic Impacts on Renoster River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	25.1	85.5	280	847	9.6	60.8
Mining	0.7	1.4	4	8	0.0	0.6
Manufacturing	34.1	73.0	187	401	3.2	50.3
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**60.0**	**159.9**	**472**	**1 256**	**12.8**	**111.7**

The unit covers a rural area with the only urban centre being the small town of Koppies. The main contributor to GDP, employment opportunities and household income in the area is irrigation agriculture with a GDP of R85.5 million, offering employment opportunities of 847 and making a contribution to household incomes of R60.8 million.

5.2.4 Goods and Services Assessment

This area includes the Renosterspruit that is dominated by dryland and some irrigated commercial agriculture with a sparse population. Also included are Doringspruit, Rietspruit and Heuningsspruit. Towns included in the IUA are Koppies and Edenville among others. Towns serve largely as agricultural service nodes but there is also a number of high value small holdings. However, given the nature of the river and the population that is resident, the usage of goods and services is likely to be low.

- Fishing (Recreational): Moderately important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farmworkers and some usage from the dams.
- Other Recreational Opportunities: The area offers a limited set of recreational opportunities associated with the riverine system but given the relative paucity of alternative recreational zones the riverine areas may play some role particularly in the lower reaches of the Renoster.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual

utilisation is low given the nature of restrictions on access to the river and associated area.

- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.

- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

5.2.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.3 MV-B: VALS RIVER

5.3.1 Water Resources Assessment

Vals River (including and upstream of C61J)

This river system does not have storage regulation capability with release capabilities, with the result that high flow control and management is not possible. Moqhaka (previously known as Kroonstad) is supplied from Serfontein Dam, which has a small storage relative to the runoff. The yield balance situation is such that there are deficits in supply as was recently experienced in restrictions to the town of Moqhaka.

The only management measure to supply the EWRs in this system would be to reduce the water use.

5.3.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.3**. The results are also provided in **Figure B-5** of **Appendix B**.

Table 5.3: PES, EIS and REC for MV-B

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC31	C60A-02607	C	Abstraction.	Agriculture and irrigation.	LOW	LOW	C	Maintain present conditions to maintain PES/REC.
VC33	C60C-02471	C	Abstraction.	Agriculture and irrigation.	LOW	MODERATE	C	Maintain present conditions to maintain PES/REC.
VC35	C60G-02399	C		Water quality related impacts due to upstream urbanization.	LOW	LOW	C	Maintain present conditions to maintain PES/REC.
EWR 14	C60J-02262	C/D	Abstraction	Agricultural activities, anthropogenic activities, WWTW.	To be included after review			

The PES is in a C/D for the EWR site and a C for the other nodes. Most of the impacts associated in this reach are due to agricultural activities, and abstraction in some areas. Water quality (wq) is a C to C/D category for most of the Vals River due to agricultural activities and some urban impacts around Kroonstad. The unnamed tributary is in a B category for water quality as the predominant land use is dryland agriculture.

There are no nodes with a High importance and the REC in all cases reflects the maintenance of the PES.

5.3.3 Socio-economic Assessment

Table 5.4: Economic Impacts on Vals River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	38.9	124.9	222	1 038	12.7	85.8
Mining	834.2	1 581.5	5 068	9 607	44.9	689.6
Manufacturing	853.6	1 827.1	4 690	10 040	80.9	1 257.9
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1 726.7**	**3 533.5**	**9 980**	**20 686**	**138.5**	**2 033.3**

The area hosts both mining and manufacturing sectors with Viljoenskroon as urban centre. The main contributor to GDP, employment opportunities and household income in the area is the manufacturing sector with a GDP of R1 827.1 million, employment opportunities of 10 040 and a contribution to household incomes of R1 257.9 million. The area also has a competing mining sector.

5.3.4 Goods and Services Assessment

This part includes the Vals River with dryland commercial agriculture and some limited irrigation. A sparse population is characteristic of most of the area. Also included as riverine resources, are the Elandspruit, Renosterpruit and Skikspruit. These are also associated with dryland agriculture. The major town is Kroonstad with Viljoenskroon also present.

- Fishing (Recreational): Moderately important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farmworkers and some usage from the dams.
- Other Recreational Opportunities: The area offers a limited set of recreational opportunities associated with the riverine system but given the relative paucity of alternative recreational zones the riverine areas may play some role particularly in the lower reaches of the Vals.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the

function of the river in this regard is of moderate importance.

- Floodplain cultivation: Although there are floodplains in the area and they are utilised it is part of the commercial agricultural utilisation sector rather than direct use for livelihoods.

5.3.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.4 MV-C: SCHOONSPRUIT AND KOEKEMOERSPRUIT

5.4.1 Water Resources Assessment

Schoonspruit River (including and upstream of C24H)

This river system has been the subject of a Catchment Management Strategy Study which also included a Reserve Determination Study. The hydrology and EWR information from that study was obtained and the WRPM configuration of the entire Schoonspruit Sub-system was updated as part of the Comprehensive Reserve Determination Study (DWA, 2010d).

The catchment of the Koekemoerspruit was included in the so-called Bloemhof Dam incremental catchment. Note that the Schoonspruit was not re-evaluated on a desktop level as part of the water quality assessment as a Reserve study (**DWAF, 2006**) had previously been conducted.

5.4.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.5**. All the required information was not explicit in the Schoonspruit EWR reports and the missing sections will have to be assessed and the rest to be derived. Although it was not planned to include the Schoonspruit in the review of the Middle and Lower Vaal Reserve studies, some aspects will have to be addressed. The results are also provided in **Figure B-6** of **Appendix B**.

Table 5.5: PES, EIS and REC for MV-C

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
S1	C24E-01164	C/D	Agricultural return flows, flow regulation for irrigation use (less flows in the river).		Not undertaken as part of the Comprehensive EWR study		C/D	To be included after review
VC21	C24F-01476	C	Abstraction.	Agriculture and barrier effect in lower reaches impacting migration.	LOW	MODERATE	C	Maintaining present day flows will maintain PES/REC.

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
S3	C24G-01661	C/D	Agricultural return flows, flow regulation for irrigation use (less flows in the river).		Not undertaken as part of the Comprehensive EWR study		C/D	To be included after review
S4	C24H-01860	C/D	Agricultural return flows, flow regulation for irrigation use (less flows in the river).	Water quality related problems relating to urbanization, mining and agriculture.	Not undertaken as part of the Comprehensive EWR study		C/D	To be included after review
VC22	C24A-01787	D/E	Abstraction.	Water quality related problems relating to urbanization, mining and agriculture.	LOW	LOW	D	For an improvement in the macroinvertebrate EC, water quality improvement is needed although this is unlikely to. To improve the vegetation, agricultural practices require improvement.
VC23	C24H-01732	D	Abstraction.	Water quality related problems relating to urbanization, mining and agriculture.	LOW	LOW	D	Fish must be improved but this is unlikely to happen unless the Klerksdorp water quality issues are addressed.

Water quality is generally poor across this area, i.e. a D on the Taaibosspruit to a D/E on the Koekemoerspruit and an E on the Jagspruit. Impacts are largely due to agriculture and urban / mining impacts. To improve the Koekemoerspruit to a D (the required REC) would require water quality improvements which are unlikely to happen as well as improvements in agricultural practices.

5.4.3 Socio-economic Assessment

Table 5.6: Economic Impacts on Schoonspruit and Koekemoerspruit (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	40.5	128.4	211	1 038	13.0	87.6
Mining	5 147.1	9 757.6	31 268	59 276	276.7	4 254.9
Manufacturing	417.5	893.7	2 294	4 911	39.6	615.3
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**5 605.1**	**10 779.7**	**33 773**	**65 226**	**329.3**	**4 957.8**

The area is a predominantly mining area. The main contributor to GDP, employment opportunities and household income in the area is therefore the mining industry with a GDP of R9 757.6 million, employment opportunities of 59 276 and a contribution to household incomes of R4 254.9 million.

5.4.4 Goods and Services Assessment

This includes the Schoonspruit, Taaibosspruit, Koekemoerspruit and Jagspruit. The important towns are

Ventersdorp, Klerksdorp, Stilfontein, and parts of the outskirts of Orkney. Land use is predominately dryland and limited irrigated agriculture with the urban nodes largely acting as agricultural service delivery towns as mentioned, and some mining.

- Fishing (Recreational): This is of moderate important in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farm workers and some usage from the dams although some populations from the towns may also make limited use of subsistence fishing but access is limited and the habitat forms are such that fish do not thrive readily.
- Other Recreational Opportunities: The area offers a limited set of recreational opportunities associated with the riverine system but given the relative paucity of alternative recreational zones the riverine areas may play some role.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.
- Floodplain cultivation: Negligible.

5.4.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.5 MV-D1: UPPER SAND RIVER

5.5.1 Water Resources Assessment

This IUA comprises of the catchment upstream of Allemanskraal Dam which is located on the Sand River in quaternary catchment C42E. There are a number of small dams in this incremental catchment which supply water for irrigation. Allemanskraal Dam is over utilised (existing allocations exceed the water resource availability) and any new allocations in the upstream catchment will have a negative impact on the assurance of supply to existing water users. Although existing water use comprises mainly of irrigation, Virginia town has an allocation of 15.2 million m^3/a from the dam. The dam has flow release regulating capabilities and it was recommended that an EWR site be considered downstream of the dam.

5.5.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.7**. The results are also provided in **Figure B-7** of **Appendix B**.

Table 5.7: PES, EIS and REC for MV-D1

VC node	SQ code	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC 40	C42D-02890	C	Abstraction in upper reach.	Agriculture, effluent from WWTW at Senekal.	LOW	LOW	C	Present flow conditions will maintain PES/REC

Agricultural activities (mainly dryland) predominate in this reach. The site is downstream of Senekal, with the ponds from the WWTW in the upper reaches. Expected impacts are elevated nutrients, with significant increases in sediments (although probably largely natural). Water quality category and the PES is a C. As the importance is low, the REC is set to maintain the PES.

5.5.3 Socio-economic Assessment

For practical economic purposes units MV-D1: Upper Sand River and MV-D2: Lower Sand River was grouped together in the Socio-economic Assessment as one economic sector. As the two units are similar it will not affect the assessment and only differ in that it represents the area above the Allemanskraal Dam and the area below.

This area is also predominantly a mining area with Welkom being the urban centre. The main contributor to GDP, employment opportunities and household income in the area is therefore the mining industry with a GDP of R2 576.1 million, employment opportunities of 15 650 and a contribution to household incomes of R1 123.3 million.

Table 5.8: Economic Impacts on Sand River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	26.2	73.7	271	1 257	3 128.8	477.2
Mining	1 358.9	2 576.1	8 255	15 650	73.1	1 123.3
Manufacturing	263.0	563.0	1 445	3 094	24.9	387.6
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1 648.1**	**3 212.8**	**9 971**	**20 000**	**3 226.7**	**1 988.1**

5.5.4 Goods and Services Assessment

This is the upper reaches of the Sand River. The area includes the town of Senekal. Land use is predominately dryland and limited irrigated agriculture. Some parts of the upper catchment have a marked aesthetic appeal and provide for recreational opportunities. The Allemanskraal Dam also offers recreational opportunities.

- Fishing (Recreational): This may be of some importance in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): This is limited to farmworkers and some usage from the river and Allemanskraal Dam.
- Other Recreational Opportunities: The area offers some of recreational opportunities associated with the riverine mostly in the upper regions.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.
- Floodplain cultivation: Negligible.

5.5.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.6 MV-D2: LOWER SAND RIVER

5.6.1 Water Resources Assessment

Effluent discharges from Welkom and the return flows from the irrigation scheme (supplied by releases from Allemanskraal Dam) may impact on the water quality downstream of the dam.

5.6.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.9**. The results are also provided in **Figure B-7** of **Appendix B**.

Table 5.9: PES, EIS and REC for MV-D2

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
V1	C42G-02828	C	Flow modification	Irrigation	MODERATE	LOW	C	Maintaining present flow conditions will maintain the PES/REC
VC42	C42F-02762	C	Flow modification and abstraction	Irrigation	MODERATE	LOW	C	Maintaining present flow conditions will maintain the PES/REC
VC46	C41L-02635	C	Abstraction	Water quality related problems associated with US reach - urbanization and mining.	MODERATE	LOW	C	Maintaining present flow conditions will maintain the PES/REC

The PES is a C for all nodes. Most of the impacts associated in this reach are due to agricultural activities, abstraction and urbanisation and mining (VC46). Water quality in the area is worst where mining impacts around Welkom and Virginia dominate. Here water quality is assumed to be a D category. Impacts at the other two sites are mostly agricultural, and are a B/C to C category

There are no nodes with a High importance so the REC in all cases reflects the maintenance of the PES.

5.6.3 Socio-economic Assessment

See Socio-Economic Assessment in **Section 0** above.

5.6.4 Goods and Services Assessment

This is the lower Sand River but also includes the Klipspruit, Koolspruit, Maselspruit, Erasmusspruit, and the Sloopspruit. Towns include Ventersburg, Henneman, and Virginia. Most land use is dryland agriculture with limited irrigation. There is some mining. Other than in the towns the population density is very sparse.

- Fishing (Recreational): This is of some importance in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): This is limited to farmworkers and some usage from the rivers. Poorer sectors of the towns of Ventersburg, Henneman and Virginia may make use of opportunities but these are likely to be very limited.
- Other Recreational Opportunities: The area offers some of recreational opportunities associated with the riverine areas but these are limited and mostly used as a result of the paucity of other options.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.
- Floodplain cultivation: Negligible.

5.6.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.7 MV-E1: UPPER VET RIVER

5.7.1 Water Resources Assessment

This IUA comprises of the catchment upstream of Erfenis Dam which is located on the Vet River in quaternary catchment C41E. There are a number of small dams in this incremental catchment which supply water for irrigation. Erfenis Dam is fully utilised (existing allocations in balance with the water resource availability) and any new allocations in the upstream catchment will have a negative impact on the assurance of supply to existing water users. Erfenis Dam supplies water for irrigation and urban use. Bultfontein, Hoopstad, Brandfort and Theunissen receive water from Erfenis Dam. The dam has flow release regulating capabilities and it was recommended that an EWR site be considered downstream of the dam.

5.7.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.10**. The results are also provided in **Figure B-7** of **Appendix B**.

Table 5.10: PES, EIS and REC for MV-E1

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC49	C41D-03169	C	Flow modification		LOW	MODERATE	C	Maintaining present flows should maintain the PES/REC
VC52	C41E-03132	C	Flow modification		LOW	LOW	C	Maintaining present flows should maintain the PES/REC
VC51	C41E-02989	B/C		Agriculture	LOW	MODERATE	B/C	Note, upper sections probably in a B EC - the whole river should be subdivided if necessary and the sections kept in the state it is now. Flow requirements will be set for a B.

The PES is a C for 2 nodes and a B/C for VC51. Most of the impacts associated in this reach are due to flow modification with agriculture being the dominant issue in VC51.Water quality impacts across the area are low, with the dominant category being a B category with some elevations in nutrients and sediment loads.

There are no nodes with a High importance so the REC in all cases reflects the maintenance of the PES.

5.7.3 Socio-economic Assessment

The area above the Erfenis Dam has both mining and manufacturing sectors with Winburg as the urban centre. The main contributor to GDP and employment opportunities in the area is the mining industry with a GDP of R1 691.7 million and employment opportunities of 10 277. The manufacturing sector, however, contributes the most to household incomes, namely R1 064.7 million.

Table 5.11: Economic Impacts on the Upper Vet River (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	26.1	70.3	259	1 202	3 002.8	459.7
Mining	892.4	1 691.7	5 421	10 277	48.0	737.7
Manufacturing	722.5	1 546.6	3 970	8 499	68.5	1 064.7
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1 641.0**	**3 308.6**	**9 650**	**19 977**	**3 119.2**	**2 262.2**

5.7.4 Goods and Services Assessment

This is the upper portion of the Vet River but also includes the Lengana River, Leeuspruit River, Vaalbankspruit, Klein Vet River and Soutspruit. The area is dominated by mostly dryland commercial agriculture. The Erfenis Dam is also in the area. The only town of any significance is Winburg. There is limited irrigation with some mining activities. Other than in the towns the population density is very sparse.

- Fishing (Recreational): Some importance in certain areas with the emphasis on the river and farm dams.
- Fishing (Subsistence): Limited to farmworkers and some usage from the rivers and small farm dams.
- Other Recreational Opportunities: The area offers some recreational opportunities associated with the riverine areas mostly in the upper regions.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.
- Floodplain cultivation: Negligible.

5.7.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.8 MV-E2: LOWER VET RIVER

5.8.1 Water Resources Assessment

The water quality of the Lower Vet River is influenced by irrigation return flows from the irrigation scheme, as well as reduced flows in the river itself. Tailwater from the irrigation canal system is also released back into the river. There are irrigation activities in the catchment which are supplied by run-of-river abstractions. EWR site 15 (EWR15) is located in this catchment and a Reserve was determined for the site as part of the Comprehensive Reserve Determination Study (DWA, 2010d).

5.8.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.12**. The results are also provided in **Figure B-7** of **Appendix B**.

Table 5.12: PES, EIS and REC for MV-E2

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
V2	C41H-03012	C	Flow modification (Erfenis Dam).		LOW	MODERATE	C	Assumed that PES/REC will be maintained if present flow conditions remain unchanged.
EWR 15	C43A-02561	D/E	Abstraction.	Intense agriculture, loss of riparian vegetation, encroachment of alien vegetation.	MODERATE	MODERATE	D	Controlling abstractions to improve flows and water quality.
RE-EWR 3	C41E-03132	C	Flow modification, upstream dams.	Agricultural activities.	MODERATE	MODERATE	C	Assumed that PES/REC will be maintained if present flow conditions remain unchanged.

This reach is the Vet River downstream of Erfenis Dam. Dryland agriculture dominates, with erosion evident in the reach. Upstream impacts would be contained in Erfenis Dam. Road crossings are also evident. Tributaries coming into the Vet River downstream of the dam have a number of instream dams along their length. There is a small waterworks at the start of the reach. The water quality category for this reach is a C category, despite there being an adequate riparian buffer. This result is in agreement with that for EWR15 (Vaal Comprehensive Reserve study) and the output of the Resource Water Quality Objectives (RWQO) study (pers. comm., Jay, DWA, September 2011) The PES is a C and the REC is set to maintain the PES due to the moderate EI.

5.8.3 Socio-economic Assessment

This area below the Erfenis Dam is mainly a farming area with Bultfontein and Hoopstad being the only towns. The main contributor to GDP, employment opportunities and household income in the area is therefore the manufacturing sector with a GDP of R1 268.5 million, employment opportunities of 6 971 and a contribution to household incomes of R873.3 million.

Table 5.13: Economic Impacts on Lower Vet River below the Erfenis Dam (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	17.4	46.9	173	801	2 001.8	306.5
Mining	445.8	845.1	2 708	5 134	24.0	368.5
Manufacturing	592.6	1 268.5	3 257	6 971	56.2	873.3
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1 055.8**	**2 160.5**	**6 137**	**12 906**	**2 082.0**	**1 548.3**

5.8.4 Goods and Services Assessment

This is the lower portion of the Vet River but also includes the Taaibos Spruit and the Bloemhof Dam. The major urban settlement is Hopetown but, as with the upper Vet portion of the catchment, the population is sparse. Commercial dryland agriculture is the dominant land use and the population density is therefore scattered and relatively sparse.

- Fishing (Recreational): This is of some importance in certain areas with the emphasis on the river and farm dams as well as the areas upstream of the Bloemhof Dam. Commercial fishing is a feature of the Bloemhof Dam, but this is excluded from this assessment.
- Fishing (Subsistence): Limited to farmworkers.
- Other Recreational Opportunities: The area offers some recreational opportunities associated with the riverine areas as well as those associated with the points of inflow into Bloemhof dam.
- Riparian vegetation: Although some species were deemed to be important in this regard the actual utilisation is low given the nature of restrictions on access to the river and associated area.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of moderate importance.
- Floodplain cultivation: Negligible from a livelihood perspective although important in terms of commercial value.

5.8.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

5.9 MV-F: VAAL RIVER FROM C24B TO BLOEMHOF DAM

5.9.1 Water Resources Assessment

Midvaal Water Company and Sedibeng Water are two bulk water suppliers abstracting water from the Vaal River in this IUA. There are contributing flows from tributary rivers such as the Renoster, Schoonspruit and Vals. There are also significant evaporative losses in this river reach. The location of Bloemhof Dam, at the downstream end of this river reach, provides operating flexibility in that water released from the Vaal Barrage is not necessarily a loss from the Integrated Vaal River System. There are, however, constraints in the volume of releases that can be made.

5.9.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 5.14**. The results are also provided in **Figure B-8** of **Appendix B**.

Table 5.14: PES, EIS and REC for MV-F

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 12	C24B-01817	D	Operation of the system and Vaal Dam upstream.	Mine effluent, agriculture run off and WWTW.	MODERATE	MODERATE	D	A change in flow seasonality which mimics a natural flow regime. More floods and freshette cues in summer. Water quality management.
EWR 13	C24J-02016	C	Operation of the system and Vaal Dam upstream.	Mine effluent, agriculture run off and WWTW.	Review of this data would be required to confirm the EIS			
VC56	C41H-02948	C	Flow modification.		LOW	MODERATE	C	If present flow conditions are maintained, then the PES/REC will be maintained

VC56 represents the reach in the lower Klipspruit before its confluence with the Vaal River. Upper tributaries are largely in dryland agricultural areas. This reach is covered by old agricultural land and is assumed to be ephemeral. A number of road crossings are present. The water quality is unlikely to move out of an A category, with the primary water quality issue probably being erosion and sediment loads. The PES is a C due to flow modification and the REC is set to maintain the PES due to the Moderate EI. The EWR sites are also in a C PES with the impacts dominated by the flow modification and water quality issues.

5.9.3 Socio-economic Assessment

This area is mainly a manufacturing area. The main contributor to GDP, employment opportunities and household income in the area is therefore the manufacturing sector with a GDP of R979.5 million, employment opportunities of 5 383 and a contribution to household incomes of R674.3 million.

Table 5.15: Economic Impacts on Vaal River C24B to Bloemhof Dam (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	60.9	146.2	728	1 558	46.5	165.5
Mining	236.3	447.9	1 435	2 721	12.7	195.3
Manufacturing	457.6	979.5	2 515	5 383	43.4	674.3
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**754.8**	**1 573.6**	**4 678**	**9 662**	**102.6**	**1 035.1**

5.9.4 Goods and Services Assessment

This includes the Vaal River all the way from the end of the Upper Vaal WMA to the Bloemhof Dam. The town of Orkney is proximate to the river. Most of the area is made up of dryland agriculture although irrigated agriculture is also important, particularly in the lower portions of this river reach.

- Fishing (Recreational): Highly important and some of the prime yellow fish and carp fishing areas in the country.
- Fishing (Subsistence): Relatively important but possibly limited to the poorer sectors of the urban areas associated with Orkney and some farmworkers.
- Other Recreational Opportunities: Usage is of moderate importance but not as notable as the areas of the Vaal upstream of this reach.
- Riparian vegetation: The utilisation is of moderate importance given the towns and their population, some of whom rely on firewood from trees close to the river for their fuel.
- Waste Water Dilution and Assimilation: Given that land use is some urban industrial and a great deal of commercial agriculture the function of the river in this regard is of high t to moderate importance.
- Floodplain cultivation: This is negligible from a livelihood perspective but important in terms of commercial agriculture.

5.9.5 Corrective Action

If the proposed action involves corrective action, which could lead to the need for extra volumes of water, it will be supplied by increased augmentation and the augmentation costs will be calculated.

5.10 MV-G: GROUNDWATER IN SCHOONSPRUIT

The upper portion of the Schoonspruit catchment (C24C) mainly flows into the ground and into a dolomite compartment. Much of this water surfaces as a spring through the Schoonspruit Eye. The interaction between

surface and groundwater was explicitly modelled as part of the Schoonspruit Study (**DWAF, 2006**). **Figure 5.1** shows the extent of the Schoonspruit dolomitic compartment.

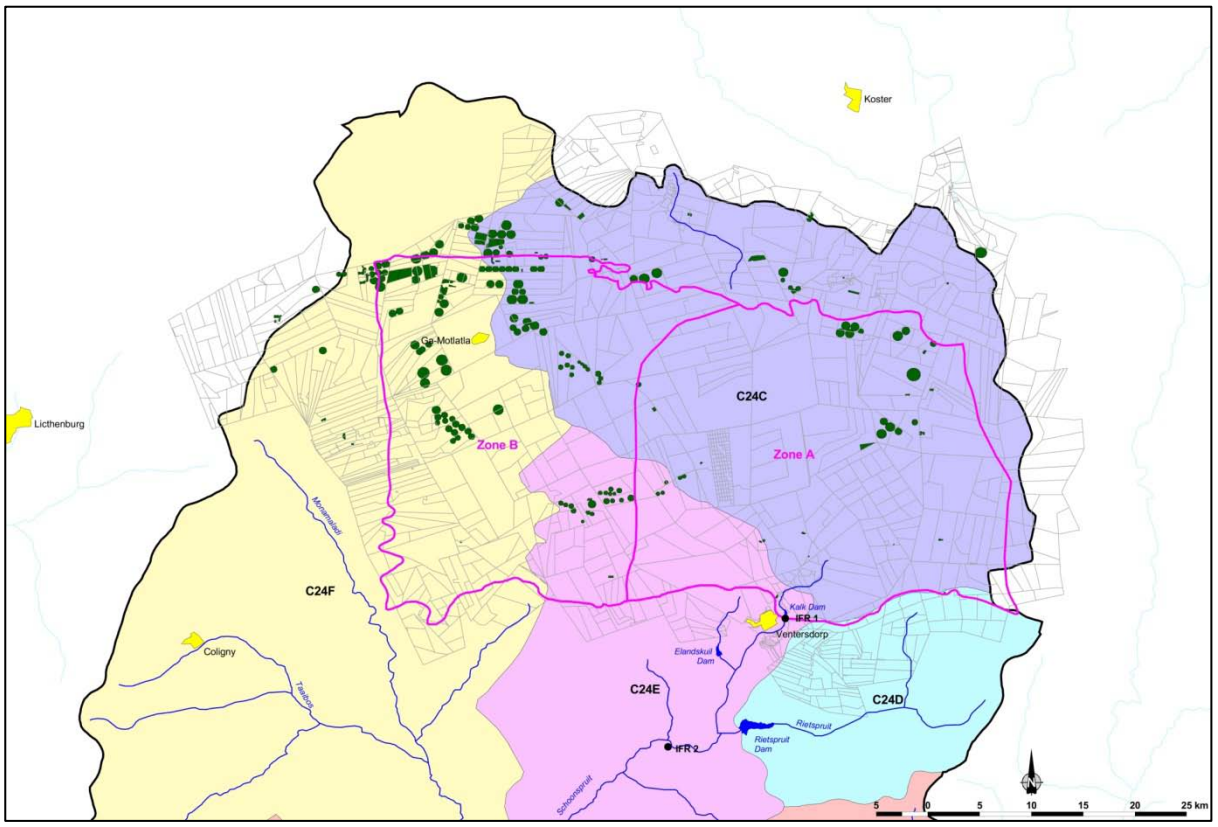


Figure 5.1: Location of Schoonspruit dolomitic compartment

The Schoonspruit Dolomitic Compartment has been named after the Schoonspruit Eye, which is dependent on the compartment for flow. It consists of dolomites of the Malmani Group. Chert rich units of the Monte Christo and Eccles Formations have an increased permeability and storage due to karst solution channels. The topography slopes downward from the Northeast to the Southwest. The Schoonspruit drains the Schoonspruit compartment and runs to the Johan Neser Dam.

The area falls in the summer rainfall area, with most of the rainfall occurring from November to February. The average rainfall for the area is 587 mm/a. Recharge is approximately 6% of the rainfall. The average water level is 20.5 mbgl, and the average yield is about 15 l/s, hence the compartment is a high yielding aquifer.

The 1 585 km^2 compartment is outlined by the contact with the Rooihoogte formation of the Pretoria group in the North and the contact with the Black Reef formation in the South. A NNW-SSE striking dyke forms the eastern boundary and a N-S running fault system the western boundary.

An important characteristic of the Schoonspruit System is the strong interaction between groundwater and surface water resources due to discharges from the dolomitic compartment. Significant irrigation developments on the dolomitic aquifer began in the late 1980s and significantly impacted on flows from the eye and to the

Schoonspruit system. Borehole abstractions dramatically increased over time from 2 767ha in 1994 to 5 017ha in 2002, with a total demand of 41 million m^3/a. Abstraction has been validated by Schoeman and Vennote over time windows in order to quantify the areas under irrigation. Over time this irrigation has also migrated and takes place further away from the spring. This has important implications to the impact on flow from the eye. Flow from the eye has been reduced from 60 million m^3/a under natural conditions after the start of irrigation. The flow from the eye was successfully simulated over the period 1920 to 2002 (**DWAF, 2006**), showing that flow reduced to 20 million m^3/a in the early 1990s, rising to 48 million m^3/a in 2000 with a reduction in abstraction.

Since flow from the eye contributes 50% of inflows to the Johan Neser Dam and a high proportion of baseflow, simulating the impacts of abstraction on discharges from the eye is crucial to the yield analysis of the Johan Neser Dam.

6 STATUS QUO OF LOWER VAAL WMA

6.1 GENERAL

The five Integrated Units of Analysis (IUA) defined within the Lower Vaal WMA are shown in **Figure A-3** of **Appendix A** and **Figure C-6** of **Appendix C** shows the WRPM configurations of these IUAs. It is important to note that although the Riet-Modder catchment is part of the Lower Vaal catchment, it falls under the Orange River WMA and was, therefore, as stated in the Terms of Reference (TOR), not included in this study's area.

The Vaalharts Irrigation Scheme, situated in the Harts River catchment, is the largest irrigation scheme in the country. The scheme comprises of the Vaalharts Weir, located on the main stem of the Vaal River downstream of Bloemhof Dam, and a canal distribution system which is in need of rehabilitation. Losses from the canal system range between 17% and 35%. The scheme is supplied with water released from Bloemhof Dam. There are a number of abstractions along the main stem of the Vaal River to supply water for irrigation and urban use (Kimberley and others). The Vaal-Gamagara Government Water Scheme also abstracts water from the Vaal River upstream of the Riet-Modder confluence with the Vaal and has an allocation of about 13 million m^3/a . The water requirements, return flows and losses included in the WRPM configuration are listed in **Table F-2** of **Appendix F**.

6.2 LV-A1: UPPER HARTS RIVER

6.2.1 Water Resources Assessment

This river reach has no upstream regulating storage and there are substantial irrigation abstractions that are already experiencing low assurance of supply. Water is also transferred from the Harts River (approximately from the outlet of C31B) into Barberspan (located in quaternary C31D). This transfer will result in some of the base flow being removed from the river reach. The exact operation of this transfer is unknown (capacity of the transfer infrastructure etc.) at this point in time and need to be investigated as part of another study. The ecological benefits of not transferring the water to Barberspan should be weighed against the benefits of having the water in Barberspan. **Barberspan Nature Reserve** is positioned 16 km north east of Delareyville. It has been identified as a RAMSAR site and is a sanctuary for waterfowl.

6.2.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 6.1**. The results are also provided in **Figure B-9** of **Appendix B**.

Table 6.1: PES, EIS and REC for LV-A1

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC55	C31B-01275	C	Abstraction	Agriculture and small farm dams	LOW	LOW	C	Maintaining present flow conditions will maintain the PES/REC
VC61	C31C-01665	C	Abstraction	Agriculture	LOW	MODERATE	C	Maintaining present flow conditions will maintain the PES/REC

Water quality category is a B to C category for the Upper Harts catchment. The PES is a C for all nodes. Most of the impacts associated in this reach are due to agricultural activities and abstraction.

There are no nodes with a High importance so the REC in all cases reflects the maintenance of the PES.

6.2.3 Socio-economic Assessment

For practical economic purposes the individual integrated units of analyses of LV-A1: Upper Harts River, LV-A2: Middle Harts River, LV-A3: Dry Harts River and LV-A4: Lower Harts River was grouped together in the Socio-economic Assessment as one economic sector. As the four units are similar it will not affect the assessment.

Table 6.2: Economic Impacts on the Hartswater River

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	**Total**	**Direct**	**Total**	**Low**	**Total**
Irrigation Agriculture	106.6	400.7	1 697	4 473	51.9	299.0
Mining	1 835.0	3 478.8	11 148	21 133	98.7	1 517.0
Manufacturing	1 455.0	3 114.5	7 995	17 114	137.9	2 144.2
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**3 396.6**	**6 993.9**	**20 840**	**42 721**	**288.5**	**3 960.1**

The area hosts the mining, manufacturing and irrigation agriculture sectors. The main urban centres are Schweizer-Reneke, Taung and Hartswater. The main contributor to GDP and employment opportunities is the mining sector with a GDP of R3 478.8 million and employment opportunities of 21 133. The manufacturing sector is the main contributor to household income, namely R2 144.2 million.

6.2.4 Goods and Services Assessment

This is Upper Harts and Klein Harts systems. The area is dominated by dryland commercial agriculture. Sannieshof is practically the only urban node of any importance in the area. The Barberspan Dam is a recreational feature. Population density is low.

- Fishing (Recreational): Of limited importance.
- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and .usage is relatively low
- Riparian vegetation: Usage is limited. .
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the

function of the river in this regard is of some importance.

- Floodplain cultivation: Negligible.

6.2.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

6.3 LV-A2: MIDDLE HARTS RIVER

6.3.1 Water Resources Assessment

Wentzel Dam is located at the outlet of quaternary C31E, and has limited release capability. The dam supplies water to Schweizer-Reneke for domestic purposes. The available yield of Wentzel Dam is fully utilised and EWR releases will result in a deficit in supply.

6.3.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 6.3**. The results are also provided in **Figure B-9** of **Appendix B**.

Table 6.3: PES, EIS and REC for LV-A2

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC57	C31E-02045	C		Agricultural activities.	LOW	MODERATE	C	Maintaining the present state should maintain the PES/REC.

This stretch is the Harts River upstream of Schweizer-Reinecke, which runs into Wentzel Dam. Land use is primarily dryland agriculture. The water quality category is a B category and the PES is a C. The REC reflects the maintenance of the PES due to the moderate EI.

6.3.3 Socio-economic Assessment

See the Socio-Economic Assessment in **Section 6.2.3** above.

6.3.4 Goods and Services Assessment

This is Middle Harts system. The area is dominated by dryland commercial agriculture. Delareyville is practically the only urban node of any importance in the area. Population density is low.

- Fishing (Recreational): Of limited importance.

- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and usage is relatively low.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance but probably not as important as the reaches below this point.
- Floodplain cultivation: Negligible.

6.3.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

6.4 LV-A3: DRY HARTS RIVER

6.4.1 Water Resources Assessment

No regulation storage is present in this catchment and the flow is largely natural. The river is non-perennial.

6.4.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 6.4**. The results are also provided in **Figure B-9** of **Appendix B**.

Table 6.4: PES, EIS and REC for LV-A3

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
VC58	C32D-03250	D	Upstream of Taung Dam & irrigation.	Agricultural activities.	LOW	LOW	D	Maintaining the present day flow will maintain the PES/REC

The upper reaches of the river flow past a number of urban / peri-urban settlements, e.g. Leshobo and Matlapaneng. In this reach it flows past Mokgareng. The lower end of the reach flows past pivot agriculture around Taung town. A number of road crossings are found in the reach. Extensive erosion is also evident. The water quality category is a C category and the PES is a D EC. Due to the low EI, the REC is set to maintain the D PES.

6.4.3 Socio-economic Assessment

See the Socio-Economic Assessment in **Section 6.2.3** above.

6.4.4 Goods and Services Assessment

This is the dry Harts system. The area is dominated by dryland commercial agriculture. Vryburg is the only urban node of any importance in the area. Population density is low to very sparse.

- Fishing (Recreational): Of limited importance but some Yellowfish are present.
- Fishing (Subsistence): Limited.
- Other Recreational Opportunities: The area offers few opportunities for recreational use and usage is relatively low.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance.
- Floodplain cultivation: Negligible.

6.4.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

6.5 LV-A4: LOWER HARTS RIVER

6.5.1 Water Resources Assessment

Taung Dam is not utilised and investigations are currently underway to determine the feasibility of using the dam to supply domestic and/or irrigation water requirements from the dam. Taung Dam will have limited release capability (remedial civil works are being carried out on the release structures). The EWR downstream of the dam will have a direct influence on the water that will be available to supply the proposed water uses.

Significant flows occur in the Harts River upstream of Spitskop Dam from the return flows of the Vaalharts Irrigation Scheme. The return flows have substantially changed the flow regime compared to natural conditions. This river reach receives flows from the Dry Harts River (upstream of and including quaternary C32D), which has no regulating storage structure as well as from Taung Dam located in quaternary C31F.

The water available in Spitskop Dam is more than the water requirements supplied from the dam. This is due to

the large volume of return flows generated by the Vaalharts Irrigation Scheme located upstream of the dam. Water is released from Spitskop Dam from where it is abstracted for irrigation along the downstream river reach. Spitskop Dam has the capability to regulate flow releases in this river reach. Investigations were done to identify potential further user of the excess water available in the dam with the purpose of improving the water quality in the Vaal.

6.5.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 6.5**. The results are also provided in **Figure B-9** of **Appendix B**.

Table 6.5: PES, EIS and REC for LV-A4

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 17	C33C-02836	D	Irrigation return flows from Vaalharts Irrigation Scheme (increased base flows) & Spitskop Dam (reduction in moderate events).	Anthropogenic activities including mining and agriculture.	MODERATE	MODERATE	D	Maintaining the present day flow will maintain the present state.
VC59	C91D-02838	A/B		Agricultural activities.	MODERATE	HIGH	A/B	As one of the few A/B rivers, it is vital to maintain the PES/REC. Impacts are not flow related however.

With reference to VC59 the impacts are related to erosion and pivot agriculture. The water quality status for the site on the Harts River is a C category, while the tributary will only be marginally affected in the lower reaches and is expected to stay in an A category. The PES is an A/B with a resulting High EI. Due to the already high PES, the REC does not require any improvements.

The EWR site is in a D EC with most of the impacts originated from flow modification.

6.5.3 Socio-economic Assessment

See the Socio-Economic Assessment in **Section 6.2.3** above.

6.5.4 Goods and Services Assessment

This is the lower Harts River. The upper portions of the area are dominated by the Hartswater Irrigation scheme with irrigated agriculture the dominant land use. The lower portion of the area below the Spitskop Dam has little river flow. Dryland commercial agriculture is the dominant landform. The major towns are Hartswater and Pampierstad in the upper area, while the population of the lower portion of the area is negligible.

- Fishing (Recreational): Of some importance but limited species.
- Fishing (Subsistence): Limited but may play some role for residents of Pampierstad.

- Other Recreational Opportunities: The area offers few some opportunities for recreational use but this is probably associated with the dam.
- Riparian vegetation: Usage is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance, particularly given the intensity of use.
- Floodplain cultivation: Negligible.

6.5.5 Corrective Action

If the ecological analysis show the need for the making available of higher volumes of water and the present sources cannot supply, reallocation from the irrigation sector will take place and the macro – economic impacts of the action will be calculated.

6.6 LV-B: VAAL RIVER REACH DOWNSTREAM OF BLOEMHOF TO DOUGLAS

6.6.1 Water Resources Assessment

The flow in the river reach between Bloemhof Dam and Vaalharts Weir is dominated by the releases made from Bloemhof Dam for the Vaalharts Irrigation Scheme. Evaporation losses along this river reach is relatively high. Vaalharts Weir serves as the structure from where the irrigation water is diverted into the canal that feeds the Vaalharts Irrigation Scheme. Vaalharts Weir is generally operated at 90% of its Full Supply Capacity (FSC). Significant operational losses have also been identified and recommendations have been made in the past to improve on the operation of the system in order to minimise losses. Bloemhof Dam has substantial flow regulation capability.

There are a number of abstractions along the main stem of the Vaal River to supply water for irrigation and urban use (Kimberley, Christiana, Warrenton, Windsorton, Barkly West and Delportshoop). The Vaal-Gamagara Government Water Scheme also abstracts water from the Vaal River upstream of the Riet-Modder confluence with the Vaal and has an allocation of about 13 million m^3/a. The confluence of the Riet- and Vaal rivers is downstream of Schmidtsdrift and upstream of Douglas Weir. Douglas Weir is the most downstream storage structure, which has limited flow-regulating capability.

The Douglas Irrigation Scheme is supplied from the Douglas Weir and, in addition to the runoff entering Douglas Weir from the upstream incremental catchments, water is transferred (pumped) from the Orange River into Douglas Weir. No releases are made from storage structures in the Vaal, Harts or Riet-Modder river systems to support the water requirements in Douglas Weir.

6.6.2 Ecological Assessment

A summary table of the status quo assessment for each node and SQ reach is provided in **Table 6.6**. The results are also provided in **Figure B-9** of **Appendix B**.

Table 6.6: PES, EIS and REC for LV-B

VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC	ACTIONS REQUIRED
EWR 16	C91A-02391	E	Bloemhof Dam.	Anthropogenic activities, mining, deteriorated water quality.	MODERATE	MODERATE	D	Improved conditions is dependent on lower winter base flows, increased flows as well as first-flush freshette cues during November. Water quality management should be priority.
EWR 18	C92B-02903	C/D	Current operation of the lower Vaal system.	Anthropogenic activities including agriculture, mining, deteriorated water quality. Alien fish species.	MODERATE	MODERATE	C/D	Maintaining the present day flow will maintain the present state.
VC60	C91D-02838	A/B		Only activities related to agriculture.	MODERATE	HIGH	A/B	As one of the few A/B rivers, it is vital to maintain the PES/REC. Impacts are not flow related however.

The Leeu River (VC60) is a tributary of the Vaal River, joining the Vaal River below Windsorton. A number of road crossings are found. The river appears to be dry (probably ephemeral) and erosion is expected. The water quality status is expected to be an A category and the PES an A/B with a resulting High EI. Due to the already high PES, the REC does not require any improvements.

The EWR sites are in an E and C/D with Moderate EI. EWR 16 which is in an E PES will require improvements in flow as well as water quality to improve to the required D REC.

6.6.3 Socio-economic Assessment

Table 6.7: Economic Impacts on Vaal River Downstream of Bloemhof to Douglas (2010)

	GDP (R Million)		Employment (Numbers)		Income Households (R Million)	
	Direct	Total	Direct	Total	Low	Total
Irrigation Agriculture	610.8	1 969.6	9 215	22 076	343.8	1 631.6
Mining	1 338.1	2 536.8	8 129	15 411	71.9	1 106.2
Manufacturing	1 315.1	2 815.1	7 227	15 469	124.7	1 938.1
Power Generation	N/A	N/A	N/A	N/A	N/A	N/A
Total	**3 264.1**	**7 321.5**	**24 571**	**52 957**	**540.4**	**4 675.9**

The area hosts the mining, manufacturing and irrigation agriculture sectors. The main urban centres are Bloemhof and Jan Kempdorp. The main contributor to GDP and household income is the manufacturing sector contributing R2 815.1 and R1 938.1 respectively. The agricultural sector contributes the most to employment opportunities, namely 22 076.

6.6.4 Goods and Services Assessment

This is the Vaal River below the Bloemhof Dam. Settlements include Christiana, Warrenton, Windsorton, Barkly West and Delportshoop. Settlement is sparse outside of these major settlements. Irrigation is important along the banks of the river but outside of this zone the dominant landform is dryland commercial agriculture with very sparse populations.

- Fishing (Recreational): Of some importance.
- Fishing (Subsistence): Limited but may play some role for residents of from the pooper parts of the towns named above.
- Other Recreational Opportunities: The area offers few some opportunities for recreational use associated with the river.
- Riparian vegetation: Usage is limited to the poorer communities. Vegetation cover is limited.
- Waste Water Dilution and Assimilation: Given that land use is primarily commercial agriculture the function of the river in this regard is of some importance, particularly given the intensity of use.
- Floodplain cultivation: Negligible.

6.6.5 Corrective Action

If the proposed action involves corrective action, which could lead to the need for extra volumes of water, it will be supplied by increased augmentation and the augmentation costs will be calculated.

6.7 LV-C: GROUNDWATER IN LICHTENBURG AREA

The Licthenburg compartment (as shown in **Figure 6.1**) consists of 10 sub-compartments covering an area of 698 km^2 and is largely underlain by the chert poor Lytellton formation. It is separated from the Schoonspruit compartment to the east by the Doornkop dyke and from the Grootpan compartment to the north by the Blaauwbank dyke.

Recharge to the aquifer is about 37 million m^3/a, which approximately equals the abstraction. Consequently spring flow from the aquifer at Aaslaagte eye has dried up. Lichtenburg obtains water from boreholes, as do Itsoseng, Sheila and Bodibe, as well as several cement plants. There is also extensive irrigation in the area, which accounts for 28 million m^3/a of the abstraction. The aquifer is highly stressed and forms part of the Bo-Molopo Groundwater Control Area.

Figure 6.1: Extent of the Lichtenburg compartment

7 SUMMARY AND CONCLUSIONS

7.1 STATUS OF WATER RESOURCES

In terms of the current water resources situation the following should be noted:

- The Vaal River is one of the largest rivers and definitely the most utilised in the country.
- The size of the catchment and the complexity of the operating rules governing the major water resources of the system, contribute to the uniqueness of the Vaal River System.
- Some of the tributary catchments (Vals, Allemanskraal and Erfenis) are in deficit and implementation of the Reserve will negatively impact on the assurance of supply to existing water users.
- Information on the reconciliation strategies of small towns presented in **Table G-2** of **Appendix G** shows that about sixteen of these towns are either currently in deficit or will be experiencing shortfalls in their water supply within the near future.

7.2 ECOLOGICAL STATUS

Two of the major impacts dominating the Vaal Catchment are water quality impacts and changes in the flow regime. Changes in the flow regime range from too little flow but the most severe impacts are from too much flow and changes in seasonality which mainly relate *to* transfers, releases, irrigation return flows, mining and urban runoff.

Areas of highest water quality impact across the Vaal River catchments are as follows:

- Rietspruit (C1 Riet-Amers): The quality is a D category, largely due to extensive agricultural activities with highly elevated nutrients and salts.
- The condition of the lower Klip River (north-west flowing Klip River) catchment is poor, with sites ranging from a D to a D/E category. The main land use is still agriculture, although there are discharges around certain urban areas (e.g. Vrede) which reduce the water quality category.
- Rietspruit and Klip rivers (Gauteng) - Note that the water quality state of this portion of the Upper Vaal catchment is severely impacted and improvements in present state cannot occur without addressing water quality related problems, e.g. through implementation of the Integrated Water Quality Management Plan set up for the Vaal (**DWAF, 2008d**).
- Lower Suikerbosrand and Blesbokspruit – The quality of the Suikerbosrand River is driven by the poor quality of the Blesbokspruit River. Impacts include mine water decants, diffuse runoff, urban runoff and point source discharges.
- Waterval catchment - Land use in the upper part of the catchment includes agricultural activities; Sasol petrochemical industry; Secunda town; coal mining in the Bethal to Secunda area (C11 and C12 tertiary catchments); and gold mining in the upper Waterval catchment. Impacts include elevated salts and nutrients, particularly phosphate. Some irrigation takes place in the lower part of the catchment, with

- issues related to elevated salts and nutrients, particularly phosphate. Water quality is poor across the area (D category) due to impacts of Sasol and Secunda and pivot irrigation.
- EWR 5 downstream of the Vaal Barrage – The salinity and nutrient impacts from the Klip, Riet, Suikerbosrand and Waterval rivers are combined in the Vaal Barrage and released downstream to this site on the Vaal River.
- The impact of Grootvlei Mine results in water quality deterioration to a D on the Molspruit tributary of the Vaal River.
- Mooi River (Upper Vaal catchment) - The main impact in the area is the uranium-laden effluent from the Wonderfonteinspruit. Impacts across the area are due to agricultural activities, urban runoff and the discharge of mining effluent.
- Middle Vaal River: EWR 12 at Vermaasdrift – Elevated nutrients and salts contribute to the poor water quality state.
- Tributaries of the Middle Vaal - Water quality is poor across this area, i.e. a D/E on the Koekemoerspruit to an E category elsewhere. Impacts are largely due to agriculture and urban / mining impacts. The Schoonspruit also runs through the urban areas of Klerksdorp and Kanana as well as the gold mining impacted areas (AngloGold Ashanti Vaal River Operations and Harmony).
- Vaal River (EWR 13) downstream of the Schoonspruit, Koekemoerspruit, Renoster and Vierfonteinspruit confluences in the Middle Vaal catchment.
- Lower Sand catchment - Water quality in the area is worst where mining impacts around Welkom and Virginia dominate. Here water quality is assumed to be a D category.
- Harts River (EWR 17 at Lloyds weir) – High salt and toxic concentrations due to agriculture and diamond mining impacts.
- Riet River – Impacts are high salts and high nutrient levels.

Due to the economic importance of this area and the important role the Vaal System plays in conveying and supplying the water resource to this economic hub, it is understandable that most of the system is in a C EC or poorer condition.

The biophysical nodes that scored a high Environmental Importance (EI) is listed in **Table 7.1** below.

Table 7.1: Summary of the desktop biophysical nodes and EWR sites with a High EI

IUA	VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC
UV-A	8VF5	C11A-01460	B/C		Yes	MODERATE	HIGH	B
UV-A	EWR 1	C11J-01838	B/C	Yes	Yes	HIGH	HIGH	B/C
UV-B	UV Uklip	C13C-02550	B		Yes	HIGH	HIGH	B
UV-B	C13C	C13D-02416	B/C		Yes	HIGH	HIGH	B
UV-B	C1KLIP-UNSPE1	C13D-02284	B/C	Yes	Yes	MODERATE	HIGH	B
UV-B	C13E	C13E-02228	B/C	Yes	Yes	MODERATE	HIGH	B
UV-C1	EWR 7	C81A-02790	A/B		Yes	HIGH	HIGH	A/B

IUA	VC node	SQ reach	PES	FLOW RELATED	NON FLOW RELATED	EIS	EI	REC
UV-C1	8WF1	C81A-02790	B		Yes	MODERATE	HIGH	B
UV-C1	UV25	C81L-02594	B		Yes	MODERATE	HIGH	B
UV-C2	GG	C81G-02882	B		Yes	MODERATE	HIGH	B
UV-D	VC16	C83G-02364	B/C		Yes	MODERATE	HIGH	B
UV-D	VC17	C23H-02395	B/C		Yes	MODERATE	HIGH	B
UV-H	C21A	C12A-01567	B/C	Yes	Yes	MODERATE	HIGH	B
UV-H	EWR 9	C21C-01675	C	Yes	Yes	HIGH	HIGH	B/C
UV M	EWR 4	C22F-01737	C	Yes	Yes	HIGH	HIGH	B/C
UV M	EWR 5	C22L-01792	C/D	Yes	Yes	HIGH	HIGH	C
LV A4	VC59	C91D-02838	A/B		Yes	Yes	HIGH	A/B
LV B	VC60	C91D-02838	A/B		Yes	Yes	HIGH	A/B

As can be seen from **Table 7.1**, most of the High EI nodes lie in the Upper Vaal, none in the Middle Vaal and two ephemeral small river reaches within the Lower Vaal. Apart from EWR 4, 5, and 9, all these sites are in a reasonable to good PES and the majority of those in a B/C EC (that should improve to a B EC) will require non-flow related intervention to achieve the required improvements.

In summary, the following can be noted:

- Some of the biggest water quality problems in South Africa occur within the study area.
- Many areas in the Vaal System (especially the Upper Vaal) are dominated by more flow than the natural flow regime (elevated flows).
- Although this river system is so heavily utilised (generally in a C category or worse condition) some features warrant protection and improvements are required where at all possible.
- The Vaal River is one of the few large rivers in South Africa; this fact on its own makes the Vaal River important.
- Protection of the Vredefort Dome. The Vaal River is a key feature within the Vredefort Dome especially around the town of Parys. Water quality issues are a serious concern – especially from the human use perspective and all the recreational activities.
- The presence of the Red Data listed *Barbus kimberleynsis* (yellow fish) and various riparian vegetation species.
- Endangered bird species are found within the study area, especially in upper reaches of Vaal and Wilge river catchments which are dominated by oxbows and wetland features.
- Seekoeivlei RAMSAR wetland in the Klip River.
- Blesbokspruit RAMSAR wetland in the Blesbokspruit.

- Barbers and Leeu Pans RAMSAR Convention accredited wetland in the Harts River catchment.
- Wolwespruit Provincial (North West Province) Nature Reserve which includes the Vaal River.

All of the above-mentioned features result in an extremely complicated set of challenges to be dealt with in the Vaal Catchment. The scope for considering a varied set of scenarios to deal with in the Classification System and the possibilities of trade-offs are limited.

7.3 SOCIO-ECONOMIC STATUS

In conclusion a summary of the socio-economic information for the IUAs are included below for easy reference.

Table 7.2: The Upper Vaal WMA (2010)

IUA Reference	Description of resources	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
UV-A	Vaal River Upstream of Grootdraai Dam	38 217	9.9%	45 004	3.5%	14 744	6.7%
UV-B	Klip River (Free State)	1 529	0.4%	5 113	0.4%	721	0.3%
UVC1-UVC3	Wilge Rivier	1 476	0.4%	9 253	0.7%	849	0.4%
UV-D	Liebenbergsvlei River	1 829	0.5%	14 582	1.1%	1 073	0.5%
UV-E	Waterval River	97 244	25.2%	337 424	26.3%	49 744	22.5%
UV-F	Krop and Klip flowing into Vaal Dam	2 334	0.6%	10 395	0.8%	1 496	0.7%
UV-G	Vaal River reach upstream of Vaal Dam and Downstream of Grootdraai Dam	62 900	16.3%	169 766	13.2%	37 141	16.8%
UV-H and UV-I: C21D-C21G	Suikerbosrand River upstream of confluence with Blesbokspruit	51 705	13.4%	225 936	17.6%	33 616	15.2%
Partly UV-I: C22A-C22E; C22H & C22J	Klip Rivier (GT)	53 849	13.9%	239 066	18.7%	37 794	17.1%
UV-L	Mooi River up to confluence with Vaal River	12 606	3.3%	55 900	4.4%	7 111	3.2%
UV-M incl. UV-J, UV-K	Vaal Dam to Middle Vaal	62 818	16.3%	169 158	13.2%	37 109	16.8%
Total		**386 507**	**100%**	**1 281 597**	**100.0%**	**221 398**	**100.0%**

The economic indicators such as Gross Domestic Product *(*GDP), employment and household income percentage magnitudes of the Upper Vaal River IUAs generally compare well. A large concentration of the main economic activities is found in the UV-E: Waterval River area due to the mining, power generation and petro-chemical industries contributing 25.2% GDP, 26.3% employment opportunities and 22.5% of the household

income. Employment wise this is followed by partly UV-I: C22A-C22E including C22H and C22J hosting iron smelting and petro-chemical industries with 13.9% GDP, 18.7% employment and 17.1% of household income.

Table 7.3: The Middle Vaal WMA (2010)

IUA Reference	Description of Resources in MV WMA	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
MV-A	Renoster River	160	0.6%	1 256	0.8%	112	0.8%
MV-B	Vals River	3 533	14.3%	20 686	13.8%	2 033	14.6%
MV-C	Schoonspruit River and Koekemoerspruit	10 780	43.6%	65 226	43.6%	4 958	35.6%
MV-D1 & MV-D2	Sand	3 213	13.0%	20 000	13.4%	1 988	14.3%
MV-E1	Upper Vet River	3 309	13.4%	19 977	13.3%	2 262	16.2%
MV-E2	Lower Vet River	2 160	8.7%	12 906	8.6%	1 548	11.1%
MV-F	Vaal River main stem from C24B to Bloemhof Dam	1 574	6.4%	9 662	6.5%	1 035	7.4%
Total		**24 729**	**100.0%**	**149 712**	**100.0%**	**13 937**	**100.0%**

The economic indicators such as GDP, employment and household income percentage magnitudes of the Middle Vaal River IUAs generally compare well. A large concentration of the main economic activities is found in the MV-C: Schoonspruit and Koekemoerspruit area with industries contributing 43.6% GDP, 43.6% employment opportunities and 35% of the household income. This is followed by UV-B: Vals River with 14.3% GDP, 13.8% employment and 14.6% of household income, MV-E1: Upper Vet River with 13.4%, 13.3% and 16.2% respectively and the combined MV-D1 and MV-D2: Sand River with 13%, 13.4% and 14.3% respectively.

Table 7.4: The Lower Vaal WMA (2010)

IUA Reference	Description of Resources in Lower Vaal WMA	Total GDP		Total Employment		Total Households	
		R Mil	%	No.	%	R Mil	%
LV-A1 to LV-A4	Harts	6 994	49%	42 721	45%	3 960	46%
LV-B incl. Vaalharts	Vaal River from Downstream of Bloemhof Dam to Douglas Weir	7 322	51%	52 957	55%	4 676	54%
Total		**14 315**	**100%**	**95 677**	**100%**	**8 636**	**100%**

Also the economic indicators such as GDP, employment and household income percentage magnitudes of the Lower Vaal River IUAs generally compare well. The area accommodates vast irrigation agriculture enterprises. The main economic activities are found in the LV-B: Vaal River from the Bloemhof Dam to the Douglas Weir area contributing 51% GDP, 55% employment opportunities and 54% of the household income. This is followed by LV-A1 to LV-A4: Harts River with 49% GDP, 45% employment and 46% of household income.

7.4 STATUS OF GOODS AND SERVICES

While the Vaal System is important in terms of its extent, this is tempered by the nature of settlement in the area. In terms of utilisation and dependence on Goods and Services, the area is home to few communities for whom these resources would be important. The urbanised nature of the catchment and the fact that the bulk of the residents live in settings where livelihoods are linked to economic modes of production that are not linked to direct resource dependence is evident. Outside of the urban centres, the areas are dominated by relatively low population densities and given over to commercial farming enterprises (typically the upper parts of the catchment) as well as portions of the middle and lower catchments. These areas also tend to score relatively low in terms of dependence on Goods and Services.

As indicated, the nature of the Vaal River system and the typology of communities in the area mean that direct dependence on Goods and Services for livelihoods is restricted. There are however some forms of utilisation of goods and services that are important. These are:

- Recreational fishing (specifically fly fishing targeting yellow fish);
- Subsistence fishing;
- Other recreational aspects associated with the rivers such as white water rafting, house boats, swimming;
- Riparian vegetation usage;
- Waste water dilutions; and
- Floodplain agricultural usage of subsistence purposes.

Of these it is probably the recreational aspects associated with the river system and in particular fishing that is most important. Particular areas of importance include most of the Vaal river main stem and in particular areas around the Vredefort Dome. There are scattered areas in which the utilisation of riparian and other associated livelihood resources may be of some restricted importance, particularly to farm workers. However, these are highly unlikely to react to implementation of possible management and operational scenarios.

Another recreational activity that is important is bird watching which is associated with the various RAMSAR convention wetlands in the study area. These are Seekoeivlei, Barbers Pan, Leeu Pan and the Blesbokspruit wetland.

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- to use its components in a sustainable way
- to share fairly and equitably the benefits arising from the use of genetic resources.

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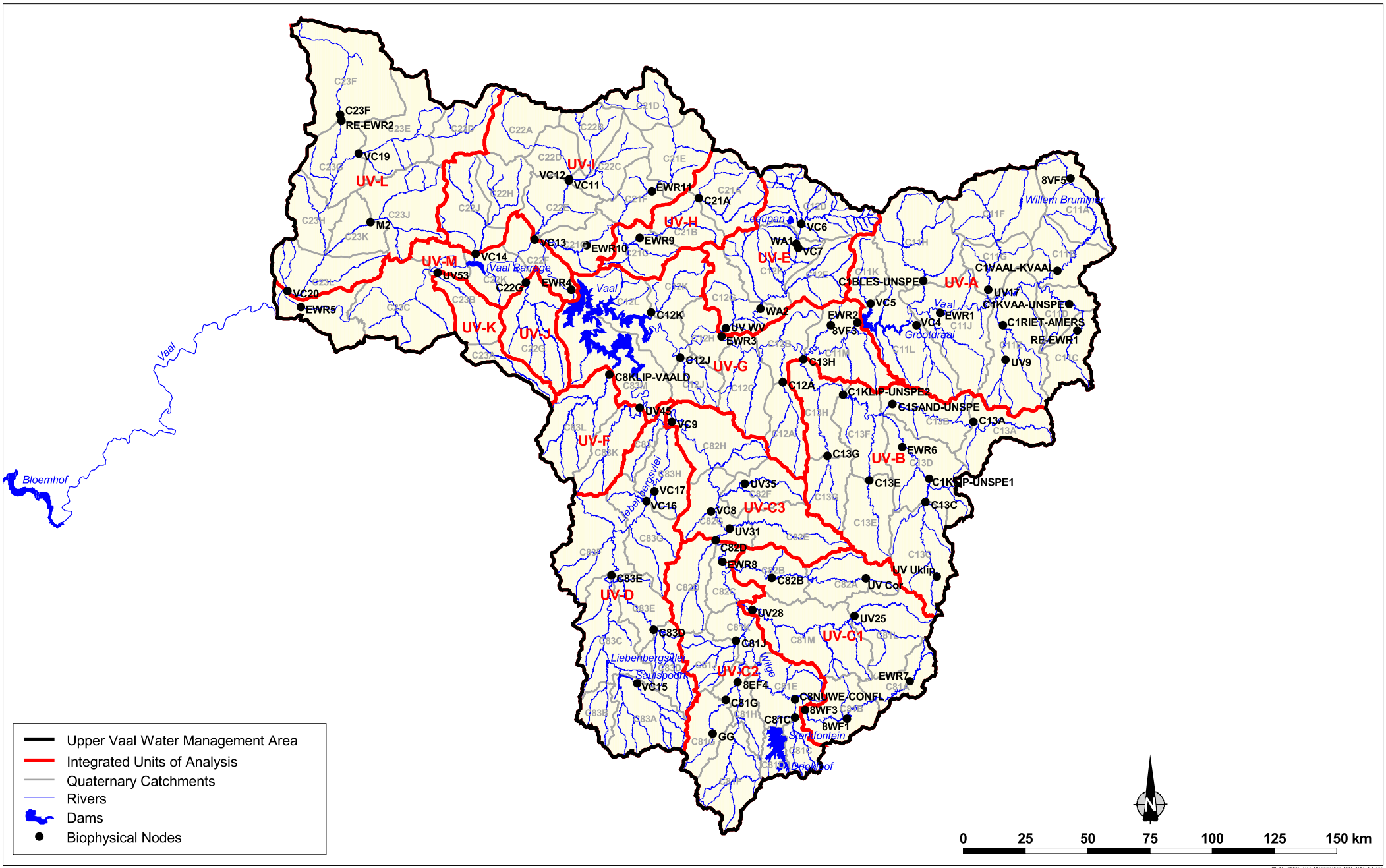
Appendix A:

Map of Water Management Areas



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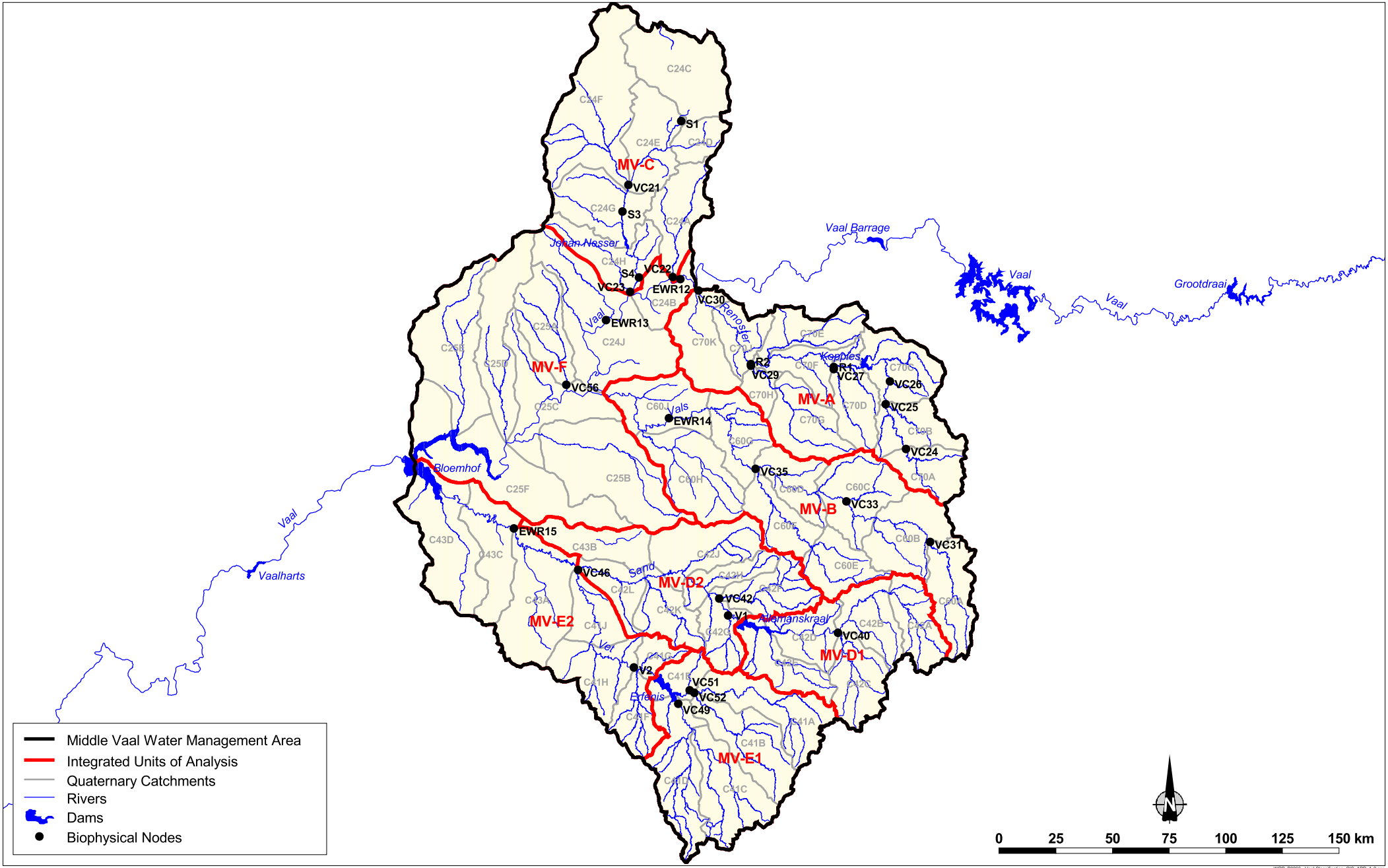
Upper Vaal Integrated Units of Analysis (IUA)

A-1


Middle Vaal Water Management Area
Integrated Units of Analysis
Quaternary Catchments
Rivers
Dams
Biophysical Nodes
MV-A
MV-B
MV-C
MV-D1
MV-D2
MV-E1
MV-E2
MV-F
S1
S3
S4
VC21
VC22
VC23
VC24
VC25
VC26
VC27
VC29
VC30
VC31
VC33
VC35
VC40
VC42
VC46
VC49
VC51
VC52
VC56
EWR12
EWR13
EWR14
EWR15
R1
R2
V1
V2
Vaal Barrage
Vaal
Grootdraai
Vaal
Vaalharts
Bloemhof
Renoster
Jenan Nasser
Kopjes
Vals
Sand
Ver
Erfenis
Adamanskraal
C24C
C24F
C24E
C24G
C24H
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C24J
C25A
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C25D
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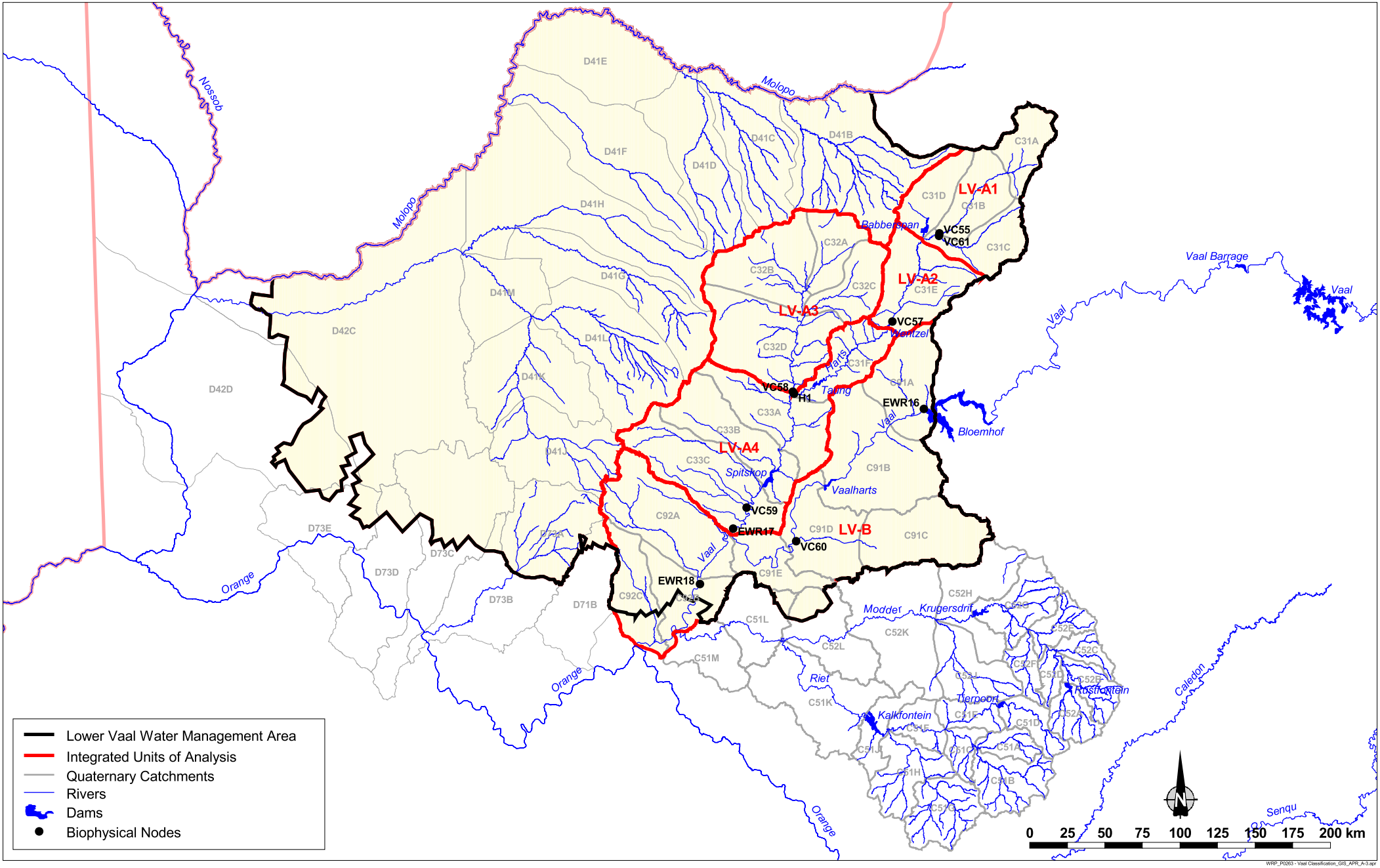
Middle Vaal Integrated Units of Analysis (IUA)
A-2



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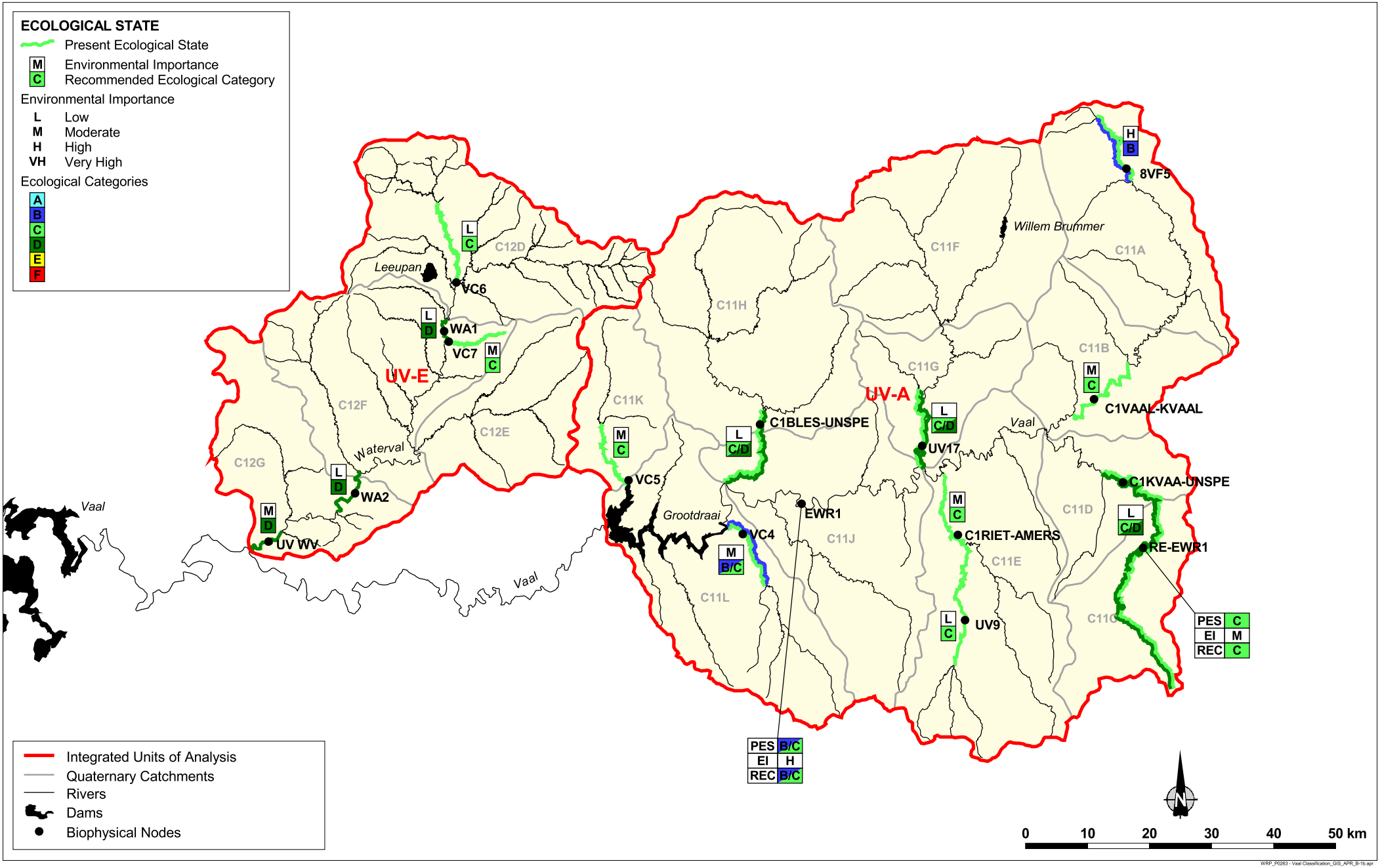
Lower Vaal Integrated Units of Analysis (IUA)

A-3

Appendix B:

Catchment Maps of the Integrated Units of Analysis



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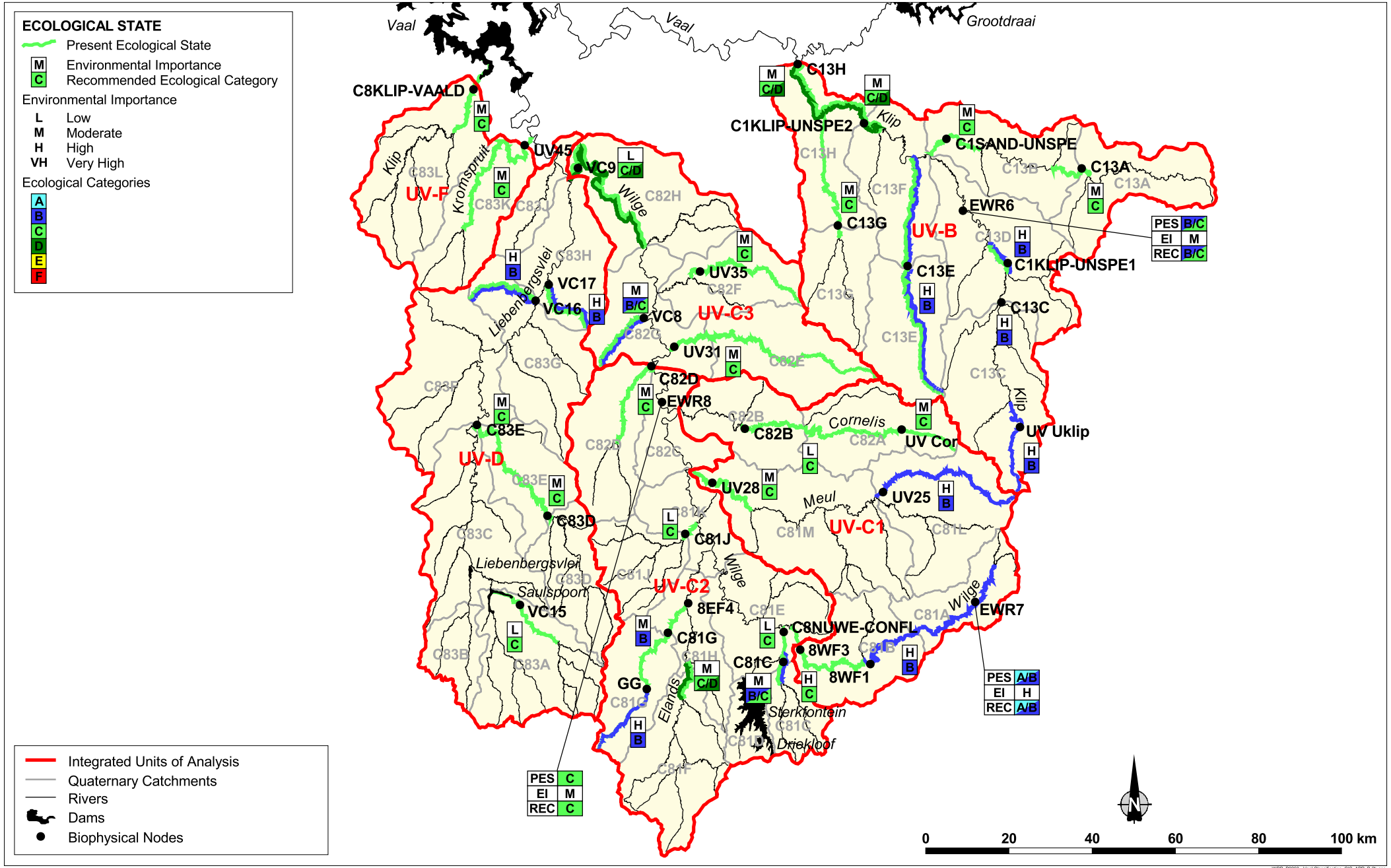
IUA : UV-A and UV-E

B-1



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IUA : UV-B, UV-C1, UV-C2, UV-C3, UV-D and UV-F

B-2

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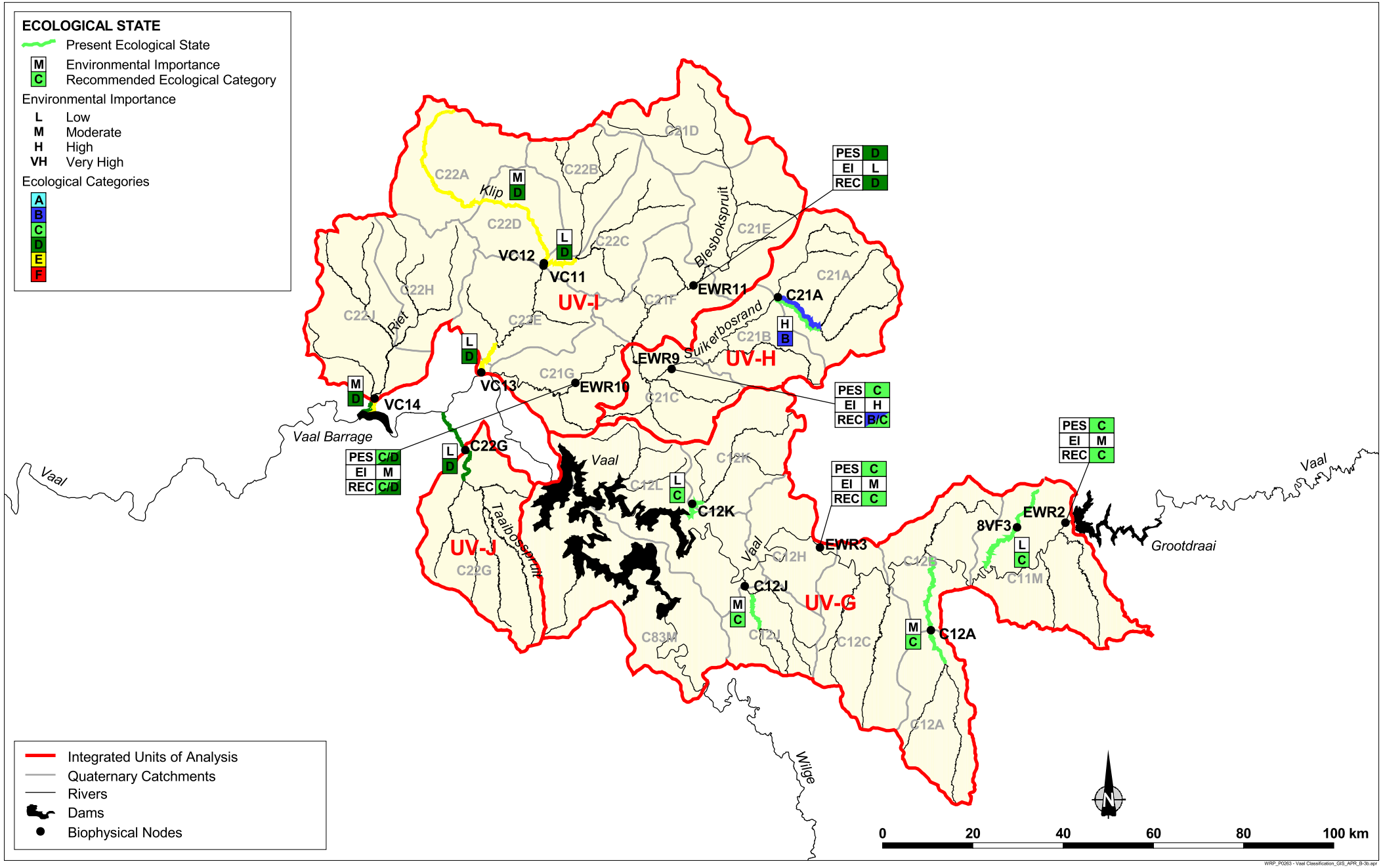

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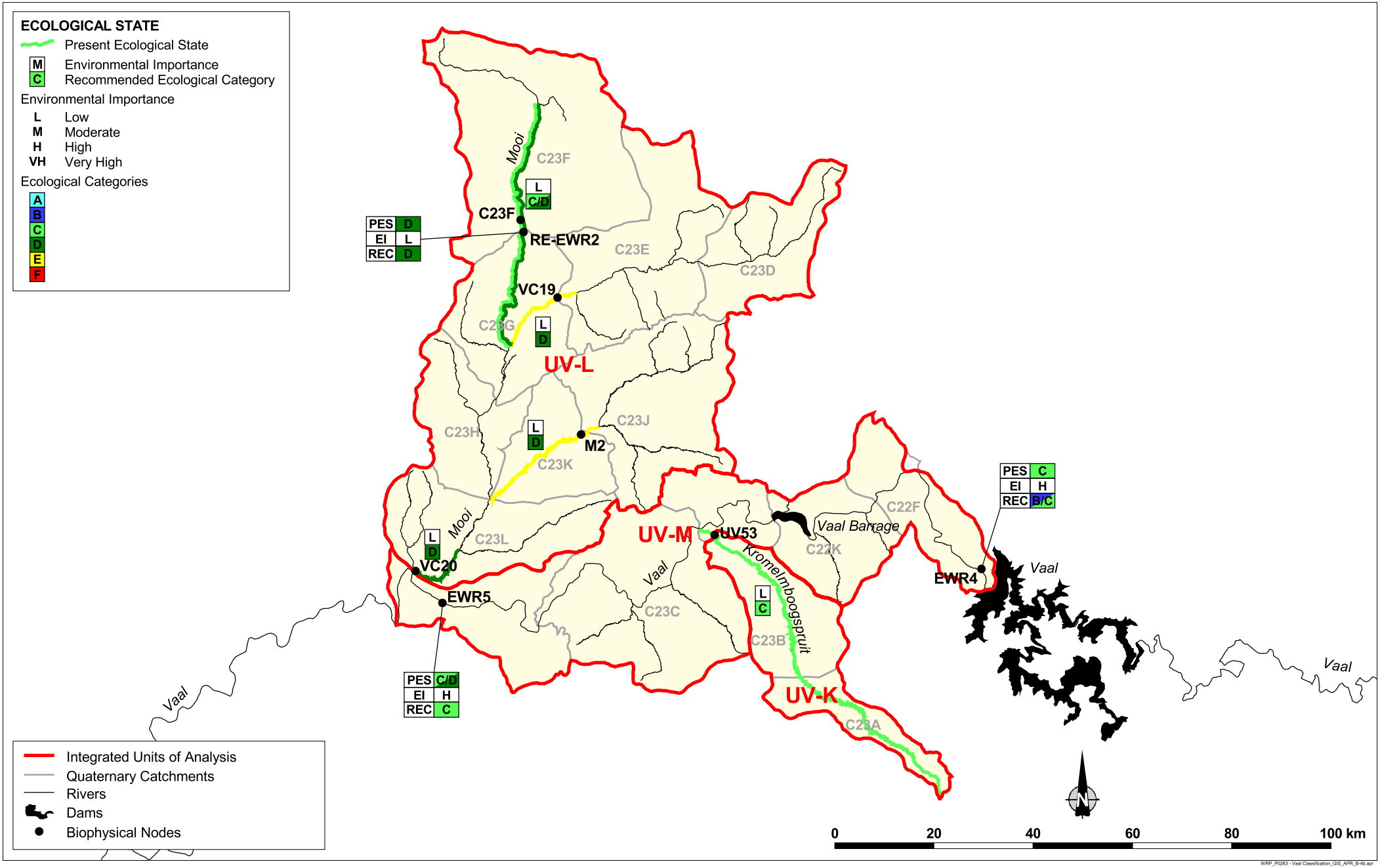
IUA : UV-G, UV-H, UV-I and UV-J

B-3



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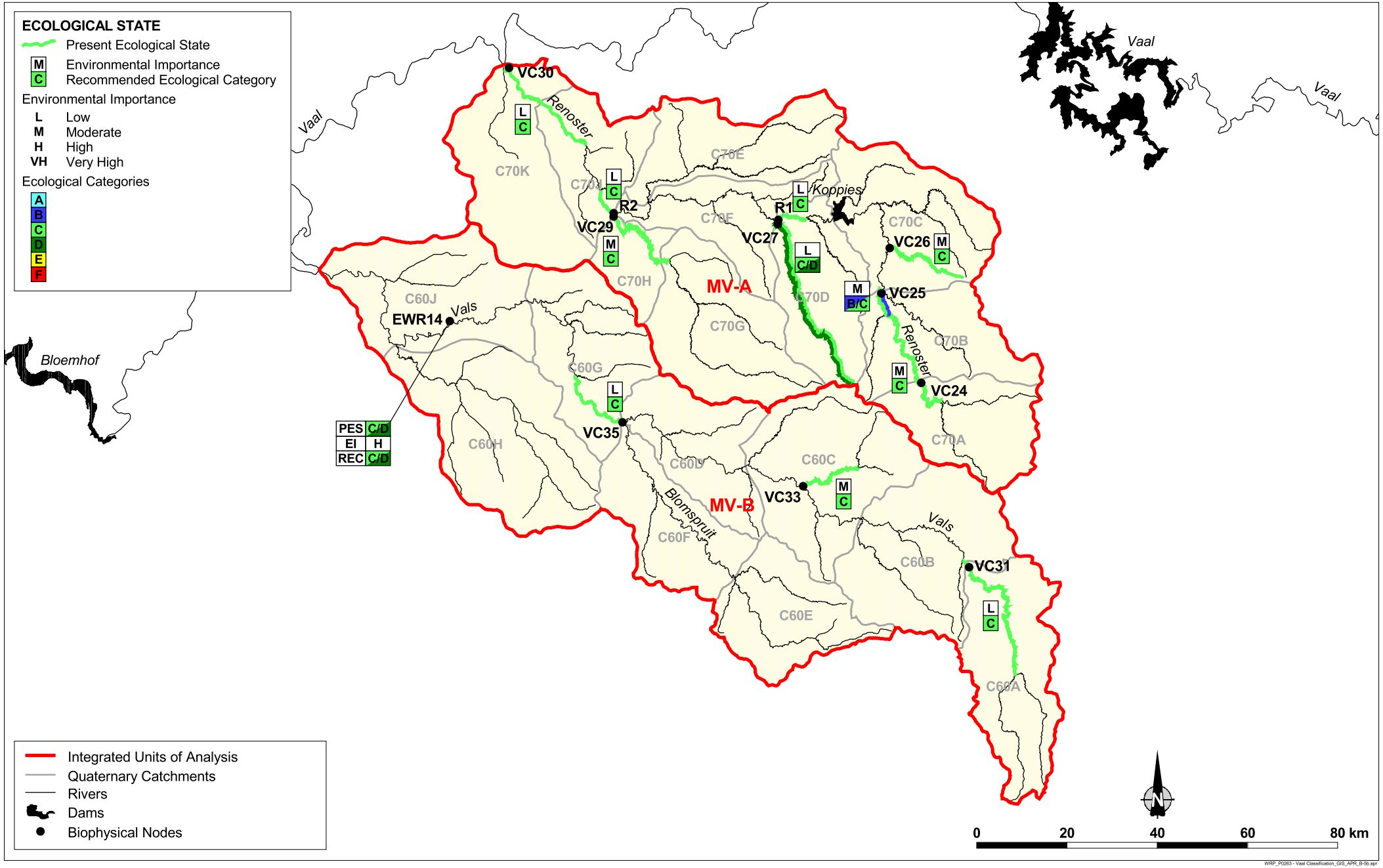
IUA : UV-K, UV-L and UV-M

B-4



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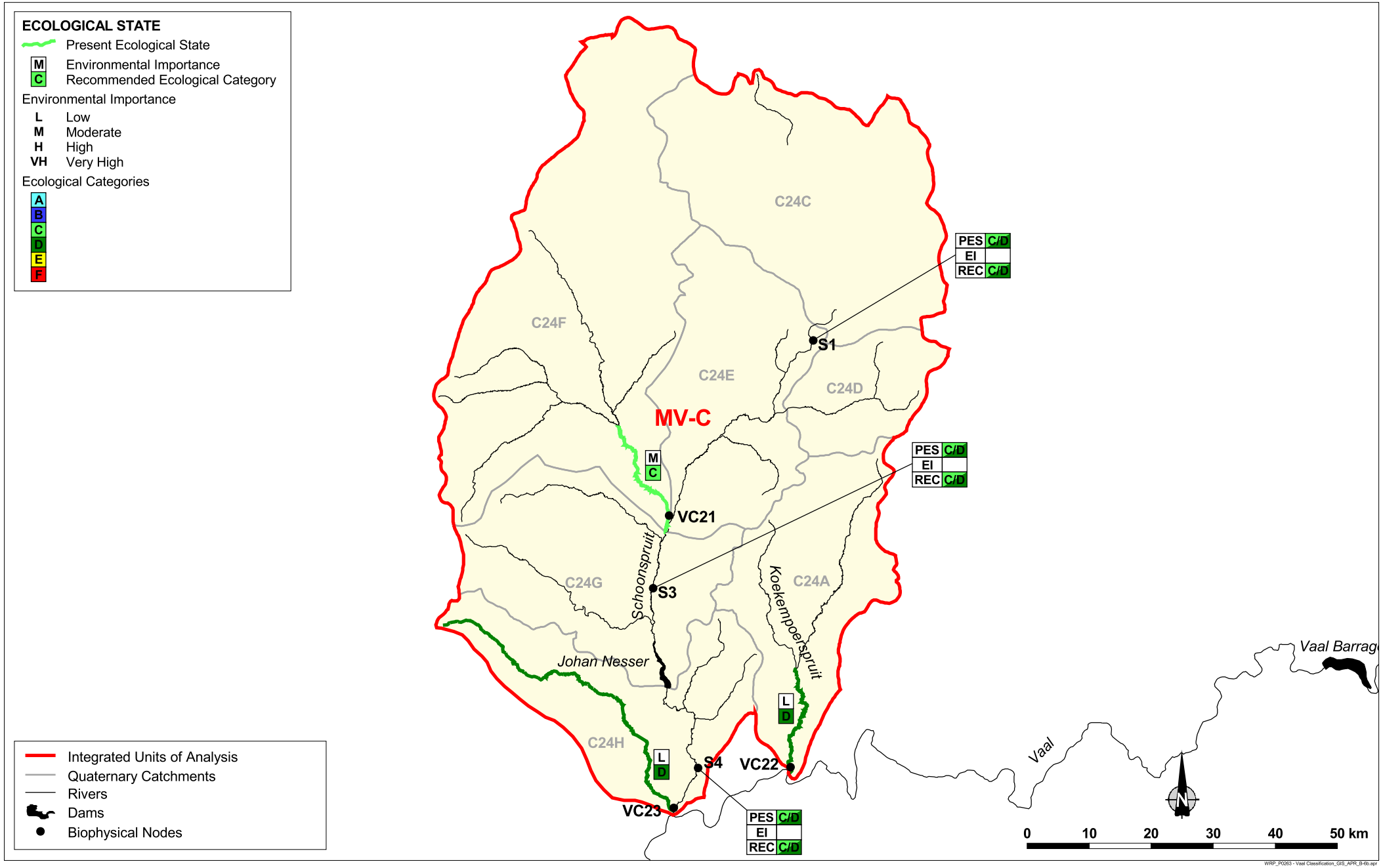
IUA : MV-A and MV-B

B-5



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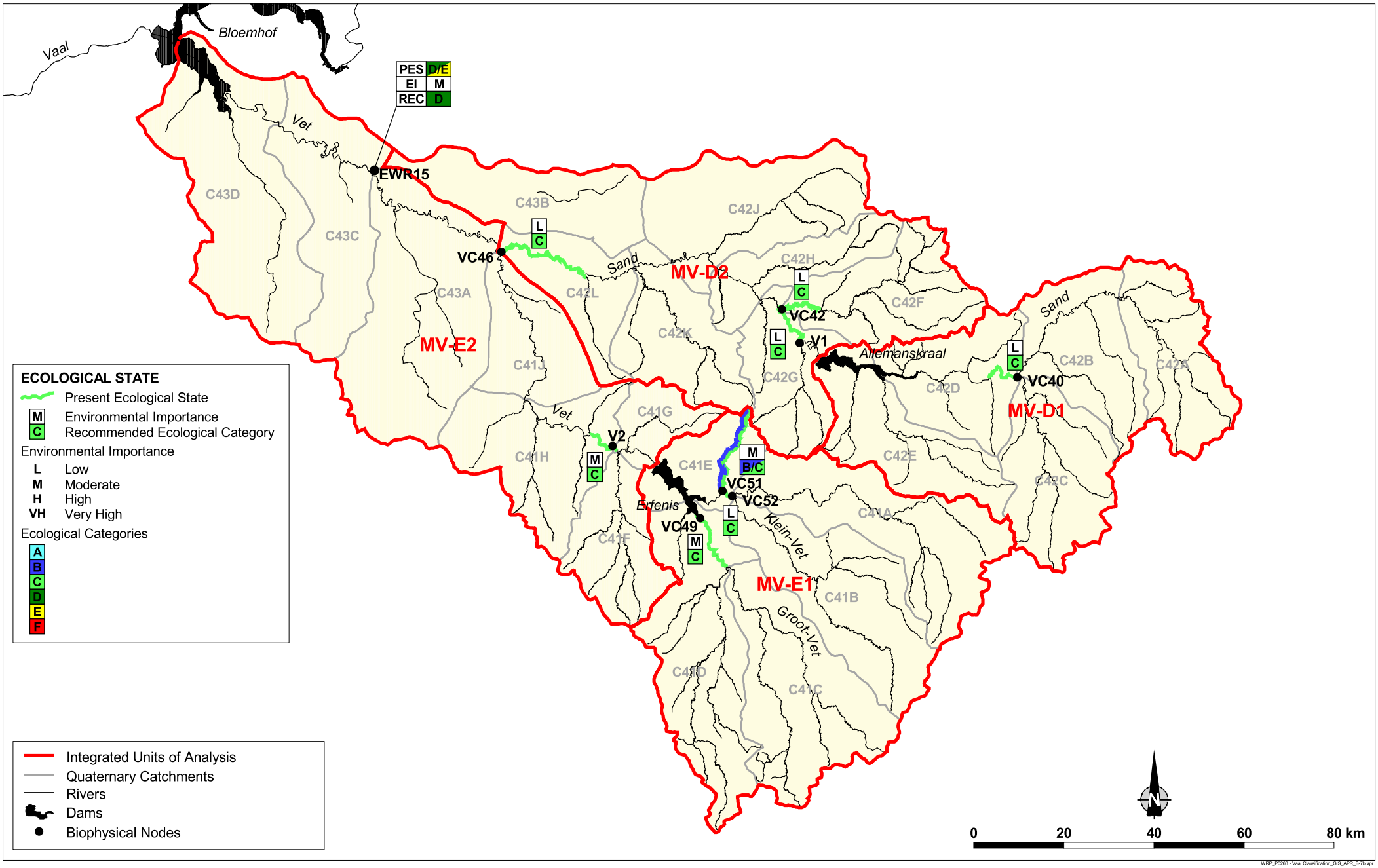
IUA : MV-C

B-6



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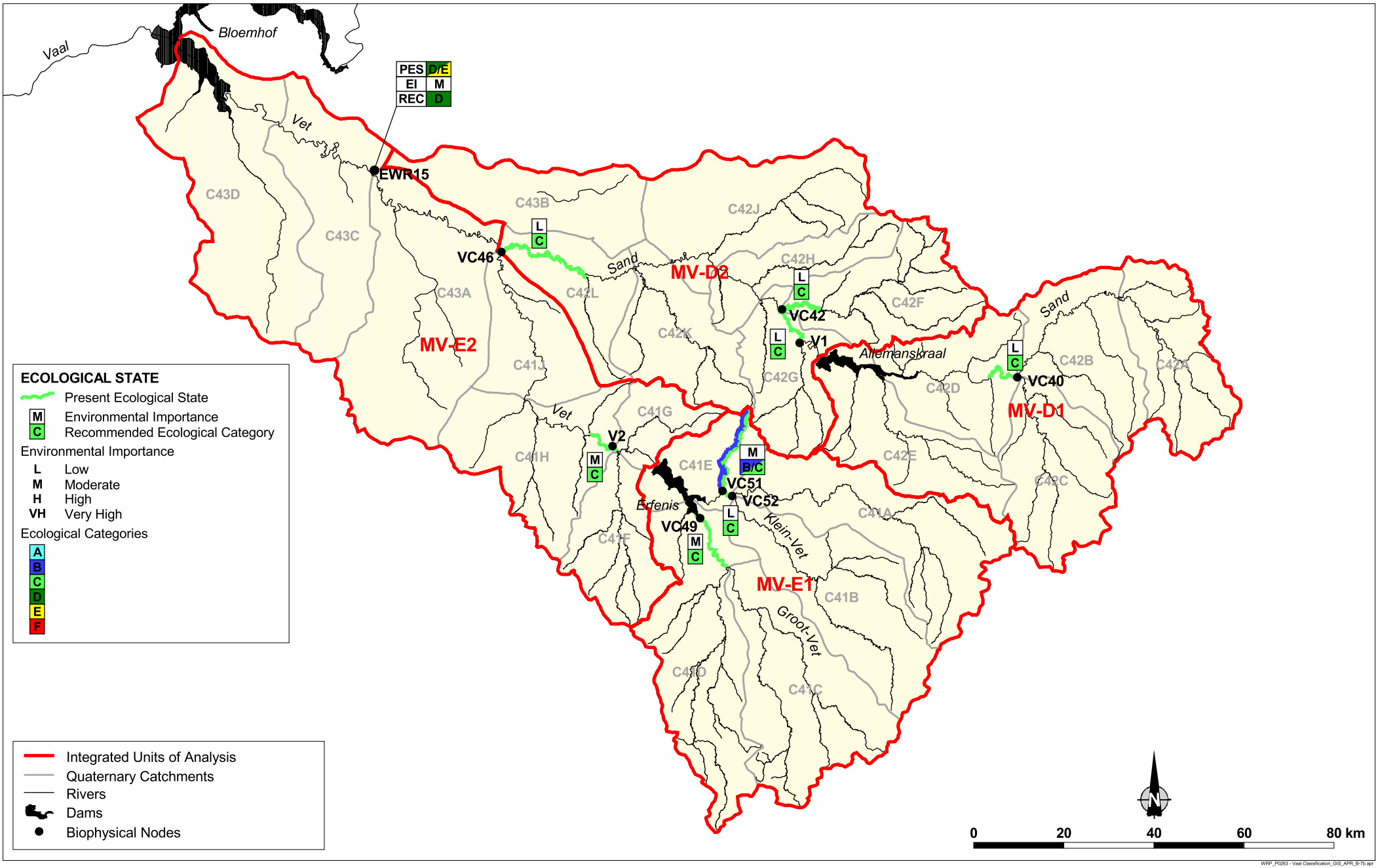
IUA : MV-D1, MV-D2, MV-E1 and MV-E2

B-7



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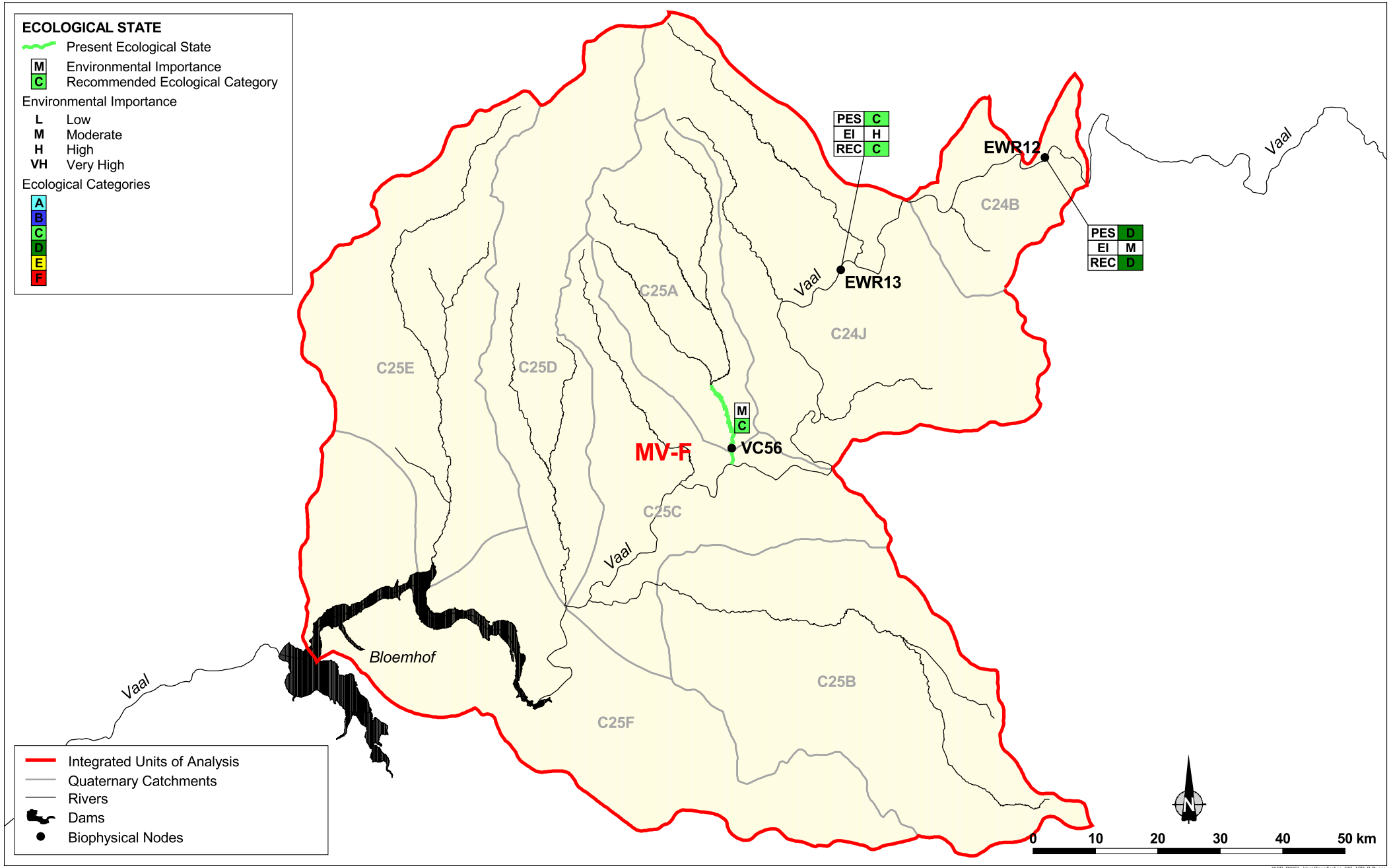
IUA : MV-D1, MV-D2, MV-E1 and MV-E2

B-7



WRP_P0263 - Vaal Classification_GIS_APR_B-8b.apr

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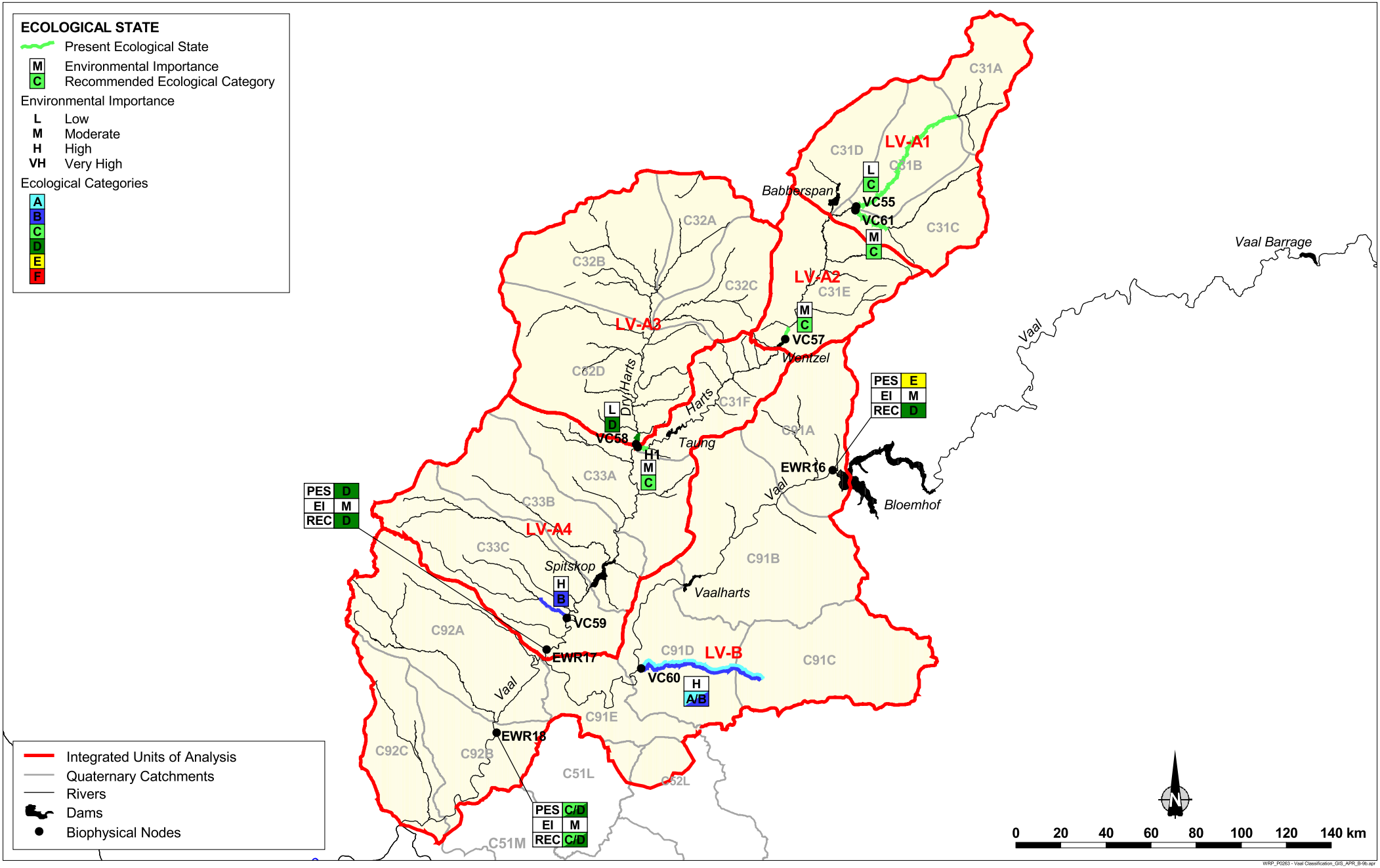
CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS, GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8, 9, 10

IUA : MV-F

B-8



WRP_P0263 - Vaal Classification_GIS_APR_B-9b.apr

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IUA : LV-A1, LV-A2, LV-A3, LV-A4 and LV-B

B-9

Appendix C:

WRPM Schematic Diagrams

USUTU

LEGEND

- Node/Junction sub-model
- Reservoir sub-model
- Channel/River reach sub-model
- Wetland modelled within channel reach sub-model
- Salt washoff sub-model
- Bed losses
- Irrigation block sub-model
- Demand / return flow modelled as min - max channel
- Demand centre sub-model
- Controlled demand through master control channel
- Specified demands/Return flows
- Penalty structure
- Incremental hydrology boundary
- Sub-system boundary

CHURCH 9 · WEST 9 · JERI 9 · MORG 9 · HEYS 9 · TM269 · GROOTD 9 · STERK 9 · FRAN 9 · KOMATI · VAAL 9 · DELA 9 · C12D · UPPER OLIFANTS · UPPER VAAL

Westoe Dam · Jericho Dam · Morgenstond Dam · Heyshope Dam · Grootdraai Dam · Vaal Dam

Driefontein · Camden · Kendal 1 · Kendal 2 · Kriel 1 · Kriel 2 · Matla 1 · Matla 2 · Sasol Secunda · Trichardtsfontein · Region B · Tutuka · Standerton · Dummy Demand · Net Urban · Sterkfontein · Saulspoort Dam · Dummy Dam 1 · Increased Urban Runoff

FROM NODE 240 (See Figure C-2) · FROM NODE 37 (See Figure C-2) · From node 55 (See Figure C-2) · From node 280 (See figure C-2) · From node 194 (See figure A-4)

To Node 11 (See Figure C-13) · To Node 1106 (See Figure C-7) · To Node 159 (See Fig C-13) · To Node 159 (See Fig C-13)

WRP_P0263_Vaal Classification _Appendix C_C-1.cdr

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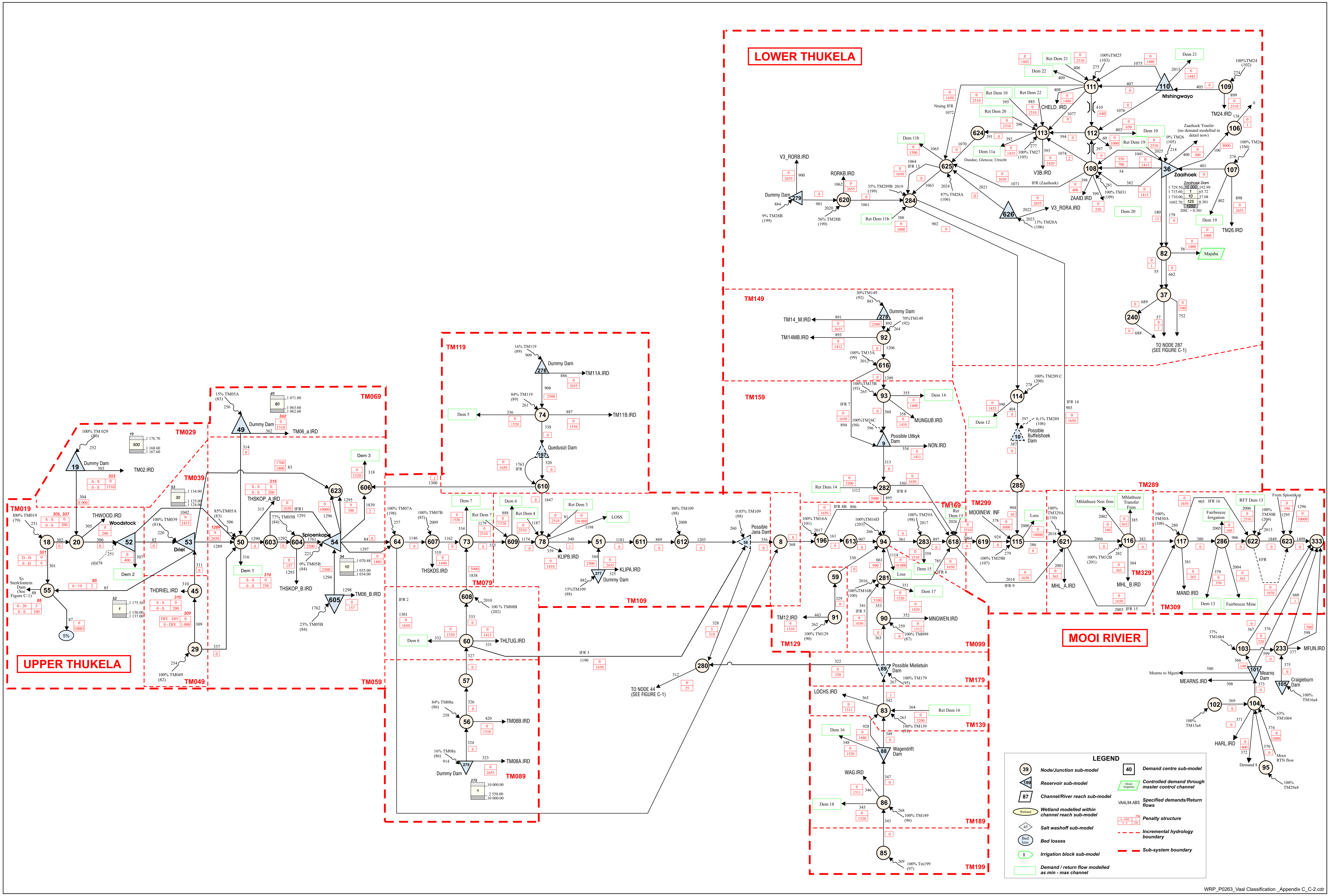
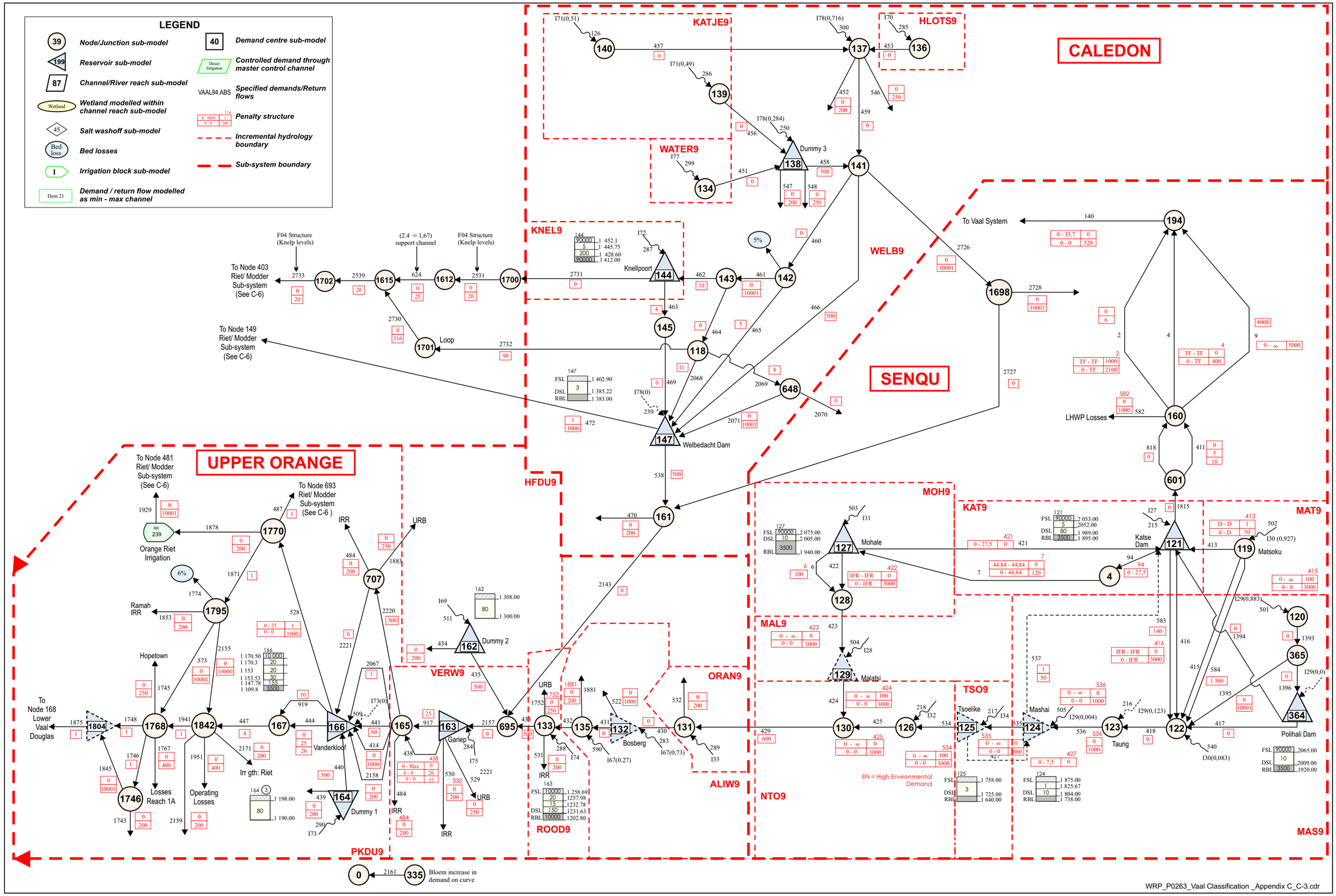
CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

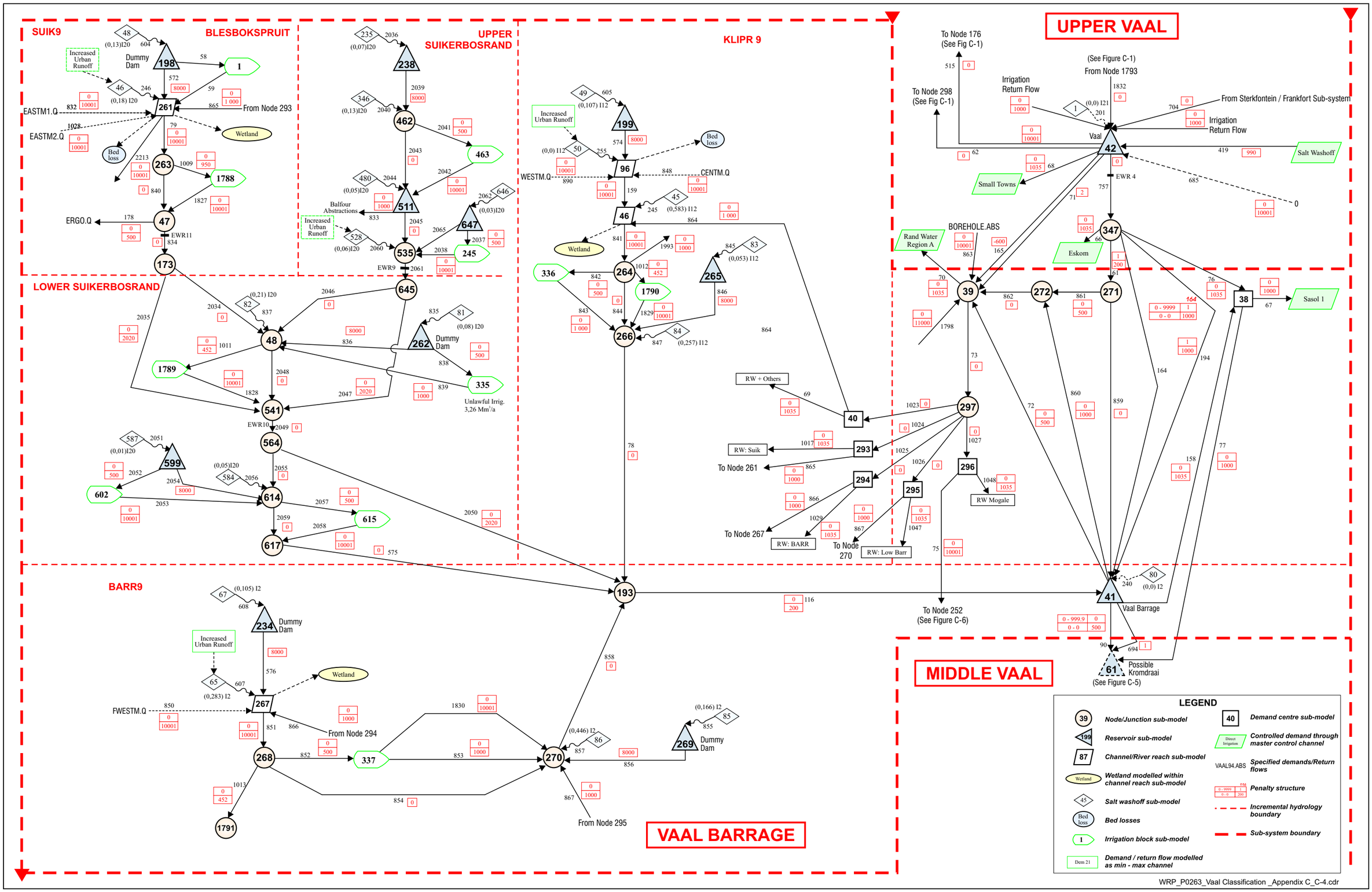
WRPM Schematic Diagram: Upper Olifants, Upper Vaal and Usutu Sub-systems

C-1

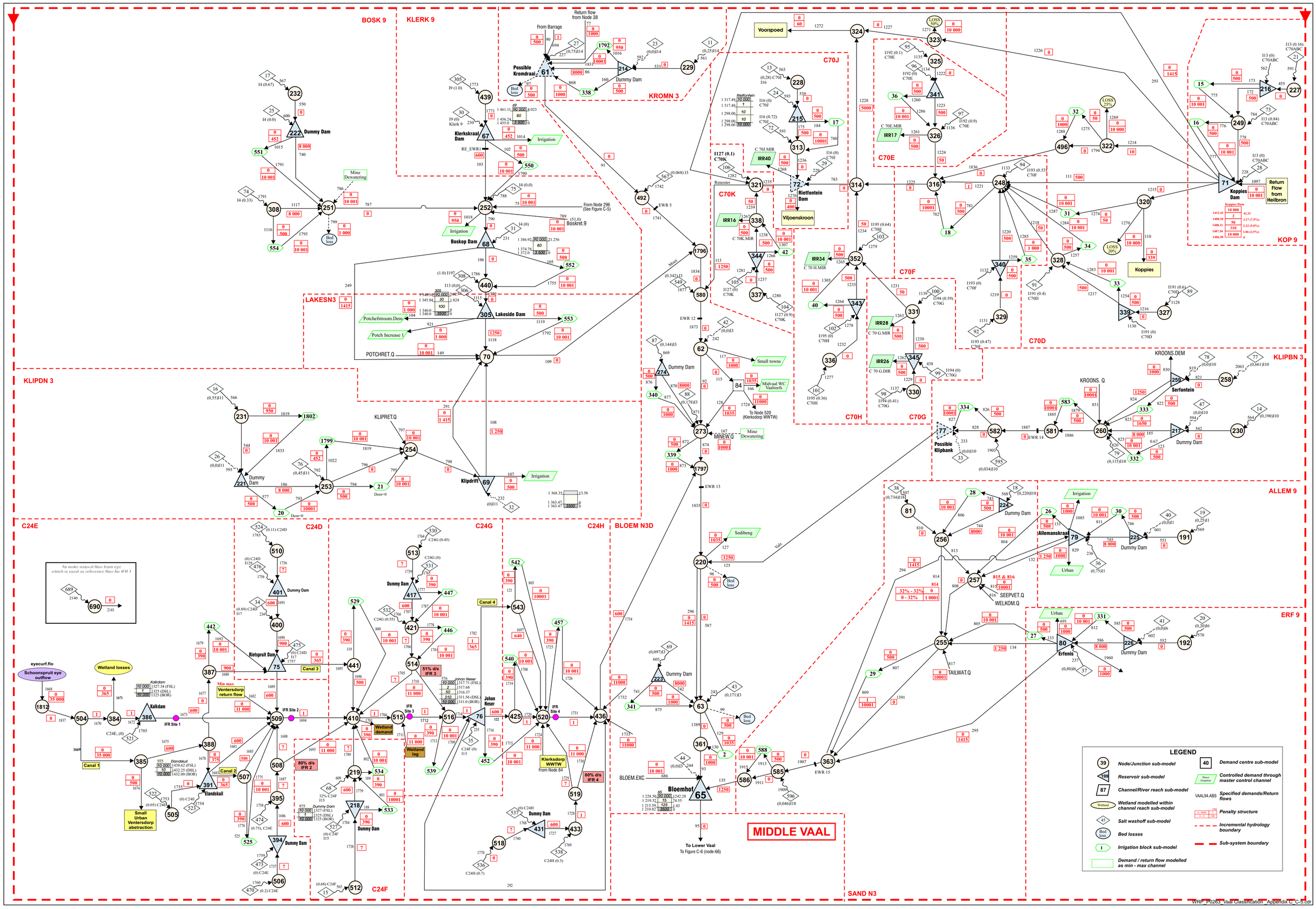


WRP_P0263_Vaal Classification _Appendix C_C-2.cdr


LEGEND
Node/Junction sub-model
Reservoir sub-model
Channel/River reach sub-model
Wetland modelled within channel reach sub-model
Salt washoff sub-model
Bed losses
Irrigation block sub-model
Demand / return flow modelled as min - max channel
Demand centre sub-model
Controlled demand through master control channel
Specified demands/Return flows
Penalty structure
Incremental hydrology boundary
Sub-system boundary
CALEDON
KATJE9
HLOTS9
WATER9
KNEL9
WELB9
SENQU
UPPER ORANGE
HFDU9
MOH9
KAT9
MAT9
MAL9
TSO9
VERW9
ORAN9
ALIW9
NTO9
ROOD9
PKDU9
MAS9
Dummy 3
Knellpoort
Loop
Welbedacht Dam
Dummy 2
Dummy 1
Mohale
Katse Dam
Matsoku
Malatsi
Tsoelike
Mashai
Taung
Polihali Dam
Bosberg
Gariep
Vanderkloof
Hopetown
Orange Riet Irrigation
Ramah IRR
Losses Reach 1A
Operating Losses
Irr gth: Riet
LHWP Losses
To Vaal System
To Node 403 Riet/ Modder Sub-system (See C-6)
To Node 149 Riet/ Modder Sub-system (See C-6)
To Node 481 Riet/ Modder Sub-system (See C-6)
To Node 693 Riet/ Modder Sub-system (See C-6)
To Node 168 Lower Vaal Douglas
F04 Structure (Knelp levels)
(2.4 -> 1,67) support channel
EN = High Environmental Demand
Bloem increase in demand on curve
WRP_P0263_Vaal Classification _Appendix C_C-3.cdr
CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10
WRPM Schematic Diagram: Senqu, Caledon and Upper Orange Sub-system
C-3



WRP_P0263_Vaal Classification _Appendix C_C-4.cdr



WRP_P0263_Vaal Classification_Appendix C_C-5.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

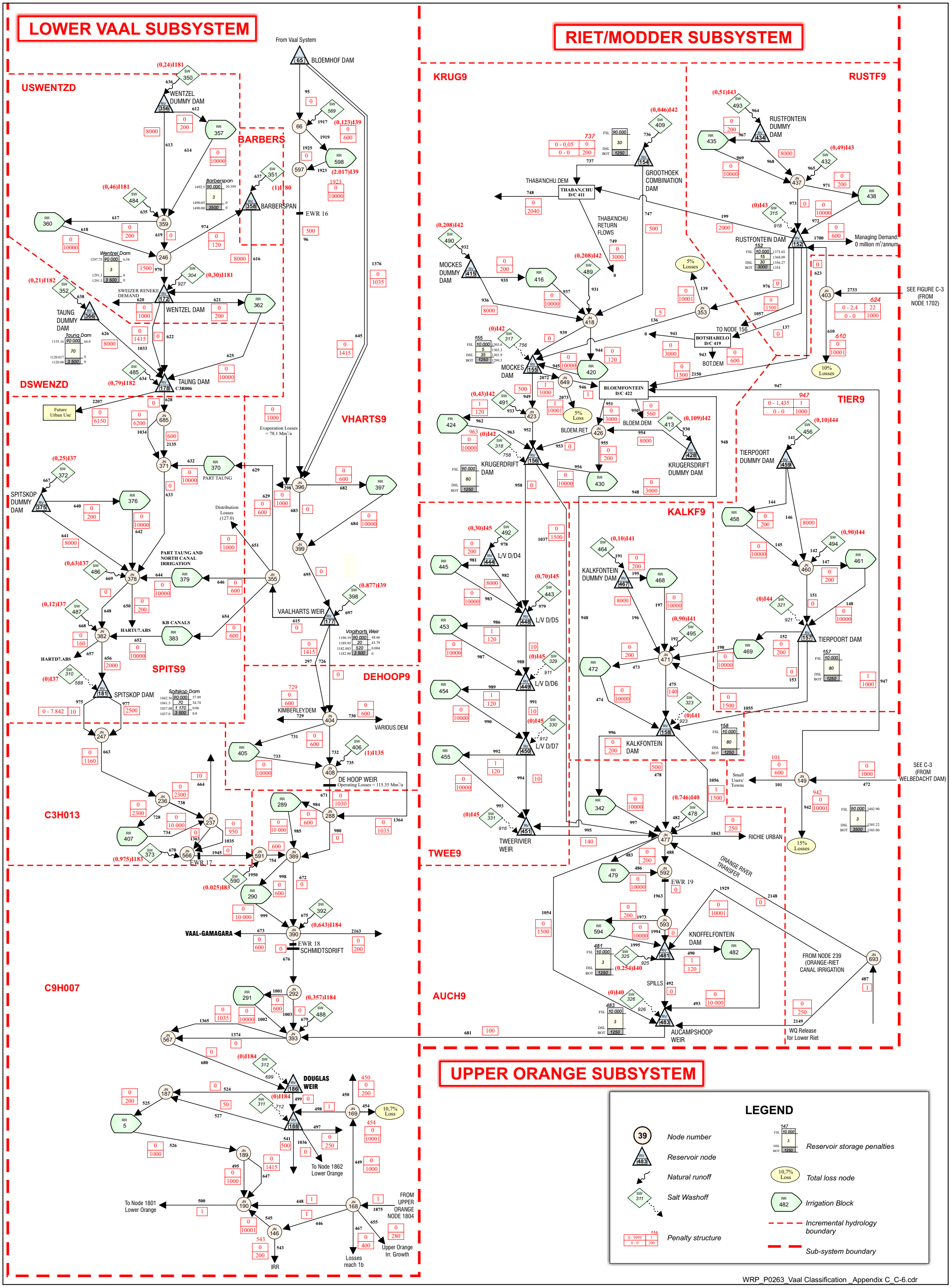
WRPM Schematic diagram: Middle Vaal Sub-system

C-5

LOWER VAAL SUBSYSTEM

RIET/MODDER SUBSYSTEM

UPPER ORANGE SUBSYSTEM



WRP_P0263_Vaal Classification _Appendix C_C-6.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Lower Vaal & Riet/ Modder Sub-systems

C-6

LEGEND

- Node/Junction sub-model
- Reservoir sub-model
- Channel/River reach sub-model
- Wetland modelled within channel reach sub-model
- Salt washoff sub-model
- Bed losses
- Irrigation block sub-model
- Demand / return flow modelled as min - max channel
- Demand centre sub-model
- Controlled demand through master control channel
- Specified demands/Return flows
- Penalty structure
- Incremental hydrology boundary
- Sub-system boundary
- Mine Sub-model

OLIFANTS UPPER REACHES

MU 8

TRICHARDTSPRUIT

MU 1

RIETSPRUIT

MU 2

STEENKOOLSPRUIT

MU 7

KORINGSPRUIT

MU 3

SAAIWATERSPRUIT

MU 5

MU 9

MIDDLE OLIFANTS

BOESMANKRANSSPRUIT

MU 4

NOUPOORTSPRUIT

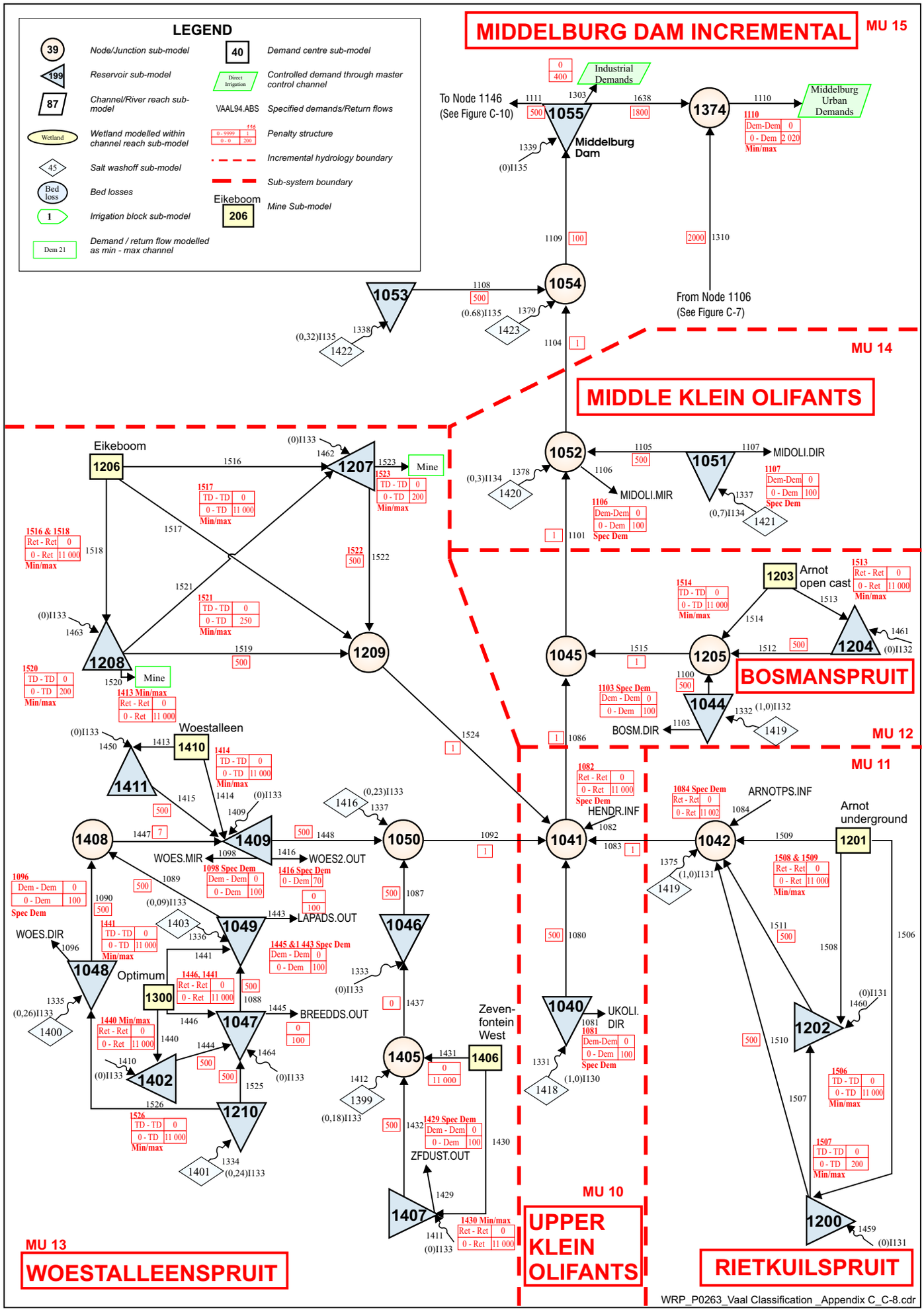
MU 6

WRP_P0258_Vaal River AOA 2010/2011 _Appendix C_C-7.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER, WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Witbank Dam Sub-system with Penalty Structure

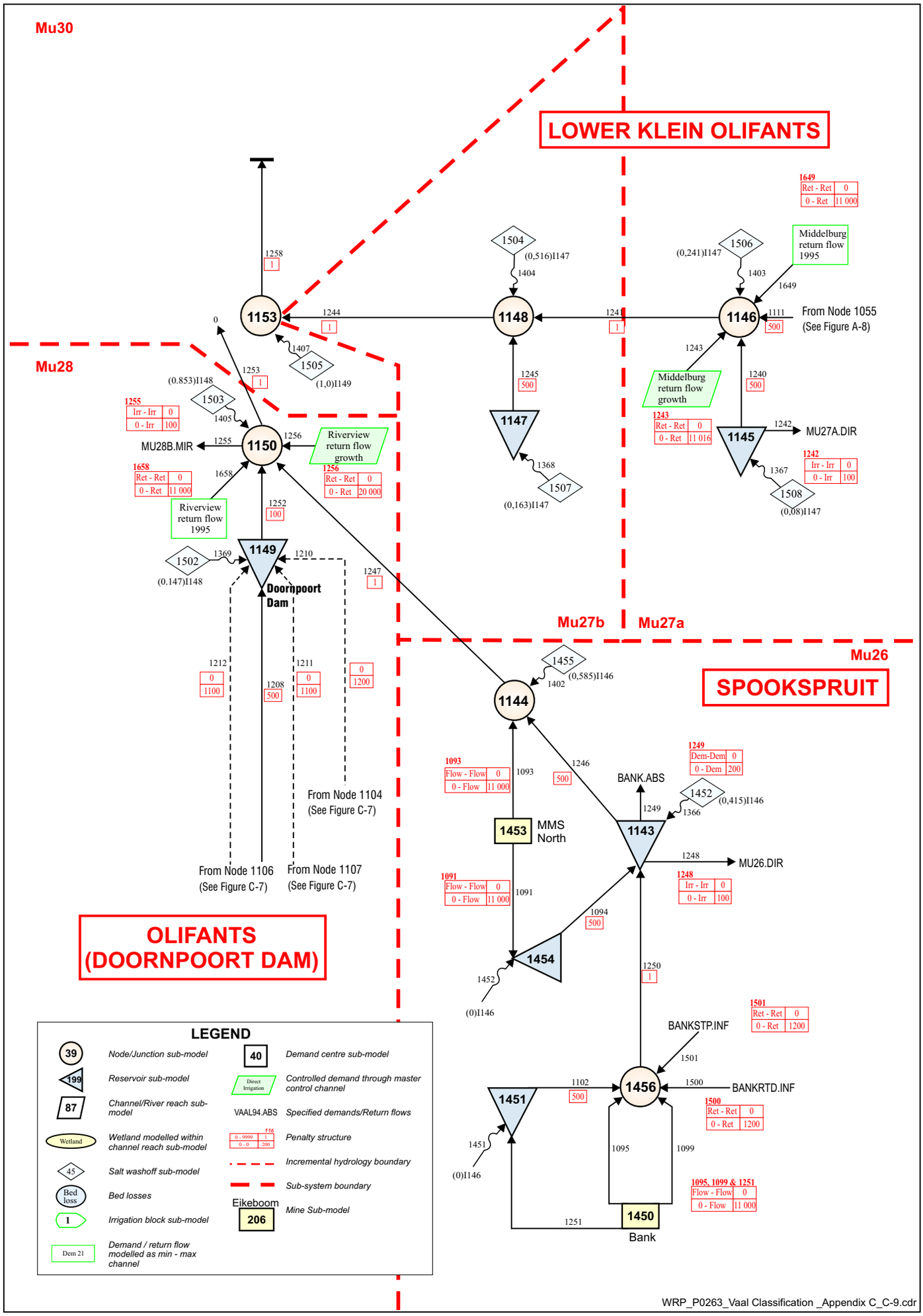
C-7



CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER,WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Middelburg Dam Sub-system With Penalty Structures

C-8



WRP_P0263_Vaal Classification _Appendix C_C-9.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER,WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Loskop Dam Incremental Sub-system With Penalty Structures

C-9

LOWER ORANGE SUB-SYSTEM

1998 ← 1961 ← 0 Ret flows on curve

0 ← 2156 ← 335 Loss demand on curve

Total Orange River losses

1926 | 0

1833

All Orange River Losses Reach 1 to Reach 7 to node 133

1971 | 1

AUG. INC 627

611

1859 — 1965 | 1 — 1858 — 1964 | 1 — 1857 — 1890 | 3 | 350 — 1860 — 1980 | 1 — 1862 — 541 | 500

From Node 188 Lower Vaal Douglas

Total Namibia Demand

0 | 1869

1834

1966 | 1

Namibia Growth Irrigation

Urban Rosh Pinah, Skorpion, Oranjemund

Mines Rosh Pinah Auchas, Skorpion

Aussenkehr Noordoewer

Haib Mine

Namibia Irrigation (Vioolsdrift)

Namibia Irrigation (Namakwaland)

1817 DEM - DEM 0 / 0 - DEM 300

1865 DEM - DEM 0 / 0 - DEM 320

1863 IRR - IRR 3 / 0 - IRR 350

1816 DEM - DEM 0 / 0 - DEM 320

1861 IRR - IRR 0 / 0 - IRR 210

1859 IRR - IRR 0 / 0 - IRR 280

1906 DEM - DEM 0 / 0 - DEM 310

1833

Losses Reach 7

MOUTH INC 630

1916 | 3,94 - 3,94 | 0 / 0 - 3,94 | 400

To Atlantic Ocean

1947 | 0

1844 — 1922 | 1 — 1861 — 1972 | 1 — 1831 — 1914 | 1 — River Mouth — Kabies — 1829 — 1910 | 1 — 1827 Vioolsdrif — 1904 | 1 — 1825 Pellendrif — 1896 | 1 — 1823 — 1962 | 1 — 1819 Neusberg — 1905 | 1 — 1818 Keimoes Weir — 1882 | 1 — 1817 Upington — 1856 | 1 — 1805 Boegoeberg — 1852 | 1 — 1801 — 500 | 1

From Node 190 Lower Vaal Douglas

1916 — 1916

1920 | 0 | 200

1921 | 500

Fish Inflow

From Node 1779 Fish River Sub-system Fig C-11

2142 | 0 | 400

692

2144 | 0 | 10001

6,6%

2146 | 0

1912 | 0 | 400

631

Losses Reach 6

659 | 0 | 280

RSA Lower Orange IRR, Growth

1827 | 232,02 | 10 | 213,85 | 176,4

2147 | 0

691

2145 | 0 | 10001

6%

1918 IRR - IRR 0 / 0 - IRR 200

1924 DEM - DEM 5 / 0 - DEM 310

1908 IRR - IRR 0 / 0 - IRR 350

1818 DEM - DEM 0 / 0 - DEM 350

1969 | 4

1968 | 4

1967 | 4

4 — 1970

1902 | 0 | 400

Losses Reach 5

1892 | 0 | 400

Losses Reach 4

1889 RET - RET 0 / 0 - RET 10 001

1927 | 0 - 14,26 | 1 / 0 - 0 | 1 000

1899

4%

1899 LOSS - LOSS 0 / 0 - LOSS 10 000

1874 RET - RET 0 / 0 - RET 10 001

1897 | 1

1857 IRR - IRR 0 / 0 - IRR 280

1888 IRR - IRR 0 / 0 - IRR 280

1894 IRR - IRR 0 / 0 - IRR 280

1900 DEM - DEM 5 / 0 - DEM 310

1898 IRR - IRR 0 / 0 - IRR 280

1868 LOSS - LOSS 0 / 0 - LOSS 10 000

6%

1184 DEM - DEM 5 / 0 - DEM 310

1876 IRR - IRR 0 / 0 - IRR 280

1870 IRR - IRR 0 / 0 - IRR 280

1895 RET - RET 1 / 0 - RET 400

1872 RET - RET 0 / 0 - RET 10 001

1880 7,64 - 7,64 | 0 / 0 - 7,64 | 400

1867 LOSS - LOSS 0 / 0 - LOSS 10 000

1893 DEM - DEM 5 / 0 - DEM 310

1866 | 0 - 9,91 | 1 / 0 - 0 | 1 000

1864 LOSS - LOSS 0 / 0 - LOSS 10 001

1805 | 884,57 | 470 | 875,32 | 874,3

1850 RET - RET 0 / 0 - RET 10 001

1854 | 0 - 9,76 | 1 / 0 - 0 | 1 000

1855 IRR - IRR 0 / 0 - IRR 280

1858 LOSS - LOSS 0 / 0 - LOSS 10 000

1862 IRR - IRR 0 / 0 - IRR 280

1842 DEM - DEM 5 / 0 - DEM 310

1844 | 5,31 - 5,31 | 0 / 0 - 5,31 | 400

1846 | 1

1848 IRR - IRR 0 / 0 - IRR 280

Losses Reach 3

Losses Reach 2

Yield

1928 | 0

Total Lower Orange RSA Demand

Alexander Bay Transhex Small Mines

Alexander Bay Irrigation

Vioolsdrift and others Irrigation

Springbok Mine and Urban

Namakwaland Irrigation (%)

Namakwa Mine and Urban

Namakwaland Irrigation (%)

Kakamas Canals Irrigation

Kakamas River Irrigation

Kakamas Urban Demand

Keimoes Irrigation

Upington Canals Irrigation

Upington & others Urban Dem

Upington River Irrigation

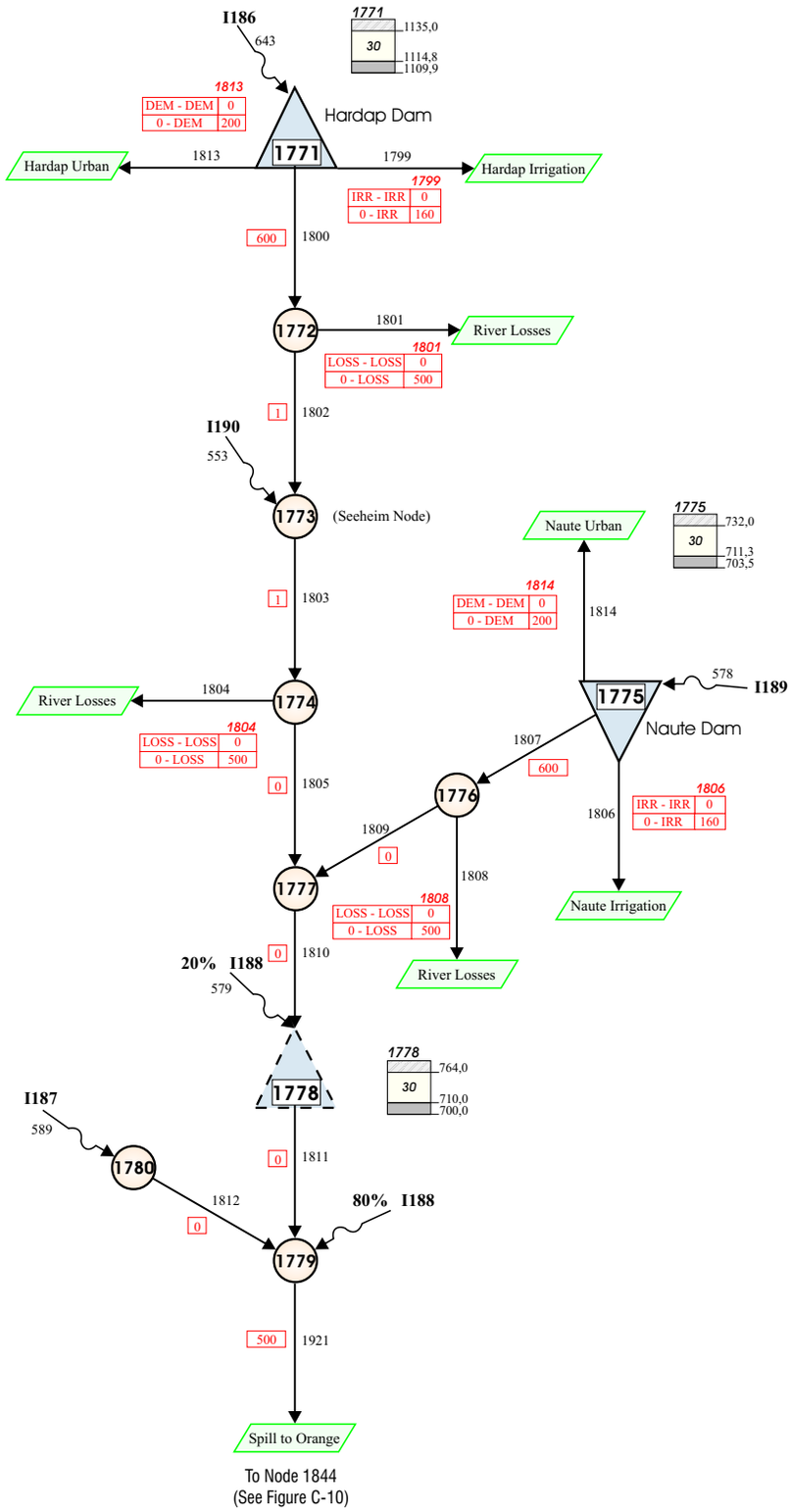
Boegoeberg Irrigation

Middle Orange Irrigation

Prieska Urban Demand

WRP_P0263_Vaal Classification _Appendix C_C-10.cdr

NAMIBIA: FISH RIVER SUB-SYSTEM

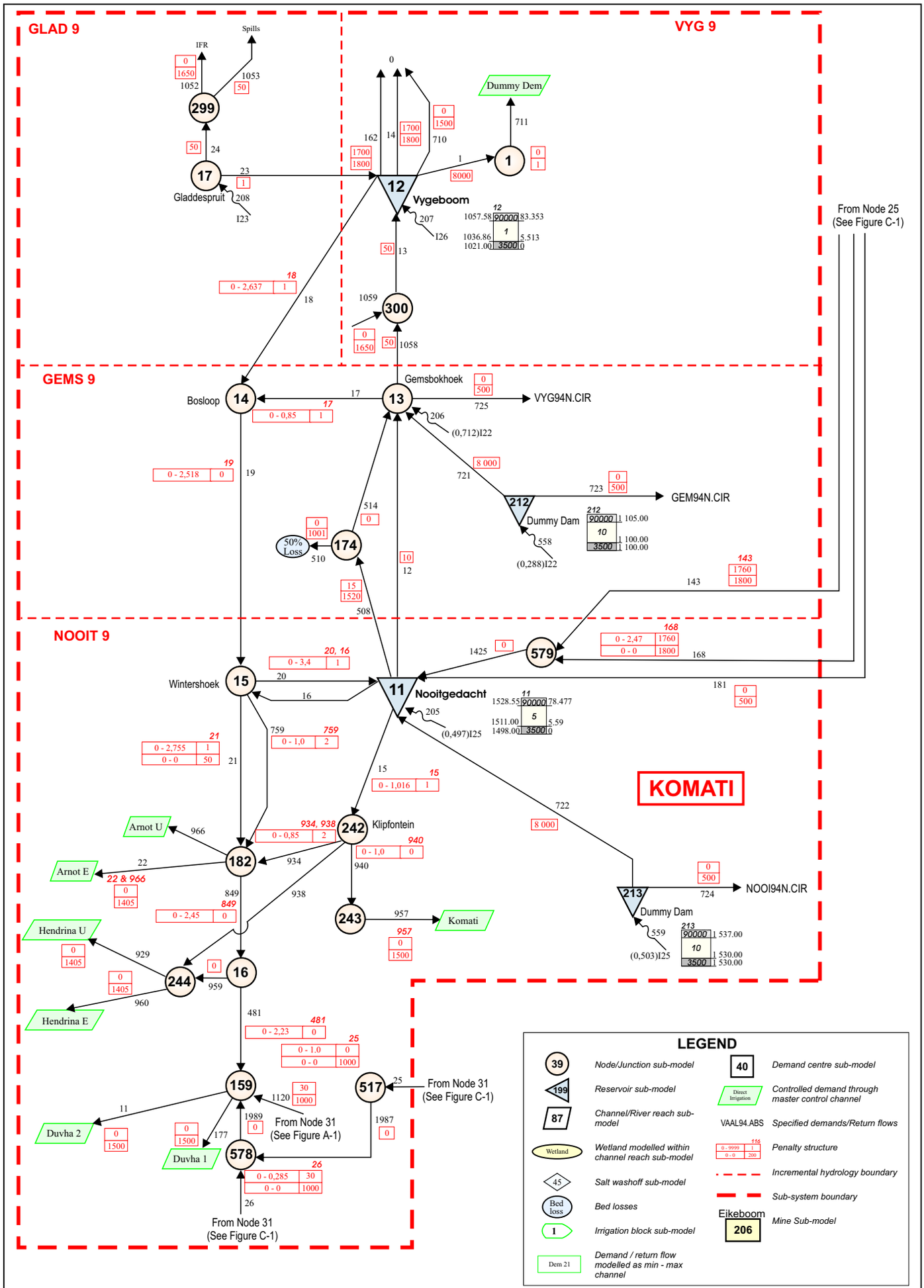


WRP_P0263_Vaal Classification _Appendix C_C-11.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER,WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Fish River Sub-system Namibia

C-11



WRP_P0263_Vaal Classification _Appendix C_C-12.cdr

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES (RIVER,WETLANDS GROUNDWATER AND LAKES) IN THE UPPER, MIDDLE AND LOWER VAAL WATER MANAGEMENT AREAS (WMA) 8,9,10

WRPM Schematic Diagram: Komati Sub-system

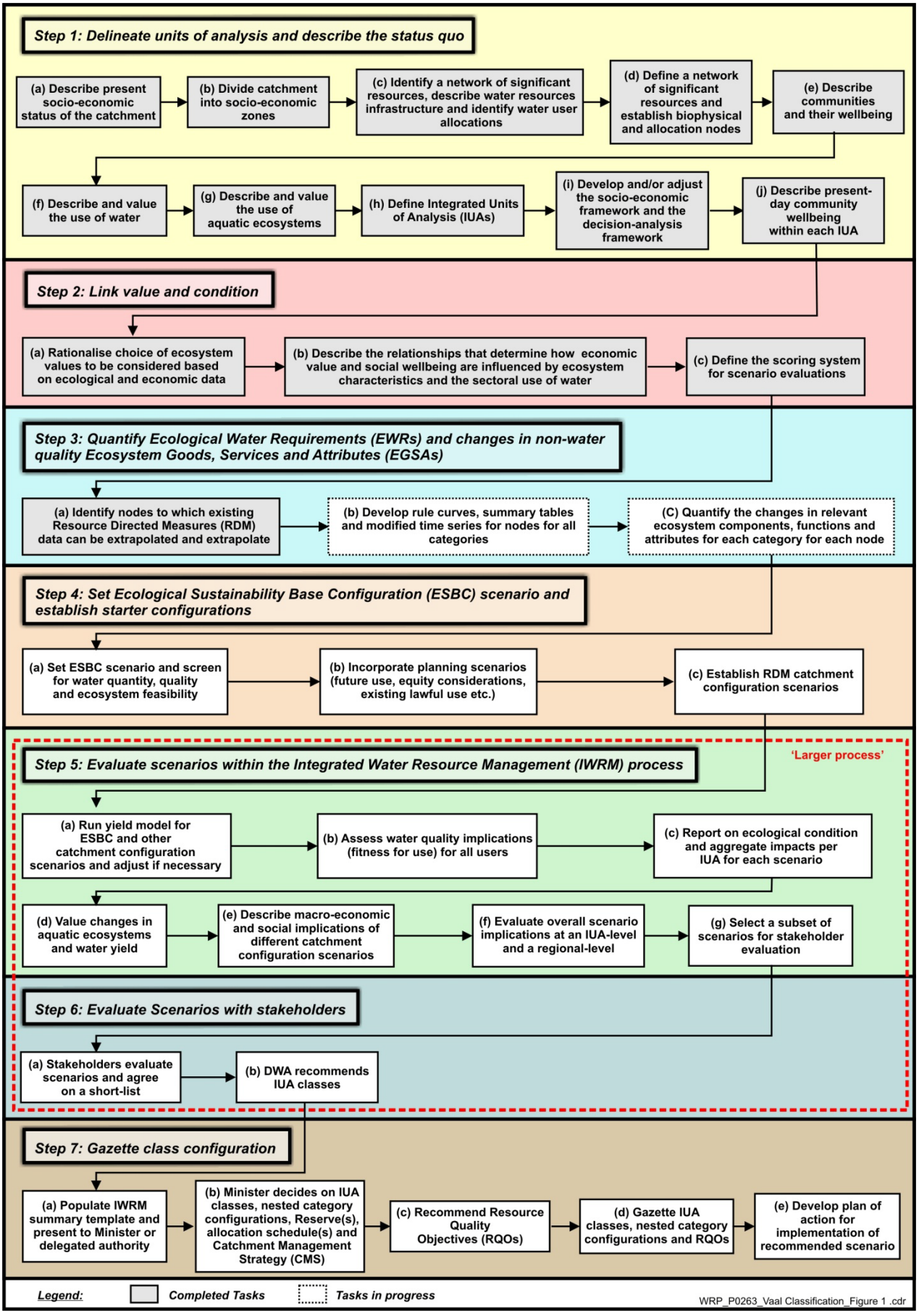
C-12

Appendix D:

Water Resource Classification System Guidelines:

Seven Step Diagram

Figure D-1: Seven Step Diagram of the WRCS Guidelines



Appendix E:

Description of the Integrated Vaal River System

E DESCRIPTION OF THE INTEGRATED VAAL RIVER SYSTEM (IVRS) AND HYDROLOGICAL DATABASE

E.1 GENERAL

Owing to a number of inter-basin transfers both to and from the Vaal River catchment, the Vaal River System is inter-linked with various other river basins. The Integrated Vaal River System (IVRS), therefore, comprises all the individual river systems that are linked to the Vaal River (refer to **Figure 1-1** on page 4 of main report) which includes the following supporting sub-systems:

- Komati Sub-system (Nooitgedacht and Vygeboom dams);
- Usutu Sub-system (Westoe, Jericho and Morgenstond dams);
- Heyshope Dam system;
- Zaaihoek Dam system;
- Upper Thukela Sub-system (Woodstock Dam and Driel Barrage); and
- Senqu Sub-system (Katse and Mohale dams).

The Vaal River System is briefly described in **Section E.2** and summarised information on the inter-basin transfer schemes shown in **Figure 1.1** (page 4 of main report) is as follows:

- **The Heyshope to Morgenstond Transfer Scheme**: transferring water from Heyshope Dam in the Assegaai River catchment to the Morgenstond Dam (Usutu Sub-system), with a maximum transfer capacity of 1.4 m^3/s.
- **The Heyshope to Grootdraai Transfer Scheme**: transferring water from Heyshope Dam in the Assegaai River catchment to the Upper Vaal WMA (Grootdraai Dam), with a maximum transfer capacity of 4.28 m^3/s.
- **The Zaaihoek to Grootdraai Transfer Scheme**: transferring water from the Zaaihoek Dam in the Slang River in the Buffalo Catchment to the Upper Vaal WMA (Grootdraai Dam), with a maximum transfer capacity of 2.79 m^3/s.
- **Thukela-Vaal Transfer Scheme**: transferring water from Woodstock Dam and Driel Barrage in the Upper Tugela Catchment to the Upper Vaal WMA (Sterkfontein Dam), with a maximum transfer capacity 20 m^3/s.
- **The Vaal–Olifants Transfer Scheme (Grootdraai)**: transferring water from Grootdraai Dam in the Upper Vaal WMA to the Upper Olifants Catchment, with a maximum transfer capacity of 6.65 m^3/s.
- **The Inkomati Transfer system**: transferring water from Nooitgedacht and Vygeboom dams in the

Komati West Catchment to the Upper Olifants Catchment.

- **The Lesotho Highlands Transfer System**: transferring water from Katse and Mohale Dams in Lesotho to the Upper Vaal WMA, with a maximum transfer capacity of 35.7 m^3/s.

- **Vaal River Eastern Sub-system Augmentation Project (VRESAP)**: Transferring water from Vaal Dam to the Sasol Secunda complex and the Eskom Power Stations in the Upper Olifants Catchment, with a maximum transfer capacity of 5.07 m^3/s.

E.2 DESCRIPTION OF THE VAAL RIVER SYSTEM

With reference to the Vaal River System it is important to distinguish between the Main Vaal System and the smaller sub-systems in the Vaal. The Main Vaal System consists basically of four major storage dams in the Vaal River Basin, i.e. the Grootdraai Dam, Sterkfontein Dam, Vaal Dam and Bloemhof Dam. These dams are located on the main stem of the Vaal River with the exception of Sterkfontein Dam which is located on the Wilge River tributary. Within the Vaal River Basin there is, however, also several smaller sub-systems which are all operated independently from the main system. These smaller sub-systems are not used to support the Main Vaal System and it is only the spillage from the smaller sub-systems that reaches the Main Vaal System.

The Vaal River System comprises of the following three Water Management Areas (WMA):

- Upper Vaal WMA;

- Middle Vaal WMA;

- Lower Vaal WMA.

E.3 HYDROLOGICAL DATABASE

The hydrological database resulting from the Vaal River System Analysis Update (VRSAU) Study (DWA, 1999) was included in the Water Resource Planning Model (WRPM) configuration in 1999. The hydrology for sub-catchments within the Komati, Usutu, Thukela and Senqu river basins was also updated as part of the VRSAU study. The VRSAU hydrology covers the period October 1920 to September 1995 (i.e. a period of 75 years). It is important to note that the hydrological analyses of the VRSAU study were not necessarily undertaken at quaternary catchment level as the focus was on the most representative modelling of relevant sub-catchments. The strategy adopted for the Annual Operating Analysis (AOA) of the IVRS is to continuously update and enhance the WRPM configuration and database as new information becomes available. Updated hydrology of the Thukela and Schoonspruit River catchments were subsequently included in the WRPM database. The updated hydrology of the Upper Waterval catchment resulting from the most recent BKS study (BKS, 2005a) was included in the WRPM database as part of the Comprehensive Reserve Determination Study.

E.4 WATER REQUIREMENTS

The water requirement projections of water users in the IVRS are updated on an annual basis as part of the Vaal River Annual Operating Analysis (AOA). Water requirement projections of bulk water users (Rand Water, Midvaal Water Company and Sedibeng Water) and large industrial users (Eskom, Sasol and Mittal Steel) are updated on a regular basis by these users themselves. The projections of other water use sectors are updated as new information becomes available from more recent assessments.

Information on water requirements and return flows is captured within a database spreadsheet. Information is available for so-called demand centres and is summarised within the context of sub-systems and user groups rather than at quaternary catchment level.

The operation of the IVRS system is based on the principle that demands are restricted during severe drought events. The objective of these restrictions is to reduce supply to less essential use to be able to protect the assurance of supply to more essential use. The basis on which restrictions are implemented is defined by means of the user priority classification definition.

The user priority classification definition requires that the different water users be grouped together into user categories and these categories should be classified according to priority for water supply. The four user categories that were considered for the IVRS are Domestic, Industrial, Strategic Industries and Irrigation. The four user categories were each split into three different levels of assurance of supply namely a Low, Medium and High priority level.

Appendix F:

Summary of Water Requirement Projections

Table F-1: **Base Scenario (Scenario A) water demand and return flow projections for the Integrated Vaal River System as adopted for the 2011/2012 Annual Operating Analysis**
Based on Rand Water High Population Demand Projections excluding WC/WDM, Midvaal April 2011, Sedibeng Water June 2011 projections, Eskom April 2011 Base projections
Sasol Secunda and Sasol Sasolburg April 2011 projections, July 2010 projections for Mittal Steel and the NWRS demand projections (Ratio Method) for smaller demand centres.

		Projected Demands and Return Flows (million m^3/a)										Extrapolated									
DESCRIPTION		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
DEMANDS:	Rand Water (1)	1478.64	1504.97	1531.30	1557.03	1587.31	1615.74	1644.91	1674.17	1702.32	1729.31	1752.03	1774.85	1797.76	1819.57	1840.24	1867.93	1895.73	1923.63	1951.63	1979.75
	Magalies Water (Vaalkop Scheme) (11)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mittal Steel (10)	12.50	12.69	12.89	13.10	13.30	13.51	13.72	13.94	14.16	14.38	14.61	14.84	15.08	15.31	15.56	15.80	16.05	16.31	16.56	16.83
	ESKOM (8)	372.56	381.68	379.82	381.06	380.23	384.94	393.26	403.34	408.87	416.31	418.48	414.94	410.42	400.22	389.13	382.66	373.34	358.28	343.41	338.06
	SASOL Sasolburg (Raw water req) (9)	20.42	21.91	22.57	23.04	23.48	23.95	24.43	24.92	25.42	25.92	26.44	26.97	27.51	28.06	28.62	29.19	29.78	30.37	30.98	31.60
	SASOL Secunda	82.46	86.78	88.50	91.25	93.18	91.76	92.06	92.35	93.88	93.30	92.97	93.32	93.68	95.24	98.06	98.46	98.91	99.46	100.01	100.43
	Midvaal Water Company	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
	Sedibeng Water (Balkfontein only)	41.04	40.98	41.37	41.67	41.91	42.11	42.28	42.44	42.57	42.70	42.81	42.91	43.01	43.10	43.18	43.26	43.33	43.40	43.47	43.53
	Other towns and industries (Vaal)	188.95	189.64	190.33	191.03	191.73	191.65	191.58	191.51	191.44	191.37	191.35	191.32	191.30	191.28	191.27	191.23	192.16	192.11	192.08	192.04
	Other towns and industries(Zaai)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vaalharts/Lower Vaal irrigation (2)	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53	541.53
	Diffuse Irrig and Aff (Vaal)	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31	11.31
	Diffuse Irrig and AFF (Sub systems)	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30	68.30
	Other irrigation in Vaal (3)	714.03	622.47	530.92	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37	439.37
	Other irrigation in sup subsystems (3)	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10	25.10
	Wetland losses (4)	45.36	45.62	45.88	46.14	46.40	46.66	46.91	47.17	47.43	47.70	47.95	48.21	48.47	48.73	48.99	49.24	49.48	49.73	49.98	50.24
	Bed losses (5)	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20	267.20
	Mooi River (net losses) (6)	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80	13.80
RETURN FLOWS:	Southern Gauteng (Rand Water)	-392.63	-399.64	-406.65	-413.67	-422.60	-430.54	-438.50	-446.46	-454.43	-462.41	-468.22	-474.03	-479.84	-485.66	-491.48	-497.77	-504.03	-510.28	-516.51	-522.72
	Midvaal Water Company	-1.08	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.10	-1.10	-1.10	-1.10	-1.10
	Sedibeng Water	-1.64	-1.64	-1.65	-1.67	-1.68	-1.68	-1.69	-1.70	-1.70	-1.71	-1.71	-1.72	-1.72	-1.72	-1.73	-1.73	-1.73	-1.74	-1.74	-1.74
	Other towns and industries	-71.01	-72.43	-73.24	-73.99	-74.91	-75.48	-76.09	-76.70	-77.32	-78.17	-78.90	-79.57	-80.27	-80.98	-81.87	-82.58	-83.30	-84.03	-84.76	-85.69
	Irrigation (7)	-143.14	-121.17	-99.20	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24	-77.24
	Mine dewatering	-112.55	-133.38	-133.38	-87.14	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87	-77.87
	Mine Water treated for Re-use	0.00	0.00	0.00	-46.25	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52
	Increased urban runoff	-103.86	-104.49	-105.14	-105.82	-106.51	-107.81	-109.14	-110.50	-111.89	-113.32	-114.78	-116.27	-117.80	-119.36	-120.97	-122.56	-124.20	-125.88	-127.61	-129.39
OVERALL GROSS SYSTEM DEMAND:		3928.19	3878.98	3815.82	3755.92	3789.15	3821.93	3860.77	3901.46	3937.70	3972.61	3998.25	4018.98	4038.83	4053.13	4066.66	4089.37	4110.39	4124.91	4139.74	4164.08
OVERALL NET SYSTEM DEMAND:		3102.29	3045.14	2995.46	2949.08	2971.75	2994.71	3023.65	3054.38	3080.64	3105.29	3122.94	3135.68	3147.49	3153.69	3158.89	3173.01	3185.41	3191.26	3197.39	3212.81

Notes :

(1): Rand Water's total raw water abstraction includes Sasolburg but excludes Authorised Users (i.e. ESKOM, ISCOR, Sasol Sasolburg , Mittal Steel and Small Users (Mining & Industrial)).
(2): Includes distribution losses within Vaalharts canal system and mainstream irrigation along Vaal River from Bloemhof Dam down to Douglas Weir.
(3): "Other irrigation" excludes diffuse irrigation
(4): Includes evaporation losses associated with wetlands as well as bed losses occuring within the Suikerbosrand and Klip rivers
(5): Vaal River bed losses include evaporation and operating losses associated with releases made from Bloemhof Dam
(6): Mooi River (Wonderfonteinspruit catchment) : Net effect of bed losses and decanting from dolomitic eyes resulting from WQT calibration
(7): Includes flow contribution resulting from the tailwater component at Erfenis Dam
(8): Includes DWA 3rd Party Users supplied from Eskom conveyance infrastructure as well as from the VRESAP pipeline (i.e. Greylingstad and Burn Stone Mine)
(9): It is assumed that Sasol's raw water requirements are not supplied through Rand Water, but that the projections of Rand Water include the potable water allocation of 6Ml/day.
(10): Represents Mittal Steel's total water requirements (i.e. includes the portion of the demand obtained from Rand Water)
(11): Represents portion of Rand Water's demand supplied by Magalies Water (drawn through the Vaalkop Scheme)

Table F-2 : **Base Scenario (Scenario A) water demand and return flow projections for the Integrated Vaal River System as adopted for the 2011/2012 Annual Operating Analysis**
Based on Rand Water High Population Demand Projections excluding WC/WDM, Midvaal April 2011, Sedibeng Water June 2011 projections, Eskom April 2011 Base projections
Sasol Secunda and Sasol Sasolburg April 2011 projections, July 2010 projections for Mittal Steel and the NWRS demand projections (Ratio Method) for smaller demand centres.

		Projections (Million m^3/a)																			
KOMATI SUB-SYSTEM		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESKOM(1):	Komati Power Station	15.24	19.79	18.68	17.15	13.69	10.86	11.16	10.94	11.10	11.39	11.53	11.39	11.20	10.08	6.42	2.77	2.62	2.62	2.62	2.62
	Arnot	29.91	30.47	30.34	30.24	30.47	31.42	31.45	31.34	31.24	30.77	29.84	29.28	28.15	25.63	23.64	23.64	22.74	19.11	14.73	13.32
	Hendrina	29.00	28.31	29.08	29.25	30.30	31.53	31.42	31.73	31.46	31.25	29.56	25.98	22.83	19.21	17.29	14.95	12.23	9.47	5.26	1.29
	Duvha 1 (Groot) - excess(2)	23.67	28.90	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56
	Duvha 2 (Komati/Usutu)	15.52	14.43	10.27	10.28	13.24	16.49	16.61	17.58	17.31	16.93	16.39	15.82	15.31	14.58	13.36	13.36	12.74	11.51	11.57	11.67
	New Stations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DWAF 3rd Party Users along Komati Pipeline	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14
	DWAF 3rd Party Users along Hendrina-Duvha Pipeline	5.07	5.08	5.09	5.11	5.12	5.12	5.13	5.13	5.13	5.14	5.14	5.15	5.16	5.17	5.18	5.18	5.18	5.18	5.18	5.17
	Other Users(3): Total DWAF 3rd Party Users	12.20	12.22	12.23	12.24	12.26	12.26	12.26	12.27	12.27	12.27	12.28	12.29	12.30	12.31	12.31	12.31	12.31	12.31	12.31	12.31
		-12.20	-12.22	-12.23	-12.24	-12.26	-12.26	-12.26	-12.27	-12.27	-12.27	-12.28	-12.29	-12.30	-12.31	-12.31	-12.31	-12.31	-12.31	-12.31	-12.31
IRRIGATION:	Nooitgedacht dummy dam	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
	Gemsbokhoek dummy dam	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67
	Gemsbokhoek node	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
DIFFUSE:	Gladdespruit Weir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93
	Vygeboom Dam	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
	"	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24	24.24
	Gemsbokhoek Weir	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06
	"	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Nooitgedacht Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Notes (1): The total ESKOM demand in the Komati System is allocated as follows: 1st 70 million m3/a on channel 11, 2nd 9 million m3/a on channel 177 and rest on channel 22.
(2): Transfers from Grootdraai to Olifants. With present poor water quality in Witbank Dam, it is unlikely that more than 9 million m3/a will be transferred through channel 177.
(3): Other users include DWAF third party users along the Hendrina-Duvha pipeline, as well as users supplied from Nooitgedacht and Vygeboom Dams. \...KOMATI SUB-SYSTEM

		Projections (Million m^3/a)																			
USUTU SUB-SYSTEM		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESKOM:	Camden	19.04	18.35	18.09	17.56	15.75	14.64	14.97	14.65	14.72	14.69	14.61	14.11	13.42	13.19	12.56	11.00	8.60	3.48	0.53	0.53
	Kriel_1 (Usutu-sup from Grootdraai)	39.92	40.77	41.90	41.24	41.17	41.83	42.45	42.45	42.77	42.89	42.13	41.58	40.82	40.82	40.82	40.82	40.82	39.78	35.87	32.22
	Kriel_2 (Grootdraai)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kriel (Total)	39.92	40.77	41.90	41.24	41.17	41.83	42.45	42.45	42.77	42.89	42.13	41.58	40.82	40.82	40.82	40.82	40.82	39.78	35.87	32.22
	Kriel (Total)	-39.92	-40.77	-41.90	-41.24	-41.17	-41.83	-42.45	-42.45	-42.77	-42.89	-42.13	-41.58	-40.82	-40.82	-40.82	-40.82	-40.82	-39.78	-35.87	-32.22
	Matla 1 (Usutu capacity)	18.16	17.23	16.14	16.94	17.14	16.35	13.67	9.54	9.18	8.86	9.23	9.74	10.18	10.04	10.22	10.22	10.23	11.36	15.39	19.04
	Matla 2 (Groot) - excess(1)	29.87	31.21	32.54	33.84	35.30	36.85	42.92	50.34	53.60	56.62	56.50	55.92	54.48	52.18	50.58	50.56	49.87	47.53	43.42	39.45
	Matla (total) : Including Kusile) New CF_1 PS	48.03	48.45	48.68	50.78	52.44	53.20	56.59	59.88	62.78	65.48	65.73	65.65	64.66	62.22	60.80	60.78	60.09	58.89	58.81	58.48
	Matla (total)	-48.03	-48.45	-48.68	-50.78	-52.44	-53.20	-56.59	-59.88	-62.78	-65.48	-65.73	-65.65	-64.66	-62.22	-60.80	-60.78	-60.09	-58.89	-58.81	-58.48
	Kendal_1 (Usutu-sup from Grootdraai)	3.73	3.80	3.77	3.63	3.50	3.63	5.69	9.81	9.86	10.06	10.45	10.49	10.81	10.95	10.77	10.77	10.76	10.68	10.55	10.55
	Kendal_2 (Grootdraai)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kendal (Total)	3.73	3.80	3.77	3.63	3.50	3.63	5.69	9.81	9.86	10.06	10.45	10.49	10.81	10.95	10.77	10.77	10.76	10.68	10.55	10.55
	Kendal (Total)	-3.73	-3.80	-3.77	-3.63	-3.50	-3.63	-5.69	-9.81	-9.86	-10.06	-10.45	-10.49	-10.81	-10.95	-10.77	-10.77	-10.76	-10.68	-10.55	-10.55
	New Stations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Other Users(2)	7.11	7.20	7.29	7.38	7.47	7.51	7.55	7.59	7.63	7.67	7.71	7.75	7.79	7.83	7.88	7.89	7.91	7.93	7.94	7.96
DIFFUSE:	Westoe Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64
	Jericho Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
	Morgenstond Dam	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
	"	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31
	Churchill Weir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes (1): Transfers from Grootdraai to Olifants through channel 10.
(2): Other users include DWAF third party users along the following pipelines: Jericho-Camden-Lilliput and Heyshope-Grootdraai. \...USUTU SUB-SYSTEM

ZAAIHOEK SUB-SYSTEM		Projections (Million m^3/a)																			
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESKOM:	Majuba	26.55	26.89	24.99	24.10	24.87	26.06	26.55	26.78	27.66	30.30	33.50	36.73	38.80	38.12	36.75	36.75	36.75	36.40	36.75	38.80
URBAN:	Wakkerstroom, Esizamelani	0.45	0.47	0.48	0.50	0.51	0.53	0.55	0.57	0.59	0.61	0.63	0.65	0.68	0.70	0.72	0.74	0.76	0.79	0.81	0.83
	Grootdraai sup from Zaaihoek	-21.15	-20.81	-22.71	-23.60	-22.83	-21.64	-21.15	-20.92	-20.04	-17.40	-14.20	-10.97	-8.90	-9.58	-10.95	-10.95	-10.95	-10.95	-10.95	-8.90
	Volksrust (from Mahawane Dam)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Mahawane Dam yield	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
	Support to Chelmsford Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIFFUSE:	Zaaihoek Dam Irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Zaaihoek Dam Afforestation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\...ZAAIHOEK SUB-SYSTEM

		Projections (Million m^3/a)																			
GROOTDRAAI SUB-SYSTEM		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESKOM:	Tutuka	36.93	35.68	33.48	33.47	33.34	33.01	33.46	34.21	34.38	36.16	38.49	38.42	38.82	39.40	39.40	39.40	39.40	39.40	39.40	39.40
	Other Users(1)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SASOL Secunda:		82.46	86.78	88.50	91.25	93.18	91.76	92.06	92.35	93.88	93.30	92.97	93.32	93.68	95.24	98.06	98.46	98.91	99.46	100.01	100.43
VRESAP Users	Greylingstad	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
	Burn Stone Mine and Others	2.86	4.08	5.82	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31
URBAN:	Lekwa LM (Former Standerton TLC)	10.57	10.70	10.84	10.97	11.11	11.16	11.21	11.25	11.30	11.35	11.42	11.48	11.55	11.62	11.69	11.72	11.75	11.77	11.80	11.82
	Amersfoort (const.1994 demand)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Amersfoort (growth only)	0.74	0.74	0.75	0.75	0.76	0.77	0.78	0.78	0.79	0.80	0.81	0.82	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89
	Amersfoort (total)	0.91	0.91	0.92	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.99	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06
	Amersfoort (total)	-0.91	-0.91	-0.92	-0.92	-0.93	-0.94	-0.95	-0.95	-0.96	-0.97	-0.98	-0.99	-0.99	-1.00	-1.01	-1.02	-1.03	-1.04	-1.05	-1.06
	Breyten (Yield from own sources)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
	Breyten (growth only): Supplied from Camden pipeline	0.79	0.80	0.81	0.82	0.83	0.83	0.84	0.84	0.84	0.85	0.84	0.83	0.82	0.82	0.81	0.81	0.81	0.80	0.80	0.80
	Breyten (total)	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.17	1.17	1.18	1.17	1.16	1.15	1.15	1.14	1.14	1.14	1.13	1.13	1.13
	Breyten (total)	-1.12	-1.13	-1.14	-1.15	-1.16	-1.16	-1.17	-1.17	-1.17	-1.18	-1.17	-1.16	-1.15	-1.15	-1.14	-1.14	-1.14	-1.13	-1.13	-1.13
	Msukaligwa LM (Former Ermelo TLC) (local sources)	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04
	Msukaligwa LM (Former Ermelo TLC) (growth on pipel	2.25	2.31	2.37	2.42	2.48	2.51	2.53	2.56	2.58	2.61	2.65	2.69	2.73	2.77	2.81	2.82	2.83	2.84	2.86	2.87
	Msukaligwa LM (Former Ermelo TLC) (total)	4.29	4.35	4.41	4.46	4.52	4.55	4.57	4.60	4.62	4.65	4.69	4.73	4.77	4.81	4.85	4.86	4.87	4.88	4.90	4.91
	Msukaligwa LM (Former Ermelo TLC) (total)	-4.29	-4.35	-4.41	-4.46	-4.52	-4.55	-4.57	-4.60	-4.62	-4.65	-4.69	-4.73	-4.77	-4.81	-4.85	-4.86	-4.87	-4.88	-4.90	-4.91
	Morgenzon (Demand supplied from own sources)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
	Morgenzon (growth exceeding yield from own sources	0.01	0.02	0.04	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11
	Morgenzon (total)	0.49	0.50	0.52	0.53	0.54	0.54	0.55	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.59	0.59	0.59	0.59	0.59	0.59
	Morgenzon (total)	-0.49	-0.50	-0.52	-0.53	-0.54	-0.54	-0.55	-0.56	-0.56	-0.57	-0.57	-0.57	-0.58	-0.58	-0.59	-0.59	-0.59	-0.59	-0.59	-0.59
	Daggakraal	1.18	1.21	1.23	1.26	1.28	1.27	1.26	1.24	1.23	1.22	1.20	1.18	1.17	1.15	1.13	1.11	1.09	1.08	1.06	1.04
	Driefontein	0.82	0.86	0.91	0.95	1.00	1.01	1.02	1.03	1.04	1.05	1.09	1.13	1.17	1.21	1.25	1.29	1.33	1.37	1.41	1.46
REGION B:	Demand on own sources	75.98	75.86	75.74	75.62	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50	75.50
	Part of increase(2)																				
	Losses on transfer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Supply from own sources	-75.98	-75.86	-75.74	-75.62	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50	-75.50
IRRIGATION:	Heyshope mainstream	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71
	Heyshope dummy dam	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82	6.82
	Grootdraai RE-EWR1 Mstr Irrig (RR368)-Unlawful Use	2.20	1.55	0.90	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Grootdraai RE-EWR1 Mstr Irrig (RR369)-Lawful Use	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Grootdraai EWR1 Mstr Irrig (RR1782)-Unlawful Use	14.09	9.93	5.77	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
	Grootdraai EWR1 Mstr Irrig (RR1800)-Lawful Use	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
	Grootdraai EWR2 Mstr Irrig (RR398)-Unlawful Use	6.33	4.46	2.59	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	Grootdraai EWR2 Mstr Irrig (RR414)-Lawful Use	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
Original irrigation block	Grootdraai mainstream (RR1800)- Lawful Use	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53	12.53
Original irrigation block	Grootdraai mainstream (RR1782)- Sug 2005 - Lawful U	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84
DIFFUSE:	Heyshope Dam (Assegaai)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
	Grootdraai Dam (RR12)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RETURN:	Ermelo (growth only) (50 %)	-1.13	-1.15	-1.18	-1.21	-1.24	-1.25	-1.27	-1.28	-1.29	-1.30	-1.32	-1.34	-1.36	-1.38	-1.40	-1.41	-1.42	-1.42	-1.43	-1.43
	Bethal	-3.99	-4.11	-4.22	-4.34	-4.45	-4.58	-4.71	-4.83	-4.96	-5.09	-5.25	-5.41	-5.57	-5.73	-5.89	-6.09	-6.29	-6.49	-6.69	-6.89
	Tutuka seepage	-0.97	-0.94	-0.88	-0.88	-0.87	-0.87	-0.88	-0.90	-0.90	-0.95	-1.01	-1.01	-1.02	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
	Mine seepage	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
	Grootdraai RE-EWR Mstr Irrig (RR368)-Unlawful Use	-0.28	-0.19	-0.11	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
	Grootdraai RE-EWR Mstr Irrig (RR369)-Lawful Use	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	Grootdraai EWR1 Mstr Irrig (RR1782)-Unlawful Use	-1.77	-1.25	-0.73	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
	Grootdraai EWR1 Mstr Irrig (RR1800)-Lawful Use	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92
	Grootdraai EWR2 Mstr Irrig (RR398)-Unlawful Use	-0.79	-0.56	-0.33	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
	Grootdraai EWR2 Mstr Irrig (RR414)-Lawful Use	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52
Original irrigation block	Grootdraai irrigation (RR12) Lawful Use	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49
Original irrigation block	Grootdraai mainstream (RR12)- Sug 2005 - Lawful Us	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
	Ermelo (up to 1994 only - 50 %) [3]	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02	-1.02
PAVED AREAS :	Waterval increased runoff	-7.13	-7.48	-7.86	-8.25	-8.66	-9.09	-9.55	-10.03	-10.53	-11.06	-11.61	-12.19	-12.80	-13.44	-14.11	-14.82	-15.56	-16.33	-17.15	-18.01
		22.62	15.94	9.27	2.59																

Notes (1): Other users include DWAF third party users along the following pipelines: Grootdraai-Tutuka, Trichardsfontein-Matla and Naauwpoort-Duvha-Slang River.

(2): Water transferred from Grrotdraai Dam to drainage region B for urban and industrial use.

(3): Ermelo's return flow based on 1994 demands (abstracted through Ch700) is not considered as part of Ch 47 to overcome problems with negative demands resulting from all urban return flows entering through Ch47

(4): Tutuka 1994 seepage from hydrology report.

		Projections (Million m^3/a)																			
VAAL & BARRAGE		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ESKOM:	Grootvlei	14.96	14.47	15.19	15.20	12.03	9.35	9.66	9.47	9.54	9.41	9.24	9.24	9.24	9.24	9.16	7.76	4.46	2.11	0.77	0.77
	Lethabo	46.21	46.19	46.76	46.27	46.18	46.41	46.08	46.19	46.17	46.40	46.40	46.12	46.32	46.54	46.30	46.38	46.19	46.39	46.44	46.16
	Kragbron(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	New coal fired 3 and 4 (Vaal Dam	0.00	0.00	0.00	0.72	1.94	5.19	5.78	6.92	8.42	9.09	9.06	8.53	8.39	8.54	10.13	12.52	14.15	16.64	18.28	20.40
	New coal fired 2 (Mokolo catchment)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mittal Steel:	(Previously known as Iscor) Incl supply from RW	12.50	12.69	12.89	13.10	13.30	13.51	13.72	13.94	14.16	14.38	14.61	14.84	15.08	15.31	15.56	15.80	16.05	16.31	16.56	16.83
SASOL Sasolburg:	Sasolburg Complex: Raw water from Vaal Rive	20.42	21.91	22.57	23.04	23.48	23.95	24.43	24.92	25.42	25.92	26.44	26.97	27.51	28.06	28.62	29.19	29.78	30.37	30.98	31.60
SMALL USERS:	(Mining & Industrial)(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mining abs. from Blesbokspruit	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56
	Balfour abstractions (Blesboksp)	1.56	1.59	1.61	1.63	1.66	1.67	1.68	1.70	1.71	1.72	1.74	1.75	1.76	1.77	1.79	1.80	1.81	1.82	1.84	1.85
URBAN:																					
	Rand Water Jun99 growth rates																				
DC40: Demand	Rand Water (with Return Flows to Klip River	427.59	435.22	442.85	450.48	460.05	468.53	477.03	485.53	494.04	502.57	508.74	514.93	521.11	527.30	533.50	540.20	546.87	553.53	560.16	566.76
	Rand Water Rgn A+C	-427.59	-435.22	-442.85	-450.48	-460.05	-468.53	-477.03	-485.53	-494.04	-502.57	-508.74	-514.93	-521.11	-527.30	-533.50	-540.20	-546.87	-553.53	-560.16	-566.76
	Rand Water: Southn Gauteng(4	427.59	435.22	442.85	450.48	460.05	468.53	477.03	485.53	494.04	502.57	508.74	514.93	521.11	527.30	533.50	540.20	546.87	553.53	560.16	566.76
	Rand Water: Northern Users - Crocodile	831.66	846.51	861.37	875.62	891.20	906.55	922.63	938.78	953.81	967.66	980.82	994.07	1007.41	1019.64	1030.71	1048.05	1065.53	1083.14	1100.88	1118.76
Supply from Magalies	Rand Water: Northern Users (Vaalkop Scheme	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RW SG: Return Flow	RW Southern Gauteng Total return flow	392.63	399.64	406.65	413.67	422.60	430.54	438.50	446.46	454.43	462.41	468.22	474.03	479.84	485.66	491.48	497.77	504.03	510.28	516.51	522.72
		-392.63	-399.64	-406.65	-413.67	-422.60	-430.54	-438.50	-446.46	-454.43	-462.41	-468.22	-474.03	-479.84	-485.66	-491.48	-497.77	-504.03	-510.28	-516.51	-522.72
DC293 : Demand	Rand Water (with return flows to Suikerbosranc	98.23	100.28	102.32	104.36	106.73	108.84	110.95	113.06	115.18	117.29	118.83	120.38	121.92	123.46	125.01	126.67	128.34	130.00	131.65	133.30
DC294 : Demand	Rand Water (with return flows to Upper Riet	50.13	50.92	51.70	52.48	53.59	54.57	55.55	56.53	57.52	58.50	59.22	59.94	60.65	61.37	62.09	62.86	63.63	64.40	65.16	65.93
DC295 : Demand	Rand Water (with return flows to Lower Riet	58.21	59.08	59.95	60.81	62.14	63.33	64.52	65.71	66.91	68.10	68.97	69.84	70.72	71.59	72.46	73.39	74.32	75.25	76.18	77.11
DC296 : Demand	Rand Water (with return flows to Mooi River	12.81	12.96	13.12	13.27	13.61	13.92	14.24	14.55	14.87	15.19	15.44	15.70	15.96	16.21	16.47	16.76	17.04	17.32	17.60	17.88
Mine Water Re-use	Mine water treated for re-use by Rand Wate	0.00	0.00	0.00	-46.25	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52	-55.52
Boreholes:	Zuurbekom supply to Rand Wate	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56
	Pretoria demand (incl. Rietvlei etc.	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	Zuurbekom supply to Rand Wate	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56
	Pretoria demand (incl. Rietvlei etc.	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00	-25.00
Region B:	From R W (Only from Grootdraai)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Towns:	Bethlehem (const.1994 demand	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48	5.48
	Bethlehem (growth only	2.46	2.41	2.37	2.32	2.27	2.18	2.09	2.00	1.91	1.82	1.73	1.65	1.56	1.47	1.38	1.29	1.20	1.11	1.02	0.94
	Bethlehem (total)	7.94	7.89	7.85	7.80	7.75	7.66	7.57	7.48	7.39	7.30	7.21	7.13	7.04	6.95	6.86	6.77	6.68	6.59	6.50	6.42
	Bethlehem (total)	-7.94	-7.89	-7.85	-7.80	-7.75	-7.66	-7.57	-7.48	-7.39	-7.30	-7.21	-7.13	-7.04	-6.95	-6.86	-6.77	-6.68	-6.59	-6.50	-6.42
	Deneysville	0.94	0.96	0.98	1.01	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.18	1.19	1.21	1.23	1.25	1.27	1.29	1.30
	Small Users(5)	3.15	3.15	3.15	3.15	3.15	3.15	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.13	3.13	3.13	3.13	3.13
	Villiers	0.88	0.90	0.92	0.94	0.96	0.98	0.99	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16
	Frankfort	2.41	2.43	2.46	2.48	2.51	2.52	2.53	2.53	2.54	2.55	2.56	2.57	2.58	2.58	2.59	2.60	2.61	2.62	2.63	2.64
	Harrismith (const.1994 demand	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39
	Harrismith (growth only	2.08	2.16	2.24	2.32	2.40	2.45	2.51	2.57	2.62	2.68	2.73	2.79	2.84	2.90	2.96	3.01	3.07	3.12	3.18	3.23
	Harrismith (total)	4.47	4.55	4.63	4.71	4.79	4.84	4.90	4.96	5.01	5.07	5.12	5.18	5.23	5.29	5.35	5.40	5.46	5.51	5.57	5.62
	Harrismith (total)	-4.47	-4.55	-4.63	-4.71	-4.79	-4.84	-4.90	-4.96	-5.01	-5.07	-5.12	-5.18	-5.23	-5.29	-5.35	-5.40	-5.46	-5.51	-5.57	-5.62
	Memel (const.1994 demand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Memel (growth only)	0.19	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	Memel (total)	0.19	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	Memel (total)	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
	Volksrust (Balfour Dam) 199	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Volksrust (growth only	1.50	1.57	1.65	1.72	1.80	1.90	2.00	2.11	2.21	2.31	2.41	2.51	2.61	2.71	2.81	2.95	3.09	3.22	3.36	3.50
	Volksrust (total)	1.50	1.57	1.65	1.72	1.80	1.90	2.00	2.11	2.21	2.31	2.41	2.51	2.61	2.71	2.81	2.95	3.09	3.22	3.36	3.50
	Volksrust (total)	-1.50	-1.57	-1.65	-1.72	-1.80	-1.90	-2.00	-2.11	-2.21	-2.31	-2.41	-2.51	-2.61	-2.71	-2.81	-2.95	-3.09	-3.22	-3.36	-3.50
	Reitz(6)	2.28	2.31	2.34	2.36	2.39	2.40	2.40	2.41	2.42	2.42	2.43	2.44	2.44	2.45	2.45	2.46	2.47	2.47	2.48	2.49
	Warden (up to 1994)	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	Warden (growth only	-0.41	-0.43	-0.45	-0.47	-0.49	-0.50	-0.51	-0.53	-0.54	-0.56	-0.57	-0.59	-0.60	-0.62	-0.63	-0.64	-0.66	-0.67	-0.69	-0.70
	Warden (total)	0.41	0.39	0.37	0.35	0.33	0.32	0.30	0.29	0.27	0.26	0.24	0.23	0.21	0.20	0.19	0.17	0.16	0.14	0.13	0.11
	Warden (total)	-0.41	-0.39	-0.37	-0.35	-0.33	-0.32	-0.30	-0.29	-0.27	-0.26	-0.24	-0.23	-0.21	-0.20	-0.19	-0.17	-0.16	-0.14	-0.13	-0.11

Notes (1): Kragbron is Highveld and Taaibos and their use is registered as "Sasol (Vaal)" as part of the Autorised User

(2): Small Users (Mining & Industrial) include USCO, Vereeniging Refractories, Vereeniging Municipality and TO

(3): Rand Water's total raw water abstraction includes Sasolburg but excludes Authorised Users (i.e. ESKOM, ISCOR, Sasol I and Small Users (Mining & Industria

(4): Sasolburg is supplied by Rand Water and is included in the Southern Gauteng dema

(5): Small users include Jim Fouche, Oranjeville and Vaal Marina. 1998 consumption not available - interpolation us

(6): Reitz includes Tweeling and Petrus Steyr

VAAL & BARRAGE (Cont 1)		Projections (Million m³/a)																			
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
URBAN:																					
Towns:																		0.97	0.97	0.97	0.97
	Vrede (const.1994 demand)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Vrede (growth only)	0.33	0.34	0.34	0.34	0.34	0.34	0.33	0.32	0.32	0.31	0.30	0.30	0.29	0.28	0.28	0.27	0.26	0.26	0.25	0.24
	Vrede (total)	1.07	1.08	1.08	1.08	1.08	1.08	1.07	1.06	1.06	1.05	1.04	1.04	1.03	1.02	1.02	1.01	1.00	1.00	0.99	0.98
	Vrede (total)	-1.07	-1.08	-1.08	-1.08	-1.08	-1.08	-1.07	-1.06	-1.06	-1.05	-1.04	-1.04	-1.03	-1.02	-1.02	-1.01	-1.00	-1.00	-0.99	-0.98
	Heilbron[1,2] Used for return flow calcs	1.17	1.18	1.18	1.19	1.20	1.20	1.20	1.20	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.18	1.18	1.18	1.18	1.18
	Heilbron (1) Used for return flow calcs: Correction	-1.17	-1.18	-1.18	-1.19	-1.20	-1.20	-1.20	-1.20	-1.19	-1.19	-1.19	-1.19	-1.19	-1.19	-1.19	-1.18	-1.18	-1.18	-1.18	-1.18
	QwaQwa (const.1994 demand)	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37	9.37
	QwaQwa (growth only)	-0.31	-0.45	-0.59	-0.73	-0.87	-1.04	-1.21	-1.38	-1.56	-1.73	-1.90	-2.07	-2.24	-2.41	-2.59	-2.76	-2.93	-3.10	-3.27	-3.45
	QwaQwa (total)	9.06	8.92	8.78	8.64	8.50	8.33	8.16	7.99	7.81	7.64	7.47	7.30	7.13	6.96	6.78	6.61	6.44	6.27	6.10	5.92
	QwaQwa (total)	-9.06	-8.92	-8.78	-8.64	-8.50	-8.33	-8.16	-7.99	-7.81	-7.64	-7.47	-7.30	-7.13	-6.96	-6.78	-6.61	-6.44	-6.27	-6.10	-5.92
IRRIGATION:	Frankfort Dummy Dam1 (RR9) Lawful Use	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61	13.61
	Frankfort Dummy Dam1 (RR1783) Unlawful Use	21.92	15.45	8.98	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51
	Frankfort EWR8 mainstream (RR11) Lawful Use	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22	6.22
	Frankfort EWR8 mainstream (RR549) Unlawful Use	16.34	11.52	6.70	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87
	Frankfort Dummy Dam2 (RR571) Lawful Use	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
	Frankfort Dummy Dam2 (RR572) Unlawful Use	13.71	9.66	5.62	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
	Frankfort mainstream (RR575) Lawful Use	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01
	Frankfort mainstream (RR576) Unlawful Use	17.63	12.42	7.22	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
	Saulspoort Dummy Dam (RR10) Lawful Use	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
	Saulspoort Dummy Dam (RR1784) Unlawful Use	0.89	0.63	0.36	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	Liebenbergsvlei mainstream (RR489) Lawful Use	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46	16.46
	Liebenbergsvlei mainstream (RR488) Unlawful Use	19.55	13.78	8.01	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
	Delangesdrift Incremental Lawful (as diffuse demands)																				
	Delangesdrift Incr (RR465) Unlawful Use	6.71	4.73	2.75	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
	Delangesdrift Incr (RR1781) Unlawful Use	2.96	2.09	1.21	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Upper Waterval Dummy dam(RR629) Lawfu	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
	Upper Waterval Dummy dam(RR642) Unlawfu	2.37	1.67	0.97	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
	Upper Waterval Mainstream (RR630) Lawful	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	Lower Waterval Dummy Dam1 (RR558) Lawful	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
	Lower Waterval Dummy Dam1 (RR547) Unlawfu	2.57	1.81	1.05	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
	Lower Waterval Mainstream (RR561) Lawful	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
	Lower Waterval Mainstream (RR632) Unlawful	4.16	2.94	1.71	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
	Lower Waterval Dummy Dam2 (RR640) Lawful	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
	Lower Waterval Dummy Dam2 (RR643) Unlawfu	2.44	1.72	1.00	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
	Lower Waterval Mainstream (RR638) Lawful	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
	Lower Waterval Mainstream (RR644) Unlawful	5.96	4.20	2.44	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	Vaal Incr EWR3 Mainstream (RR499) Lawful	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71	13.71
	Vaal Incr EWR3 Mainstream (RR502) Unlawful	25.64	18.07	10.51	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94
	Vaal EWR3 Dummy Dam1 (RR13) Lawful Use	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57
	Vaal EWR3 Dummy Dam1 (RR1786) Unlawful Use	8.55	6.03	3.50	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
	Vaal mainstream (RR14) Lawful Use	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61	7.61
	Vaal mainstream (RR1787) Unlawful Use	49.83	35.12	20.41	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71	5.71
	Vaal Dummy Dam2 (RR545) Lawful Use	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
	Vaal Dummy Dam2 (RR546) Unlawful Use	16.61	11.70	6.80	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
	Blesbokspruit Dummy Dam (RR1) Lawful Use	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
	Blesbokspruit Mainstream (RR1788) Unlawful Use	3.80	2.68	1.56	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Upper Suikerbos Mainstream (RR463) Unlawful Use	1.32	0.93	0.54	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Upper Suikerbos Dummy Dam (RR245) Lawful Use	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
	Lower Suikerbos Dummy Dam1 (RR335) Lawful Use	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
	Lower Suikerbos Mainstream (RR1789) Unlawful Use	6.63	4.67	2.71	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
	Lower Suikerbos Dummy Dam2 (RR602) Lawful Use	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
	Lower Suikerbos Mainstream (RR615) Unlawful Use	2.29	1.62	0.94	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	Klip River Mainstream (RR336) Lawful Use	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63
	Klip River Mainstream (RR1790) Unlawful Use	25.17	17.74	10.31	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
	Barrage Mainstream (RR337) Lawful Use	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69
	Barrage Mainstream (RR1791) Unlawful Use	24.40	17.20	10.00	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
DIFFUSE:	Tugela Diversion Weir	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
	Woodstock Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Driel Barrage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Spioenkop Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sterkfontein Dam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Frankfort incremental (RR11)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Delangesdrift incremental - Lawful Use	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79	2.79
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Vaal Dam incremental (RR14)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Suikerbosrand incremental	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klip River incremental	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Barrage incremental	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes (1): Only component not supplied by Rand Water. Heilbron from 1998 assumed to be included with demand "Rand Water Rgn A+C

		Projections (Million m³/a)																				
BARRAGE to BLOEMHOF		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
VAALREEFS MINE:	from river	1.70	1.73	1.76	1.79	1.82	1.85	1.89	1.92	1.95	1.98	2.02	2.05	2.08	2.12	2.15	2.18	2.21	2.25	2.28	2.31
MIDVAAL WC:	from river	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
SEDIBENG WATER:	Balkfontein (from Vaal River)	41.04	40.98	41.37	41.67	41.91	42.11	42.28	42.44	42.57	42.70	42.81	42.91	43.01	43.10	43.18	43.26	43.33	43.40	43.47	43.53
	Virginia (from Sand R)(1)	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20
	Virginia (difference)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Virginia (total)	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20	15.20
	Virginia (total)	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20	-15.20
URBAN:	Vierfontein (C24B)	0.13	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07
	Parys, Vredefort & C23L	5.57	5.62	5.66	5.71	5.75	5.75	5.74	5.74	5.74	5.74	5.73	5.73	5.73	5.72	5.72	5.72	5.72	5.71	5.71	5.71
	Potch (1994 demand)	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55	12.55
	Potch incr within limit of 19 millio	3.87	4.06	4.24	4.43	4.61	4.78	4.95	5.11	5.28	5.44	5.61	5.78	5.94	6.11	6.27	6.44	6.45	6.45	6.45	6.45
	Potch (total demand)	16.42	16.61	16.79	16.98	17.16	17.33	17.50	17.66	17.83	17.99	18.16	18.33	18.49	18.66	18.82	18.99	19.16	19.32	19.49	19.65
	Potch (total demand)	-16.42	-16.61	-16.79	-16.98	-17.16	-17.33	-17.50	-17.66	-17.83	-17.99	-18.16	-18.33	-18.49	-18.66	-18.82	-18.99	-19.16	-19.32	-19.49	-19.65
	Potch (increase)(2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.32	0.49	0.65
IRRIGATION:	Kromdraai dummy (RR338) Lawful Use	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26
	Kromdraai dummy (RR1792) Unlawful Use	5.12	3.61	2.10	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
	Klerkskraal irrigation (Diffuse) Unlawfu	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Klerkskraal Dam (RR550) Lawfu	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36	6.36
	Boskop irrigation (Diffuse) Node 252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Gerhard Minnebron irrigation (RR554) Lawfu	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22
	Boskop dummy dam (RR551) Lawful Use	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68
	Boskop Dam (RR552) Lawful	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80	20.80
	Lakeside Dam (RR553) Lawful	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59	8.59
	Klipdrift (Diffuse from Node 231) RR1802 - Unlawfu	0.46	0.32	0.19	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	Klipdrift (Diffuse from Node 253) RR1799-Unlawfu	0.55	0.39	0.23	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Klipdrift Dummy Dam (RR20) Lawfu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipdrift Mainstream (RR21) Lawfu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipdrift Dam meterec	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41	6.41
	Koppies dummy dam (RR15	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39	2.39
	Koppies riparian (RR16)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	Koppies Dam GWS Canal Irrigation (RR32)	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03
	Koppies Dam GWS River Irrigation (RR31)	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
	Renoster C70D Dummy Dam (RR33)	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	Renoster C70D Mainstream (RR34)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	Renoster C70E Dummy Dam (RR36)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
	Renoster C70E Mainstream (IRR17)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70F Dummy Dam (RR35)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
	Renoster C70F Mainstream (RR18)	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
	Renoster C70G Dummy Dam (IRR26)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70G Mainstream (IRR28)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70H Dummy Dam (RR40)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
	Renoster C70H Mainstream (IRR34)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Rietfontein dummy dam (RR17	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
	Proposed Rietfontein Dam (IRR40)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70K Dummy Dam (RR42)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	Renoster C70K Mainstream (IRR16)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Schoonspruit C24E Mainstream (RR525)	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
	Schoonspruit C24E Mainstream (RR442)	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76
	Rietspruit Dam (RR529)	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92	9.92
	Schoonspruit C24F Dummy Dam (RR533)	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
	Schoonspruit C24F Mainstream (RR534)	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
	Schoonspruit C24G Dummy Dam (RR447)	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
	Schoonspruit C24G Mainstream (RR446)	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
	Schoonspruit C24G Minstream (RR539)	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13	7.13
	Johan Neser Dam 1 (RR452)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
	Johan Neser Dam 2 (RR542)	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	Johan Neser Mainstream 1 (RR540)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Johan Neser Mainstream 2 (RR457)	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
	Serfontein Dam (RR333)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipbank dummy dam (RR332	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51	6.51
	Klipbank riparian U/S EWR14 (RR583)	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04
	Klipbank riparian (RR334)	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55
	Allem dummy dam (RR30	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34
	Allemanskraal Dam (RR26)	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76	36.76
	Erfenis dummy dam (RR331)	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
	Erfenis Dam (RR27)	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60	43.60
	Sand dummy dam (RR28	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
	Sand River riparian U/S EWR15 (RR29)	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03	3.03
	Sand River riparian D/S EWR15 (RR588)	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78	8.78
	Bloem upper dum dam (RR340	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.46
	Bloem upper riparian (RR339)	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93
	Bloem lower dum dam (RR341	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76
	Bloem lower riparian (RR2)	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83	31.83

DIFFUSE:	All afforestation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Kromdraai irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klerkskraal irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Boskop irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipdrift irrigation	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
	Koppies irrigation (RR16)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Rietfontein irrigation (RR18)	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
	Klipbank irrigation (RR334)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Rietspruit irrigation	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	Neser irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Allemanskraal irrigation	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
	Erfenis irrigation	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
	Sand irrigation (RR29)	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
	Bloemhof incr irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		6.13	4.32	2.51																	

Notes (1): Goudveld quota limits abstraction from the Sand River, Virginia, to 12.8 million m3/a (higher for at leat the first year of the projection at 15.2 million m3

(2): Potchefstroom demand above 19 million m3/a supplied from Vaal Rive

		Projections (Million m³/a)																			
BARRAGE to BLOEMHOF (Cont.)																					
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN:																					
Urban & Industrial	Parys (25 - 40 %)	-1.67	-1.68	-1.70	-1.71	-1.87	-1.87	-1.87	-1.87	-1.86	-2.01	-2.01	-2.01	-2.00	-2.00	-2.15	-2.14	-2.14	-2.14	-2.14	-2.28
	SASOL I (69.5 %)	-14.19	-15.23	-15.68	-16.01	-16.32	-16.65	-16.98	-17.32	-17.66	-18.02	-18.38	-18.75	-19.12	-19.50	-19.89	-20.29	-20.70	-21.11	-21.53	-21.96
	Flip Human Ret Flows to Moo	-8.14	-8.23	-8.33	-8.43	-8.64	-8.84	-9.04	-9.24	-9.45	-9.65	-9.81	-9.97	-10.14	-10.30	-10.46	-10.64	-10.82	-11.00	-11.18	-11.36
	Potchefstroom (within limit	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99	-9.99
	Potch (within limit & increase - 55 %	-2.13	-2.23	-2.33	-2.44	-2.54	-2.63	-2.72	-2.81	-2.90	-2.99	-3.09	-3.18	-3.27	-3.36	-3.45	-3.54	-3.63	-3.72	-3.82	-3.91
	SEDIBENG (Balkfontein - 4 %)	-1.64	-1.64	-1.65	-1.67	-1.68	-1.68	-1.69	-1.70	-1.70	-1.71	-1.71	-1.72	-1.72	-1.72	-1.73	-1.73	-1.73	-1.74	-1.74	-1.74
	MIDVAAL WC and Vaalreefs (2.3 %)	-1.08	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.10	-1.10	-1.10	-1.10	-1.10
Irrigation:	Kromdraai dummy (RR338) Lawful Use	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29
	Kromdraai dummy (RR1792) Unlawful Use	-0.51	-0.36	-0.21	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
	Klerkskraal Dam (RR550) Lawfu	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28
	Gerhard Minnebron irrigation (RR554) Lawfu	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
	Boskop dummy dam (RR551) Lawful Use	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	Boskop Dam (RR552) Lawful	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
	Lakeside Dam (RR553) Lawful	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31
	Klipdrift (Diffuse from Node 231) RR1802 - Unlawfu	-0.04	-0.03	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipdrift (Diffuse from Node 253) RR1799-Unlawfu	-0.05	-0.04	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	Klipdrift dummy dam (RR20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipdrift riparian (RR21)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Koppies dummy dam (RR15	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31
	Koppies riparian (RR16)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
	Koppies Dam GWS Canal Irrigation (RR32)	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
	Koppies Dam GWS River Irrigation (RR31)	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42
	Renoster C70D Dummy Dam (RR33)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	Renoster C70D Mainstream (RR34)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70E Dummy Dam (RR36)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	Renoster C70F Dummy Dam (RR35)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Renoster C70F Mainstream (RR18)	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28
	Renoster C70H Dummy Dam (RR40)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
	Schoonspruit C24E Mainstream (RR525)	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14	-1.14
	Schoonspruit C24E Mainstream (RR442)	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80	-0.80
	Rietspruit Dam (RR529)	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16	-2.16
	Schoonspruit C24F Dummy Dam (RR533)	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07
	Schoonspruit C24F Mainstream (RR534)	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08
	Schoonspruit C24G Dummy Dam (RR447)	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
	Schoonspruit C24G Mainstream (RR446)	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08
	Schoonspruit C24G Minstream (RR539)	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30
	Johan Neser Dam 1 (RR452)	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	Johan Neser Dam 2 (RR542)	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	Johan Neser Mainstream 1 (RR540)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
	Johan Neser Mainstream 2 (RR457)	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16
	Serfontein Dam (RR333)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Klipbank dummy dam (RR332	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65
	Klipbank riparian U/S EWR14 (RR583)	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45	-1.45
	Klipbank riparian (RR334)	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18
	Allem dummy dam (RR30	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60
	Allemanskraal Dam (RR26)	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02	-7.02
	Erfenis dummy dam (RR331)	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
	Erfenis Dam (RR27)	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77	-4.77
	Sand dummy dam (RR28	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
	Sand River riparian U/S EWR15 (RR29)	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
	Sand River riparian D/S EWR15 (RR588)	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
	Bloem upper dum dam (RR340	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
	Bloem upper riparian (RR339)	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36	-2.36
	Bloem lower dum dam (RR341	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29
	Bloem lower riparian (RR2)	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80	-4.80
Mine Dewatering:	Mines in Wonderfonteinspruit	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27	-36.27
	Mines in Loopspruit	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56	-4.56
	Decanting (Dolomitic eyes)	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00	-51.00
	Mines in Sand-vet catchmen	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80	-1.80
	Sand River (Erfenis tailwater)	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77	-10.77
	Mines in Vaal incrementa	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32	-18.32
BED LOSSES:	Vaal at node 61	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49	15.49
	Vaal at node 220	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45	39.45
	Vaal at node 63	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81	18.81
	Boskop Dam Incr. (node 251)	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80	64.80

		Projections (Million m³/a)																			
BLOEMHOF DAM		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
URBAN:	Marquard,Winburg, Exelsior,Verkeerdevlei	1.87	1.90	1.93	1.96	1.99	2.00	2.01	2.03	2.04	2.05	2.06	2.07	2.08	2.10	2.11	2.12	2.13	2.14	2.15	2.16
	Ventersdorp,Coligny,Steynsr,Edenvill	3.29	3.35	3.41	3.46	3.52	3.55	3.59	3.62	3.66	3.69	3.73	3.76	3.79	3.83	3.86	3.90	3.93	3.97	4.00	4.04
	Senekal &Paul Rou	2.29	2.29	2.30	2.30	2.30	2.29	2.28	2.26	2.25	2.23	2.22	2.21	2.19	2.18	2.16	2.15	2.13	2.12	2.11	2.09
	Kroonstad (1994 dev level)	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57
	Kroonstad increase	2.01	1.95	1.88	1.82	1.75	1.62	1.49	1.36	1.23	1.10	0.97	0.85	0.72	0.59	0.46	0.33	0.20	0.07	-0.06	-0.19
	Kroonstad (total)	11.58	11.52	11.45	11.39	11.32	11.19	11.06	10.93	10.80	10.67	10.54	10.42	10.29	10.16	10.03	9.90	9.77	9.64	9.51	9.38
	Kroonstad (total)	-11.58	-11.52	-11.45	-11.39	-11.32	-11.19	-11.06	-10.93	-10.80	-10.67	-10.54	-10.42	-10.29	-10.16	-10.03	-9.90	-9.77	-9.64	-9.51	-9.38
	Lindley within lim	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Lindley increase	0.24	0.25	0.26	0.27	0.27	0.28	0.28	0.29	0.29	0.30	0.30	0.31	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.34
	Lindley (total)	0.41	0.42	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.51
	Lindley (total)	-0.41	-0.42	-0.43	-0.44	-0.44	-0.45	-0.45	-0.46	-0.46	-0.47	-0.47	-0.48	-0.48	-0.48	-0.49	-0.49	-0.50	-0.50	-0.51	-0.51
	Koppies (incl. Nat Cons)	0.97	0.97	0.97	0.97	0.98	0.97	0.96	0.96	0.95	0.94	0.94	0.93	0.92	0.92	0.91	0.90	0.90	0.89	0.88	0.88
	Voorspoed Mine (Koppies Dam)	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28	5.28
	Viljoenskroon	1.29	1.30	1.30	1.30	1.31	1.30	1.29	1.29	1.28	1.27	1.26	1.25	1.25	1.24	1.23	1.22	1.22	1.21	1.20	1.19
	Theunissen and Bultfontei	3.79	3.83	3.87	3.91	3.95	3.96	3.96	3.97	3.97	3.97	3.98	3.98	3.99	3.99	4.00	4.00	4.00	4.01	4.01	4.02
	Hoopstad	0.88	0.88	0.89	0.90	0.91	0.91	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.89	0.89	0.89
	Brandfort / Majwemaswe	2.81	2.82	2.83	2.84	2.85	2.84	2.83	2.82	2.81	2.80	2.79	2.79	2.78	2.77	2.76	2.75	2.74	2.73	2.72	2.72
REGION G:	Proj for Other users(2) excluding Vaal Gamagara	21.44	21.57	21.69	21.82	21.94	21.99	22.04	22.10	22.15	22.20	22.25	22.31	22.36	22.41	22.46	22.52	22.57	22.62	22.68	22.73
"	Correction For Total	-21.44	-21.57	-21.69	-21.82	-21.94	-21.99	-22.04	-22.10	-22.15	-22.20	-22.25	-22.31	-22.36	-22.41	-22.46	-22.52	-22.57	-22.62	-22.68	-22.73
LOSSES:	Bloemhof Dam releases																				
RETURN:	Marq,Winb, Exels,Verk vlei (20 %	-0.37	-0.38	-0.39	-0.39	-0.40	-0.40	-0.40	-0.41	-0.41	-0.41	-0.41	-0.41	-0.42	-0.42	-0.42	-0.42	-0.43	-0.43	-0.43	-0.43
	Senekal & Paul Roux (20 %	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.45	-0.45	-0.45	-0.44	-0.44	-0.44	-0.44	-0.43	-0.43	-0.43	-0.42	-0.42	-0.42
	Henneman	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Viljoenskroon (30 %)	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.38	-0.38	-0.38	-0.38	-0.37	-0.37	-0.37	-0.37	-0.36	-0.36	-0.36	-0.36
	Kroonstad (1994 dev level)	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94	-5.94
	Kroonstad increase (51 %)	-1.03	-0.99	-0.96	-0.93	-0.89	-0.83	-0.76	-0.69	-0.63	-0.56	-0.50	-0.43	-0.37	-0.30	-0.23	-0.17	-0.10	-0.04	0.03	0.10
	Welkom	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40
	Heilbron (60% of NWRS demand): Tota	-0.70	-0.71	-0.71	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71
	Heilbron (60% of NWRS demand): Correction for Tota	0.70	0.71	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	Heilbron : 50% to Koppies Dam	-0.35	-0.35	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.35	-0.35	-0.35	-0.35
	Koppies (30 % - 60 %)	-0.39	-0.39	-0.39	-0.39	-0.44	-0.44	-0.43	-0.43	-0.43	-0.47	-0.47	-0.46	-0.46	-0.46	-0.50	-0.50	-0.49	-0.49	-0.49	-0.53

Notes (1): Includes Bultfontein

(2): Other users include Vryburg, Hartswater, Jan Kempdorp, Pampierstat, Bloemhof, Christiana, Boshof, Warrenton, Windsorton, Barkley West and Delportshoc

		Projections (Million m³/a)																			
BLOEMHOF TO CONFLUENCE WITH ORANGE (Including Harts & Riet/Modder Subsystems		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
URBAN:	Kimberley	19.33	19.15	18.98	18.80	18.63	18.36	18.10	17.84	17.57	17.31	17.05	16.78	16.52	16.26	15.99	15.73	15.47	15.20	14.94	14.68
	Other Users(1) Region G	21.44	21.57	21.69	21.82	21.94	21.99	22.04	22.10	22.15	22.20	22.25	22.31	22.36	22.41	22.46	22.52	22.57	22.62	22.68	22.73
	Schweizer Reneke	1.17	1.20	1.24	1.27	1.31	1.34	1.38	1.42	1.46	1.50	1.54	1.59	1.63	1.68	1.72	1.77	1.82	1.87	1.93	1.98
* K	ThabaN'chu	4.49	4.19	3.90	3.60	3.30	3.61	3.92	4.22	4.53	4.84	4.53	4.22	3.92	3.61	3.30	3.58	3.87	4.15	4.44	4.72
* K	Botshabelo	16.93	17.60	18.27	18.93	19.60	20.23	20.85	21.48	22.11	22.74	23.36	23.99	24.62	25.25	25.88	26.56	27.26	27.97	28.71	29.46
	Mangaung LM	18.32	18.59	18.86	19.13	19.40	19.59	19.78	19.97	20.15	20.34	20.53	20.72	20.90	21.09	21.28	21.47	21.66	21.86	22.06	22.26
* K	Bloemfontein	52.05	52.82	53.58	54.35	55.12	55.65	56.18	56.72	57.25	57.78	58.31	58.84	59.38	59.91	60.44	60.99	61.54	62.09	62.66	63.22
	Vaal-Gamagara	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70
* K	Small Users:Welbedacht-Bloem pipelin	1.94	1.95	1.95	1.96	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.89	1.89	1.88	1.87	1.88	1.89	1.90	1.92	1.93
IRRIGATION:	RR598 Lower Vaal Irrig (U/S of EWR16)																				
	RR397 Lower Vaal Irrig (U/S of VH Weir)	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42
	RR405 Lower Vaal Irrig (U/S of De Hoop)	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06
	RR289 Lower Vaal Irrig (D/s of De Hoop; u/s of Harts)	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20
	RR290 Lower Vaal Irrig (D/s of Harts; u/s of Schmidtsdri	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67
	RR291 Lower Vaal Irrig (D/s of Schmidt; u/s of Riet/Mod	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
	RR357 (Wentzel Dummy Dam)	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
	RR360 (Mainstream Wentzel Dam)	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62
	RR362 (Wentzel Dam Irrigation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	RR370 Vaalharts GWS Part Taung	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34
	RR379 Vaalharts GWS North Canal & Part Taun	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04
	RR383 Vaalharts GWS West Canal & Barkley West	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38
	RR376 (Spitskop Dummy Dam)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	RR407 (Spitskop Dam Irrigation)	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81
	RR435 (Rustfontein Dummy Dam)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
	RR438 (Rustfontein Mainstream)	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
	RR416 (Mockes Dummy Dam)	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
	RR420 (Mockes Dam Mainstream)	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43
	RR424 (Krugersdrift Mainstream 1)	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29
	RR430 (Krugersdrift Mainstream 2)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
	RR445 (Lower Modder Diffuse Irrig)	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27
	RR453 (Lower Modder 1)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR454 (Lower Modder 2)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR455 (Lower Modder 3)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR458 (Tierpoort Dummy Dam)	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
	RR461 (Tierpoort Mainstream)	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	RR468 (Kalkfontein Dummy Dam)	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79
	RR469 (Tierpoort Dam)	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66
	RR472 (Kalkfontein Mainstream)	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92
	RR479 (Riet River Settlement & Others)	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53
	RR484 (Kalkfontein Canals)	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51
	RR482 (Lower Riet)	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76
DIFFUSE:	Harts River: HARTU7.ABS	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
	Harts River: HARTD7.ABS	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
	All Afforestation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LOSSES:	River Evaporation d/s Bloemhof Dan	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10
	Vaalharts Irrigation Distribution Losses	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02
	Lower Vaal Operational Losses	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35

		Projections (Million m³/a)																			
BLOEMHOF TO CONFLUENCE WITH ORANGE (Continued)		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RETURN:																					
Urban & Industrial	ThabaN'chu	-2.25	-2.10	-1.95	-1.80	-1.65	-1.80	-1.96	-2.11	-2.27	-2.42	-2.27	-2.11	-1.96	-1.80	-1.65	-1.79	-1.93	-2.08	-2.22	-2.36
	Botshabelo	-7.28	-7.57	-7.85	-8.14	-8.43	-8.70	-8.97	-9.24	-9.51	-9.78	-10.05	-10.32	-10.59	-10.86	-11.13	-11.42	-11.72	-12.03	-12.34	-12.67
	Bloemfontein DC to Tweeriviere Weir	-1.81	-1.84	-1.87	-1.89	-1.92	-1.94	-1.96	-1.98	-1.99	-2.01	-2.03	-2.05	-2.07	-2.09	-2.11	-2.12	-2.14	-2.16	-2.18	-2.20
* K	Bloemfontein DC to Krugersdrift	-24.85	-25.22	-25.59	-25.95	-28.20	-26.57	-26.83	-27.08	-27.34	-27.59	-27.84	-28.10	-28.35	-28.61	-31.00	-29.12	-29.38	-29.65	-29.92	-30.19
	Total Return Flow : Bloemfontein	-26.67	-27.06	-27.45	-27.85	-28.24	-28.51	-28.79	-29.06	-29.33	-29.60	-29.88	-30.15	-30.42	-30.69	-30.97	-31.25	-31.53	-31.81	-32.10	-32.39
	Correction for Bloem Return Flow	26.67	27.06	27.45	27.85	28.24	28.51	28.79	29.06	29.33	29.60	29.88	30.15	30.42	30.69	30.97	31.25	31.53	31.81	32.10	32.39
Irrigation:	RR397 Lower Vaal Irrig (U/S of VH Weir)	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30	-2.30
	RR405 Lower Vaal Irrig (U/S of De Hoop)	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34	-2.34
	RR289 Lower Vaal Irrig (D/s of De Hoop; u/s of Harts)	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27	-2.27
	RR290 Lower Vaal Irrig (D/s of Harts; u/s of Schmidtsdri	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72	-0.72
	RR291 Lower Vaal Irrig (D/s of Schmidt; u/s of Riet/Mod	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
	RR357 (Wentzel Dummy Dam)	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
	RR360 (Mainstream Wentzel Dam)	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46
	RR362 (Wentzel Dam Irrigation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	RR370 Vaalharts IS Part Taung	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79	-0.79
	RR379 Vaalharts IS North Canal&Taung	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74	-40.74
	RR383 Vaalharts IS Remainder	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63	-3.63
	RR376 (Spitskop Dummy Dam)	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
	RR435 (Rustfontein Dummy Dam)	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
	RR438 (Rustfontein Mainstream)	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09	-1.09
	RR416 (Mockes Dummy Dam)	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57
	RR420 (Mockes Dam Mainstream)	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13
	RR424 (Krugersdrift Mainstream 1)	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83	-1.83
	RR430 (Krugersdrift Mainstream 2)	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52	-1.52
	RR445 (Lower Modder Diffuse Irrig)	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49	-1.49
	RR453 (Lower Modder 1)	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74
	RR454 (Lower Modder 2)	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74
	RR455 (Lower Modder 3)	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74
	RR458 (Tierpoort Dummy Dam)	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42
	RR461 (Tierpoort Mainstream)	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
	RR468 (Kalkfontein Dummy Dam)	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78	-2.78
	RR469 (Tierpoort Dam)	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65
	RR472 (Kalkfontein Mainstream)	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75
	RR479 (Riet River Settlement & Others)	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82	-6.82
	RR484 (Kalkfontein Canals)	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44	-2.44
	RR482 (Lower Riet)	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71	-5.71

Notes (1): Other users include Hoopstad, Bloemhof, Christiana, Vryburg, Warrenton, Barkley West, Union Lime, Delportshoop, Jan Kempdorp, Hartswater, Pampierstat and Windsort

		Projections (Million m³/a)																			
BLOEMHOF TO CONFLUENCE WITH ORANGE (Including Harts & Riet/Modder Subsystems		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
URBAN:	Kimberley	19.33	19.15	18.98	18.80	18.63	18.36	18.10	17.84	17.57	17.31	17.05	16.78	16.52	16.26	15.99	15.73	15.47	15.20	14.94	14.68
	Other Users(1) Region G	21.44	21.57	21.69	21.82	21.94	21.99	22.04	22.10	22.15	22.20	22.25	22.31	22.36	22.41	22.46	22.52	22.57	22.62	22.68	22.73
	Schweizer Reneke	1.17	1.20	1.24	1.27	1.31	1.34	1.38	1.42	1.46	1.50	1.54	1.59	1.63	1.68	1.72	1.77	1.82	1.87	1.93	1.98
* K	ThabaN'chu	4.49	4.19	3.90	3.60	3.30	3.61	3.92	4.22	4.53	4.84	4.53	4.22	3.92	3.61	3.30	3.58	3.87	4.15	4.44	4.72
* K	Botshabelo	16.93	17.60	18.27	18.93	19.60	20.23	20.85	21.48	22.11	22.74	23.36	23.99	24.62	25.25	25.88	26.56	27.26	27.97	28.71	29.46
	Mangaung LM	18.32	18.59	18.86	19.13	19.40	19.59	19.78	19.97	20.15	20.34	20.53	20.72	20.90	21.09	21.28	21.47	21.66	21.86	22.06	22.26
* K	Bloemfontein	52.05	52.82	53.58	54.35	55.12	55.65	56.18	56.72	57.25	57.78	58.31	58.84	59.38	59.91	60.44	60.99	61.54	62.09	62.66	63.22
	Vaal-Gamagara	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70	13.70
* K	Small Users:Welbedacht-Bloem pipelin	1.94	1.95	1.95	1.96	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.89	1.89	1.88	1.87	1.88	1.89	1.90	1.92	1.93
IRRIGATION:	RR598 Lower Vaal Irrig (U/S of EWR16)																				
	RR397 Lower Vaal Irrig (U/S of VH Weir)	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42
	RR405 Lower Vaal Irrig (U/S of De Hoop)	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06	25.06
	RR289 Lower Vaal Irrig (D/s of De Hoop; u/s of Harts)	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20
	RR290 Lower Vaal Irrig (D/s of Harts; u/s of Schmidtsdri	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67
	RR291 Lower Vaal Irrig (D/s of Schmidt; u/s of Riet/Mod	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
	RR357 (Wentzel Dummy Dam)	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
	RR360 (Mainstream Wentzel Dam)	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62
	RR362 (Wentzel Dam Irrigation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	RR370 Vaalharts GWS Part Taung	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34	6.34
	RR379 Vaalharts GWS North Canal & Part Taun	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04	270.04
	RR383 Vaalharts GWS West Canal & Barkley West	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38	51.38
	RR376 (Spitskop Dummy Dam)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	RR407 (Spitskop Dam Irrigation)	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81	12.81
	RR435 (Rustfontein Dummy Dam)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
	RR438 (Rustfontein Mainstream)	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29	3.29
	RR416 (Mockes Dummy Dam)	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
	RR420 (Mockes Dam Mainstream)	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43	5.43
	RR424 (Krugersdrift Mainstream 1)	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29	9.29
	RR430 (Krugersdrift Mainstream 2)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
	RR445 (Lower Modder Diffuse Irrig)	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27	20.27
	RR453 (Lower Modder 1)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR454 (Lower Modder 2)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR455 (Lower Modder 3)	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49	9.49
	RR458 (Tierpoort Dummy Dam)	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
	RR461 (Tierpoort Mainstream)	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	RR468 (Kalkfontein Dummy Dam)	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79	41.79
	RR469 (Tierpoort Dam)	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66
	RR472 (Kalkfontein Mainstream)	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92
	RR479 (Riet River Settlement & Others)	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53	93.53
	RR484 (Kalkfontein Canals)	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51	33.51
	RR482 (Lower Riet)	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76	40.76
DIFFUSE:	Harts River: HARTU7.ABS	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
	Harts River: HARTD7.ABS	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
	All Afforestation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LOSSES:	River Evaporation d/s Bloemhof Dan	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10	78.10
	Vaalharts Irrigation Distribution Losses	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02	127.02
	Lower Vaal Operational Losses	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35	115.35

Appendix G:

Summary of Information Relative to Biophysical Nodes

Table G-1: Summarised information on biophysical nodes

IUA	Site name	SQ REACH	LATITUDE	LONGITUDE	QUAT	MAJOR RIVERS	TRIBUTARY	Shreve	Strahler (Order)	ECOR	GEOM ZONE	ALT (m)	Cum Gross Area (km^2)	Natural MAR (Mm^3/a)	Width
UV-A	8VF5	C11A-01460	-26.36667	30.1167	C11A	Vaal		2	2	11.02	E - Lower foothills	1670	196.9	13.27	4.35
UV-A	C1VAAL-KVAAL	C11B-01770	-26.70190	30.0831	C11B	Vaal		6	2	11.05	E - Lower foothills	1659	1073.4	69.33	7.64
UV-A	RE EWR 1 KIEINVAAL	C11C-01846	-26.91275	30.17497	C11C	Vaal	Klein Vaal	1	1	11.02	E - Lower foothills	1620	318.0	26.09	5.47
UV-A	UV9	C11E-01985	-27.02988	29.88956	C11E	Rietspruit	Skulpspruit	3	2	11.05	E - Lower foothills	1635	215.1	12.03	4.20
UV-A	C1RIET-AMERS	C11E-01895	-26.90710	29.8716	C11E	Vaal	Rietspruit	5	3	11.05	E - Lower foothills	1597	746.0	41.73	6.42
UV-A	C1KVAA-UNSPE	C11C-01846	-26.81970	30.1366	C11D	Vaal	Klein Vaal	1	1	11.02	F - Lowland river	1601	533.1	41.66	6.42
UV-A	UV17	C11G-01799	-26.78102	29.80636	C11G	Vaal	Drinkwaterspruit	7	2	11.05	F - Lowland river	1582	1330.9	66.07	7.51
UV-A	EWR1	C11J-01838	-26.87280	29.61384	C11J	Vaal		24	4	11.05	F - Lowland river	1570	4984.0	288.80	12.43
UV-A	C1BLES-UNSPE	C11J-01821	-26.76123	29.5405	C11H	Vaal	Blesbokspruit	5	2	11.05	E - Lower foothills	1568	1084.4	70.66	7.69
UV-A	VC4	C11L-01945	-26.92028	29.52035	C11K	Vaal	Kaalspruit						355.3	18.62	
UV-A	VC5	C11K-01824	-26.85022	29.3294	C11K	Vaal	Leeuspruit	2	2	11.05	E - Lower foothills	1560	340.0	18.07	4.83
UV-B	UV Uklip	C13C-02550	-27.82105	29.64983	C13C	Vaal	Klip	1	1	15.04	E - Lower foothills	1757	87.9	5.67	3.25
UV-B	C13C	C13D-02416	-27.55480	29.58993	C13C	Vaal	Klip	5	2	11.06	F - Lowland river	1691	837.0	54	7.01
UV-B	C1KLIP-UNSPE1	C13D-02284	-27.47008	29.6005	C13D	Vaal	Klip (Grootdraai)	7	3	11.06	F - Lowland river	1686	1090.1	68.04	7.59
UV-B	EWR6	C13D-02226	-27.36166	29.48503	C13D	Vaal	Klip	8	3	11.06	E - Lower foothills	1593	1583.0	95.31	8.51
UV-B	C13A	C13B-02175	-27.25890	29.7712	C13A	Klip	Sandspruit	4	3	11.03	F - Lowland river	1648	595.0	51.37	6.90
UV-B	C1SAND-UNSPE	C13B-02135	-27.20843	29.4370	C13B	Klip	Sandspruit	4	2	11.03	F - Lowland river	1551	1139.1	78.84	7.98
UV-B	C13E	C13E-02228	-27.48590	29.356	C13E	Klip	Komandospruit	1	1	11.03	E - Lower foothills	1635	603.0	33.6	5.97
UV-B	C1KLIP-UNSPE2	C13H-02118	-27.18252	29.2344	C13F	Vaal	Klip (Grootdraai)	14	3	11.03	F - Lowland river	1530	4128.5	248.05	11.80
UV-B	C13G	C13H-02156	-27.40470	29.1806	C13G	Klip	Spruitsonderdrif	2	2	11.03	E - Lower foothills	1622	435.0	20.8	5.07
UV-B	C13H	C13H02077	-27.06060	29.0667	C13H	Vaal	Klip	16	3	11.03	F - Lowland river	1530	589.0	19.22	4.93
UV-C1	EWR7	C81A-02790	-28.20185	29.55827	C81A	Vaal	Wilge	2	2	11.03	F - Lowland river	1692	170.0	23.47	5.28
UV-C1	8WF1	C81A-02790	-28.34607	29.3074	C81B	Vaal	Wilge	2	2	11.03	F - Lowland river	1664	590.5	69.03	7.63
UV-C1	8WF3	C81B-02864	-28.32117	29.1323	C81B	Vaal	Wilge	3	2	11.03	F - Lowland river	1603	932.0	81.11	8.06
UV-C1	UV25	C81L-02594	-27.97461	29.31991	C81L	Wilge	Meul	1	1	11.03	E - Lower foothills	1691	364.0	26.49	5.50
UV-C1	UV28	C82A-02542	-27.96968	28.89911	C81M	Wilge	Meul	8	3	11.03	E - Lower foothills	1588	1831.2	104.03	8.77
UV-C1	UV Cor	C81M-02609	-27.83821	29.35921	C82A	Wilge	Cornelius	1	1	11.03	E/D	1852	155.8	7.82	3.63
UV-C1	C82B_N	C82B-02540	-27.85085	28.97361	C82B	Wilge	Cornelis					1657	811.6	39.63	6.31

Table G-1 (cont): Summarised information on biophysical nodes

IUA	Site name	SQ REACH	LATITUDE	LONGITUDE	QUAT	MAJOR RIVERS	TRIBUTARY	Shreve	Strahler (Order)	ECOR	GEOM ZONE	ALT (m)	Cum Gross Area (km^2)	Natural MAR (Mm^3/a)	Width
UV-C2	C81G	C81G-02882	-28.29600	28.8042	C81G	Elands	Klerkspruit	1	1	15.01	E - Lower foothills	1614	435.0	22.13	5.18
UV-C2	GG	C81G-02882	-28.41915	28.7569	C81G								115.0	5.85	
UV-C2	C81J	C81K-02710	-28.08190	28.8374	C81J	Wilge	Vaalbanksspruit	6	3	11.03	E - Lower foothills	1591	392.0	12	4.20
UV-C2	C81C	C81C-02978	-28.34950	29.0921	C81C	Nuwejaarspruit	Fraser/Modder	3	2	11.03	E - Lower foothills	1621	250.0	18.41	4.86
UV-C2	C8NUWE-CONFL	C81E-02930	-28.28459	29.0902	C81E	Wilge	Nuwejaarspruit	4	2	11.03	E - Lower foothills	1604	526.6	39.87	6.33
UV-C2	EWR8	C82C-2505	-27.80017	28.76778	C82C	Vaal	Wilge	37	4	11.03	F - Lowland river	1573	7503.0	474.25	14.72
UV-C2	C82D	C82D-02490	-27.72390	28.7378	C82D	Wilge	Rus-se-spruit	2	2	11.03	E - Lower foothills	1556	572.0	19.6	4.97
UV-C3	UV31	C82E-02418	-27.67999	28.79244	C82G	Wilge	Holspruit	1	1	11.03	E - Lower foothills	1558	728.7	32.90	5.92
UV-C3	VC8	C82G-02415	-27.62093	28.71455	C82G	Wilge	Wilge Trib						151.5	6.34	3.38
UV-C3	UV35	C82F-02326	-27.5164	28.84841	C82F	Wilge	Grootspruit	1	1	11.03	E - Lower foothills	1581	295.6	11.08	4.09
UV-C3	VC9	C82H-02200	-27.30345	28.54006	C82H	Vaal	Wilge						10632.8	591.39	15.87
UV-D	VC15	C83A-02863	-28.24825	28.43693	C83A	Liebenbergsvlei							374.9	14.36	
UV-D	C83D	C83E-02588	-28.05430	28.496	C83D	Liebenbergsvlei	Tierkloof	5	2	11.03	F - Lowland river	1634	465.0	12.42	4.25
UV-D	C83E_N	C83E-02579	-27.86420	28.3152	C83E	Liebenbergsvlei	Tierkloof	6	2	11.03	F - Lowland river	1590	891.0	23.31	5.27
UV-D	VC16	C83G-02364	-27.59181	28.44803	C83G	Liebenbergsvlei	Unnamed tributary						138.7	4.74	
UV-D	VC17	C23H-02395	-27.55691	28.47909	C83H	Liebenbergsvlei	Unnamed tributary						75.5	2.66	
UV-E	VC6	C12D-01576	-26.57524	2903541	C12D	Vaal	Waterval						695.4	59.33	
UV-E	WA1	C12F-01722	-26.64608	29.0186	C12F	Vaal	Waterval	36	4	11.05	F - Lowland river	1560	970.3	80.37	8.03
UV-E	VC7	C12F-01728	-26.66121	29.02656	C12F	Waterval	Unnamed tribuutary						41.3	2.12	
UV-E	WA2	C12G-01896	-26.88543	28.8836	C12F	Vaal	Waterval	46	4	11.05	F - Lowland river	1534	2278.0	149.84	9.93
UV-E	UV WV	C12G-01963	-26.96028	28.74577	C12G	Vaal	Waterval	56	4	11.05	F - Lowland river	1499	2786.9	177.67	10.53
UV-F	UV45	C83K-02204	-27.25842	28.40691	C83K	Wilge	Kromspruit	2	2	11.03	F - Lowland river	1492	545.6	25.70	5.45
UV-F	C8KLIP-VAALD	C83L-02057	-27.14232	28.2780	C83L	Vaal	Klip (flows into Vaal Dam from FS)	5	2	11.03	F - Lowland river	1490	764.7	35.59	6.09
UV-G	EWR2	C11M-01894	-26.92110	29.27929	C11M	Vaal		39	4	11.03	F - Lowland river	1537	7995.0	457.68	14.54
UV-G	8VF3	C11M-01901	-26.93450	29.1716	C11M	Vaal	Brakspruit	1	1	11.05	E - Lower foothills	1553	75.1	3.36	2.72
UV-G	C12A	C12B-02028	-27.14630	28.9869	C12A	Vaal	Venterspruit	2	2	11.03	E - Lower foothills	1527	485.0	21	5.08
UV-G	EWR3	C12C-01997	-26.99087	28.72971	C12H	Vaal		64	4	11.03	F - Lowland river	1487	15638.0	852.13	17.97
UV-G	C12K	C12L-01881	-26.91350	28.4396	C12K	Vaal	Molspruit	3	2	11.03	E - Lower foothills	1492	479.0	22	5.16
UV-G	C12J	C12J-02091	-27.07250	28.5643	C12J	Vaal	Bankplaasspruit	4	3	11.03	E - Lower foothills	1492	344.0	12.43	4.25

Table G-1 (cont): Summarised information on biophysical nodes

IUA	Site name	SQ REACH	LATITUDE	LONGITUDE	QUAT	MAJOR RIVERS	TRIBUTARY	Shreve	Strahler (Order)	ECOR	GEOM ZONE	ALT (m)	Cum Gross Area (km^2)	Natural MAR (Mm^3/a)	Width
UV-H	C21A	C12A-01567	-26.49603	28.61488	C21A	Vaal	Suikerbosrand	4	3	11.03	F - Lowland river	1598	707.0	28.65	5.65
UV-H	EWR 9	C21C-01675	-26.64670	28.38197	C21C	Vaal	Suikerbosrand	5	3	11.01	E - Lower foothills	1509	1175.0	31.31	5.83
UV-I	EWR10	C21G-01627	-26.68137	28.16798	C21G	Vaal	Suikerbosrand	15	3	11.01	F - Lowland river	1453	3271.0	86.97	8.25
UV-I	EWR11	C21F-01447	-26.47892	28.42488	C21F	Suikerbosrand	Blesbokspruit	5	2	11.03	E - Lower foothills	1528	1098.0	29.14	5.68
UV-I	VC11	C22C-01509	-26.45020	28.08742	C22C	Klip River	Rietspruit						857.0	36.60	6.14
UV-I	VC12	C22A-01315	-26.44551	28.0883	C22D	Vaal	Klip River						893.0	39.21	6.29
UV-I	VC13	C22E-01619	-26.66614	27.95634	C22E	Vaal	Klip River						2309.4	96.98	8.57
UV-I	VC14	C22K-01765	-26.72464	27.71865	C22J	Vaal	Rietspruit						926.1	22.10	5.17
UV-J	C22G	C22K-01795	-26.82200	27.9262	C22G	Vaal	Taaibosspruit	5	3	11.03	F - Lowland river	1430	831.0	18.4	4.86
UV-K	UV53	C23A-01811	-26.79594	27.56550	C23B	Vaal	Kromelmboogspruit	1	1	11.01	E - Lower foothills	1416	724.1	14.30	4.46
UV-L	C23F	C23G-01250	-26.23650	27.1525	C23F	Vaal	Mooi River	2	2	11.01	E - Lower foothills	1469	1324.0	37.69	6.21
UV-L	RE EWR 2 MOOI	C23G-01250	-26.25867	27.15973	C23G	Vaal	Mooi	2	2	11.01	E - Lower foothills	1457	1324.0	37.69	6.21
UV-L	VC19	C23G-01406	-26.37560	27.23191	C23E	Mooi	Mooirivierloop						1360.00	25.96	5.46
UV-L	M2	C23K-01579	-26.62159	27.28771	C23K	Mooi	Loopspruit						890.0	20.26	5.02
UV-L	VC20	C23L-01827	-26.87589	26.95687	C23L	Vaal	Mooi						5535.30	132.21	9.52
UV-M	EWR4		-26.84262	28.1123	C22F	Vaal		212	5	11.03	E - Lower foothills	1445	38638.0	1977.26	23.95
UV-M	EWR5		-26.93243	27.01367	C23L	Vaal		254	5	11.08	F - Lowland river	1309	49739.0	2288.01	25.17
MV-A	VC24	C70B-02323	-27.58352	27.882275	C70A	Vaal River	Renoster River	2	2	11.03	E - Lower foothills	1506	613	18.46	4.86
MV-A	VC25	C70B-02297	-27.40814	27.785685	C70B	Renoster River	Renoster River	3	2	11.03	E - Lower foothills	1444	881.2	25.55	5.43
MV-A	VC26	C70C-02233	-27.31769	27.8012	C70C	Renoster River	Leufonteinspruit	1	1	11.03	F - Lowland river	1429	80.69	2.11	2.32
MV-A	R1	C70D-02182	-27.26827	27.548079	C70D	Vaal River	Renoster River	9	3	11.03	F - Lowland river	1380	2413.28	63.86	7.43
MV-A	VC27	C70D-02215	-27.27708	27.547543	C70D	Renoster River	Doringspruit	1	1	11.03	Z	1378	421.72	7.86	3.64
MV-A	R2	C70J-02163	-27.26447	27.17648	C70F	Vaal River	Renoster River	15	3	11.01	F - Lowland river	1336	4092	93.14	8.45
MV-A	VC29	C70H-02208	-27.27119	27.176474	C70H	Renoster River	Heuningspruit	3	2	11.01	F - Lowland river	1347	1152	17.94	4.82
MV-A	VC30	C70J-01955	-26.98060	26.93294	C70K	Vaal River	Renoster River	21	3	11.08	Z	1301	5867.6	120.92	9.23

Table G-1 (cont): Summarised information on biophysical nodes

IUA	Site name	SQ REACH	LATITUDE	LONGITUDE	QUAT	MAJOR RIVERS	TRIBUTARY	Shreve	Strahler (Order)	ECOR	GEOM ZONE	ALT (m)	Cum Gross Area (km^2)	Natural MAR (Mm^3/a)	Width
MV-B	VC31	C60A-02607	-27.94630	28.004229	C60A	Vaal River	Vals River	2	2	11.03	E - Lower foothills	1519	860	31.24	5.82
MV-B	VC33	C60C-02471	-27.79619	27.621892	C60C	Vals River	Elandsspruit/Elands	2	2	11.03	E - Lower foothills	1412	349.32	8.20	3.69
MV-B	VC35	C60G-02399	-27.67892	27.20915	C60G	Vaal River	Vals River	17	3	11.08	F - Lowland river	1345	4898	131.70	9.51
MV-B	EWR14	C60J-02262	-27.48685	26.8132	C60J	Vaal River	Vals River	21	3	11.07	F - Lowland river	1291	5930	145.79	9.84
MV-C	S1	C24E-01164	-26.31172	26.837609	C24C	Vaal River	Schoonspruit	1	1	11.01	D	1490	1350	60.6	7.30
MV-C	VC21	C24F-01476	-26.56915	26.60899	C24F	Vaal River	Taaibosspruit	5	3	11.08	F - Lowland river	1345	2020	19.5	4.96
MV-C	S3	C24G-01661	-26.67500	26.586108	C24G	Vaal River	Schoonspruit	11	4	11.08	F - Lowland river	1343	2694	105.52	8.82
MV-C	S4	C24H-01860	-26.93333	26.66528	C24H	Vaal River	Schoonspruit	14	4	11.08	F - Lowland river	1311	3503	117.31	9.14
MV-C	VC22	C24A-01787	-26.92917	26.8168	C24A	Vaal River	Koekemoerspruit	2	2	11.01	F - Lowland river	1297	839	26.19	5.48
MV-C	VC23	C24H-01732	-26.99178	26.62734	C24H	Schoonspruit	Jagspruit	1	1	11.08	E - Lower foothills	1285	498.5	5.24	3.17
MV-D1	VC40	C42D-02890	-28.31707	27.60086	C42D	Vet River	Sand River	13	3	11.03	E - Lower foothills	1433	2215	66.40	7.53
MV-D2	V1	C42G-02828	-28.25993	27.102847	C42G	Vet River	Sand River	26	3	11.03	E - Lower foothills	1343	3973.79	104.16	8.78
MV-D2	VC42	C42F-02762	-28.19390	27.060448	C42F	Sand River	Koolspruit	8	2	11.03	E - Lower foothills	1327	734	19.26	4.94
MV-D2	VC46	C41L-02635	-28.09275	26.41862	C42L	Vet River	Sand River		45	11.08	F - Lowland river	1269	7555	180.27	10.58
MV-E1	VC49	C41D-03169	-28.61337	26.884934	C41D	Vaal River	Vet River	16	4	11.03	E - Lower foothills	1337	2112.50	72.01	7.74
MV-E1	VC52	C41E-03132	-28.56817	26.95692	C41E	Vet River/Erfenis	Klein Vet River	8	3	11.03	E - Lower foothills	1348	2083	81.86	8.08
MV-E1	VC51	C41E-02989	-28.55838	26.93505	C41E	Klein Vet River	Soutspruit	1	1	11.03	E - Lower foothills	1338	158.56	3.87	2.86
MV-E2	V2	C41H-03012	-28.47366	26.681267	C41H	Vaal River	Vet River	32	4	11.1	F - Lowland river	1303	5551	190.94	10.79
MV-E2	EWR15	C43A-02561	-27.93482	26.12569	C43A	Vaal River	Vet River	85	4	11.08	F - Lowland river	1250	16040	413.55	14.04
MV-F	EWR12		-26.93615	26.85025	C24B	Vaal River		295	5	11.01	F - Lowland riverF	1348	62305	2546.42	26.10
MV-F	EWR13		-27.10413	26.52185	C24J	Vaal River		314	5	11.08	F - Lowland river	1285	70809	2714.89	26.68
MV-F	VC56		-27.36349	26.350052	C25A	Vaal River	Klipspruit	3	2	11.08	E - Lower foothills		864	4.75	3.1
LV-A1	VC55	C31B-01275	-26.60623	25.68545	C31B	Vaal River	Harts River	4	2	11.08	F - Lowland river	1363	3145	17.06	4.7
LV-A3	VC61	C31C-01665	-26.62120	25.683003	C31C	Harts River	Klein Harts	2	2	11.08	F - Lowland river	1365	1553.7	12.18	4.2
LV-A2	VC57	C31E-02045	-27.13729	25.374564	C31E	Vaal River	Harts River	13	3	29.02	E - Lower foothillsE	1306	9108.6	45.33	6.6
LV-A3	VC58	C32D-03250	-27.55923	24.704448	C32D	Harts River	Dry harts	20	3	29.02	F - Lowland river	1080	10205	48.7	6.7
LV-A4	H1	C31F-2358	-27.57115	24.713	C33A	Vaal River	Harts River	21	3	29.02	F - Lowland river	1084	11023	58.96	7.2
LV-A4	EWR17	C33C-02836	-28.37694	24.30305	C33C	Vaal River	Harts River	56	4	29.02	Z	1026	31029	147.85	9.8
LV-A4	VC59	C33C-02746	-28.25104	24.394014	C33C	Harts River	Unnamed Trib	2	2	29.02	D	1029	1167.1	3.29	2.7

Table G-1 (cont): Summarised information on biophysical nodes

IUA	Site name	SQ REACH	LATITUDE	LONGITUDE	QUAT	MAJOR RIVERS	TRIBUTARY	Shreve	Strahler (Order)	ECOR	GEOM ZONE	ALT (m)	Cum Gross Area (km^2)	Natural MAR (Mm^3/a)	Width
LV-B	EWR16	C91A-02391	-27.65541	25.59564	C91A	Vaal River		446	5	11.08	F - Lowland river	1222	108474	3303.1	28.5
LV-B	EWR18	C92B-02903	-28.70758	24.07578	C92C	Vaal River		511	5	29.02	F - Lowland river	1022	157685	3407.79	28.8
LV-B	VC60	C91D-02838	-28.45070	24.73437	C91D	Vaal River	Leeu River	1	1	29.02	Z	1115	4743	11.62	4.2

Table G-2a: Reconciliation Strategy Results of Small Towns in Upper Vaal WMA relative to Biophysical Nodes

Site name	SQ REACH	IUA	QUAT	MAJOR RIVERS	TRIBUTARY	Town Name	Dams	Water Source Type	Current Water Use (million m^3/a)	Deficit Date	WCWDM Saving		Shortfall 2020 - after WCWDM		Shortfall 2030 - after WCWDM	
											(million m^3/a)	% of current use	(million m^3/a)	% of current use	(million m^3/a)	% of current use
8VF5	C11A-01460	UV-A	C11A	Vaal		Breyten	Torbanite Dam	Surface	1.080	No Deficit	0.2854	26%	0	0%	0	0%
C1VAAL-KVAAL	C11B-01770	UV-A	C11B	Vaal		*None*										
RE EWR 1 KIEINVAAL	C11C-01846	UV-A	C11C	Vaal	Klein Vaal	*None*										
UV9	C11E-01985	UV-A	C11E	Rietspruit	Skulpspruit	*None*										
C1RIET-AMERS	C11E-01895	UV-A	C11E	Vaal	Rietspruit	Amersfoort	Schulpspruit and Daggakraal (Amersfoort) Dam	Surface	0.967	2014	0.48	50%	0.26	27%	0.46	48%
C1KVAA-UNSPE	C11C-01846	UV-A	C11D	Vaal	Klein Vaal	*None*										
UV17	C11G-01799	UV-A	C11G	Vaal	Drinkwaterspruit	Ermelo	Willem Brummer and Douglas	Surface	3.190	No Deficit	0.85	27%	0	0%	0	0%
EWR1	C11J-01838	UV-A	C11J	Vaal												
C1BLES-UNSPE	C11J-01821	UV-A	C11H	Vaal	Blesbokspruit	Bethal	Rand Water	Surface	3.483							
VC4	C11L-01945	UV-A	C11L	Vaal	Kaalspruit	*None*										
VC5	C11K-01824	UV-A	C11K	Vaal	Leeuspruit	*None*										
UV Uklip	C13C-02550	UV-B	C13C	Vaal	Klip	*None*										
C13C	C13D-02416	UV-B	C13C	Vaal	Klip	Memel	Klip River to an off channel storage dam	Surface	0.394	2012	0.03	8%	0.108	27%	0.203	52%
C1KLIP-UNSPE1	C13D-02284	UV-B	C13D	Vaal	Klip (Grootdraai)	None										
EWR6	C13D-02226	UV-B	C13D	Vaal	Klip	-										
C13A	C13B-02175	UV-B	C13A	Klip	Sandspruit	None										
C1SAND-UNSPE	C13B-02135	UV-B	C13B	Klip	Sandspruit	None										
C13E	C13E-02228	UV-B	C13E	Klip	Komandospruit	None										
C1KLIP-UNSPE2	C13H-02118	UV-B	C13F	Vaal	Klip (Grootdraai)	None										
C13G	C13H-02156	UV-B	C13G	Klip	Spruitsonderdrif	Vrede	Vrede and Thembalihle	Surface	0.606	No Deficit	Minimal		0	0%	0	0%
C13H	C13H02077	UV-B	C13H	Vaal	Klip	None										
EWR7	C81A-02790	UV-C1	C81A	Vaal	Wilge	None										
8WF1	C81A-02790	UV-C1	C81B	Vaal	Wilge	None										
8WF3	C81B-02864	UV-C1	C81B	Vaal	Wilge	None										
UV25	C81L-02594	UV-C1	C81L	Wilge	Meul	None										
UV28	C82A-02542	UV-C1	C81M	Wilge	Meul	None										
UV Cor	C81M-02609	UV-C1	C82A	Wilge	Cornelius	None										
C82B	C82B-02540	UV-C1	C82B	Wilge	Cornelis	Warden is d/s of this point	Cornelis River and Warden Dam	Surface	0.505	Current	0.03	6%	0.536	106%	0.646	128%
8EF4	C81F-02995	UV-C2	C81F	Vaal	Elands	None										
C81G	C81G-02882	UV-C2	C81G	Elands	Klerkspruit	Kestel	Metsi Matsho Dam wand the Fika Patso Dam	Surface	0.533	No Deficit	0.215	40%	0	0%	0	0%
GG	C81G-02882	UV-C2	C81G			None										
C81J	C81K-02710	UV-C2	C81J	Wilge	Vaalbankspruit	None										
C81C	C81C-02978	UV-C2	C81C	Nuwejaarspruit	Fraser/Modder	None										
C8NUWE-CONFL	C81E-02930	UV-C2	C81E	Wilge	Nuwejaarspruit	None										
EWR8	C82C-2505	UV-C2	C82C	Vaal	Wilge	-										
C82D	C82D-02490	UV-C2	C82D	Wilge	Rus-se-spruit	None										
UV31	C82E-02418	UV-C3	C82G	Wilge	Holspruit	None										
VC8	C82G-02415	UV-C3	C82G	Wilge	Wilge Trib	-										
UV35	C82F-02326	UV-C3	C82F	Wilge	Grootspruit	None										
VC9	C82H-02200	UV-C3	C82H	Vaal	Wilge	None										
VC15	C83A-02863	UV-D	C83A	Liebenbergsvlei		None										
C83D	C83E-02588	UV-D	C83D	Liebenbergsvlei	Tierkloof	None										
C83E	C83E-02579	UV-D	C83E	Liebenbergsvlei	Tierkloof	Bethlehem	Liebenbergsvlei River System and the Saulspoort, Gerrands, Loch Lomond, Loch Athlone and Menin Dams	Surface	7.690	No Deficit	3.293	43%	0	0%	0	0%
VC16	C83G-02364	UV-D	C83G	Liebenbergsvlei	Unnamed tributary	Petrus Steyn	Middelpunt Dam (headwaters of C83F)	Surface	0.918	Current	0.043	5%	0.457	50%	0.557	61%
						Reitz	Geluk, Geluk Buiteloop and Reitz Reward Dams		1.238	Current	0.026	2%	0.959	77%	1.195	97%
VC17	C23H-02395	UV-D	C83H	Liebenbergsvlei	Unnamed tributary	None										

Table G-2a (cont): Reconciliation Strategy Results of Small Towns in Upper Vaal WMA relative to Biophysical Nodes

Site name	SQ REACH	IUA	QUAT	MAJOR RIVERS	TRIBUTARY	Town Name	Dams	Water Source Type	Current Water Use (million m^3/a)	Deficit Date	WCWDM Saving		Shortfall 2020 - after WCWDM		Shortfall 2030 - after WCWDM	
											(million m^3/a)	% of current use	(million m^3/a)	% of current use	(million m^3/a)	% of current use
VC6	C12D-01576	UV-E	C12D	Vaal	Waterval	Leslie, Landra, Eendrag	Rand Water	Surface								
WA1	C12F-01722	UV-E	C12F	Vaal	Waterval	Secunda	Rand Water	Surface								
VC7	C12F-01728	UV-E	C12F	Waterval	Unnamed tribuutary	None										
WA2	C12G-01896	UV-E	C12F	Vaal	Waterval	None										
UV WV	C12G-01963	UV-E	C12G	Vaal	Waterval	None										
UV45	C83K-02204	UV-F	C83K	Wilge	Kromspruit	None										
C8KLIP-VAALD	C83L-02057	UV-F	C83L	Vaal	Klip (flows into Vaal	None										
EWR2	C11M-01894	UV-G	C11M	Vaal		Standerton	Vaal River/Grootdraai Dam	Surface	10.210	Current	2.51	25%	0	0%	0	0%
8VF3	C11M-01901	UV-G	C11M	Vaal	Brakspruit	None										
C12A	C12B-02028	UV-G	C12A	Vaal	Venterspruit	None										
EWR3	C12C-01997	UV-G	C12H	Vaal		Villiers										
C12K	C12L-01881	UV-G	C12K	Vaal	Molspruit	Grootvlei	Supplied by Bulk	Supplied by								
C12J	C12J-02091	UV-G	C12J	Vaal	Bankplaasspruit	None										
C21A	C12A-01567	UV-H	C21A	Vaal	Suikerbosrand	None										
EWR 9	C21C-01675	UV-H	C21C	Vaal	Suikerbosrand	None										
EWR10	C21G-01627	UV-I	C21G	Vaal	Suikerbosrand	None										
EWR11	C21F-01447	UV-I	C21F	Suikerbosrand	Blesbokspruit	None										
VC11	C22C-01509	UV-I	C22C	Klip River	Rietspruit	***Various urban areas***										
VC12	C22A-01315	UV-I	C22D	Vaal	Klip River	***Various urban areas***										
VC13	C22E-01619	UV-I	C22E	Vaal	Klip River	***Various urban areas***										
VC14	C22K-01765	UV-I	C22J	Vaal	Rietspruit	***Fringe of urban areas***										
C22G	C22K-01795	UV-J	C22G	Vaal	Taaibosspruit	None										
UV53	C23A-01811	UV-K	C23B	Vaal	Kromelmboogspruit	None										
C23F	C23G-01250	UV-L	C23F	Vaal	Mooi River	None										
RE EWR 2 MOOI	C23G-01250	UV-L	C23G	Vaal	Mooi	-										
VC19	C23G-01406	UV-L	C23E	Mooi	Mooirivierloop	Carletonville	Not our area									
M2	C23K-01579	UV-L	C23K	Mooi	Loopspruit	Fochville	Not our area									
VC20	C23L-01827	UV-L	C23L	Vaal	Mooi	Potchefstroom	Potchefstroom Dam, Boskop Dam and	Surface	18.542	2016	6.856	37%	0	0%	0	0%
EWR4		UV-M	C22F	Vaal		-										
EWR5		UV-M	C23L	Vaal		-										

Table G-2b: Reconciliation Strategy Results of Small Towns in Middle Vaal WMA relative to Biophysical Nodes

Site name	SQ REACH	IUA	QUAT	MAJOR RIVERS	TRIBUTARY	Town Name	Dams	Water Source Type	Current Water Use (million m^3/a)	Deficit Date	WCWDM Saving		Shortfall 2020 - after WCWDM		Shortfall 2030 - after WCWDM	
											(million m^3/a)	% of current use	(million m^3/a)	% of current use	(million m^3/a)	% of current use
VC24	C70B-02323	MV-A	C70A	Vaal River	Renoster River	Petrus Steyn	Middelpunt Dam (headwaters of C83F)	Surface	0.918	Current	0.043	5%	0.457	50%	0.557	61%
VC25	C70B-02297	MV-A	C70B	Renoster River	Renoster River	None										
VC26	C70C-02233	MV-A	C70C	Renoster River	Leufonteinspruit	None										
R1	C70D-02182	MV-A	C70D	Vaal River	Renoster River	Koppies	Koppies Dam	Surface	0.940	No Deficit	0.050	5%	0	0%	0	0%
VC27	C70D-02215	MV-A	C70D	Renoster River	Doringspruit	Edenville	Groundwater	Groundwater	0.493	No Deficit	0.036	7%	0	0%	0	0%
R2	C70J-02163	MV-A	C70F	Vaal River	Renoster River	None										
VC29	C70H-02208	MV-A	C70H	Renoster River	Heuningspruit	None										
VC30	C70J-01955	MV-A	C70K	Vaal River	Renoster River	None										
VC31	C60A-02607	MV-B	C60A	Vaal River	Vals River	None										
VC33	C60C-02471	MV-B	C60C	Vals River	Elandsspruit/Elands	None										
VC35	C60G-02399	MV-B	C60G	Vaal River	Vals River	Kroonstad	Bloemhoek, Serfontein, Groblers, Barend Wessels and Strydom Dam	Surface	15.340	Current	7.092	46%	2.65	17%	4.8	31%
						Lindley	Lindley:Piekniekdraai and Grootkrans	Surface	0.768	Current	0.015	2%	0.59	77%	0.73	95%
EWR14	C60J-02262	MV-B	C60J	Vaal River	Vals River	-										
S1	C24E-01164	MV-C	C24C	Vaal River	Schoonspruit	Ventersdorp	Schoonspruit Spring	Surface	1.850	No Deficit	0.418	23%	0.000	0%	0.000	0%
VC21	C24F-01476	MV-C	C24F	Vaal River	Taaibosspruit	None										
S3	C24G-01661	MV-C	C24G	Vaal River	Schoonspruit	-										
S4	C24H-01860	MV-C	C24H	Vaal River	Schoonspruit	-										
VC22	C24A-01787	MV-C	C24A	Vaal River	Koekemoerspruit	Stilfontein	Vaal (Midvall Water Company)	Surface	3.622	No Deficit	1.008	28%	0.000	0%	0.000	0%
VC23	C24H-01732	MV-C	C24H	Schoonspruit	Jagspruit	None										
VC40	C42D-02890	MV-D1	C42D	Vet River	Sand River	Paul Roux	Groundwater	Groundwater	0.184							
V1	C42G-02828	MV-D2	C42G	Vet River	Sand River	Senekal influences this	Cyferfontein and De Put Dam	Surface Water	2.487	2017	2.063	83%	0.000	0%	0.000	0%
VC42	C42F-02762	MV-D2	C42F	Sand River	Koolspruit	None										
VC46	C41L-02635	MV-D2	C42L	Vet River	Sand River	Ventersburg	Vaal River and Groundwater (Sedibeng)	Surface and Grou	0.529	Vaal allocation	0.121	23%	0.410	78%	0.540	102%
						Hennenman/Phomolong	Vaal River (Sedibeng)	Surface	1.205	Vaal allocation	0.132	11%	1.470	122%	1.800	149%
						Theunissen	Erfenis Dam	Surface	2.220	Vaal allocation	1.36	61%	0.560	25%	0.950	43%
						Viginia	Vaal River (Sedibeng)	Surface	5.200	Vaal allocation	0.763	15%	3.650	70%	5.350	103%
VC49	C41D-03169	MV-E1	C41D	Vaal River	Vet River	None										
VC52	C41E-03132	MV-E1	C41E	Vet River/Erfenis	Klein Vet River	Winburg	Rietfontein Dam	Surface	1.030	Vaal allocation	0.314	30%	0.335	33%	0.464	45%
						Marquard	Laaispruit/Marquard and New Hope Dam	Surface	1.154	Current	0.742	64%	0.595	52%	0.893	77%
VC51	C41E-02989	MV-E1	C41E	Klein Vet River	Soutspruit	None										
V2	C41H-03012	MV-E2	C41H	Vaal River	Vet River	None										
EWR15	C43A-02561	MV-E2	C43A	Vaal River	Vet River	Bultfontein	Erfenis Dam		6.330	Vaal allocation	1.16	18%	0.19	3%	0.53	8%
EWR12		MV-F	C24B	Vaal River		-										
EWR13		MV-F	C24J	Vaal River		-										
VC56	s	MV-F	C25A	Vaal River	Klipspruit	Leeudoringstad	Part of a System	Part of a System	0.630	No Deficit	minimal		0	0%	0	0%

Table G-2c: Reconciliation Strategy Results of Small Towns in Lower Vaal WMA relative to Biophysical Nodes

Site name	SQ REACH	IUA	QUAT	MAJOR RIVERS	TRIBUTARY	Town Name	Dams	Water Source Type	Current Water Use (million m^3/a)	Deficit Date	WCWDM Saving		Shortfall 2020 - after WCWDM		Shortfall 2030 - after WCWDM	
											(million m^3/a)	% of current use	(million m^3/a)	% of current use	(million m^3/a)	% of current use
VC55	C31B-01275	LV-A1	C31B	Vaal River	Harts River	Lichtenburg		Groundwater								
VC61	C31C-01665	LV-A3	C31C	Harts River	Klein Harts	None										
VC57	C31E-02045	LV-A2	C31E	Vaal River	Harts River	Delarreyville		Groundwater	0.727	2015	0.273	38%	0	0%	0	0%
VC58	C32D-03250	LV-A3	C32D	Harts River	Dry harts	Vryburg		Surface and Groundwater	3.580	Current	0.875	24%	0	0%	0.625	17%
						Pudimoe, Dry Hartz, Myra		Surface and Groundwater	1.500	Current	minimial		0	0%	0	0%
H1	C31F-2358	LV-A4	C33A	Vaal River	Harts River	-										
EWR17	C33C-02836	LV-A4	C33C	Vaal River	Harts River	-										
VC59	C33C-02746	LV-A4	C33C	Harts River	Unnamed Trib	None										
EWR16	C91A-02391	LV-B	C91A	Vaal River		-										
EWR18	C92B-02903	LV-B	C92C	Vaal River		-										
VC60	C91D-02838	LV-B	C91D	Vaal River	Leeu River	Boshof		Groundwater	0.730	Current	0.315	43%	0.482	66%	0.581	80%

Appendix H:

Members of Project Steering Committee

Last Name	First Name	Company
Aaron	Nontsikelelo	Lejweleputswa District Municipality
Abrahams	Abe	Department of Water Affairs (DWA)
Ah Shene Verdoorn	Carolyn	Birdlife South Africa
Armour	Jack	Free State Agriculture
Atwaru	Yakeen	Department of Water Affairs (DWA)
Augoustinos	Mario	Vaaldam Catchment Executive Committee
Bakane-Tuoane	Manana Anne	Emfuleni Local Municipality
Barnard	Hendrik	Ga-Segonyana Local Municipality
Basson	Noeline	Sedibeng Water
Batchelor	Garth	Department of Economic Development Environment and Tourism
Bezuidenhout	P J	Overberg District Council
Bierman	Bertus	Joint Water Forum and Anglo American Platinum
Blair	Vernon	Department of Water Affairs (DWA)
Boden	Denis	National Petroleum Refiners of S A (Pty) Ltd (NATREF)
Bosch	Gert	Sishen Iron Ore Mine
Bosman	Lourie	Agri Mpumalanga (Plaas Uitgezogt)
Botha	Hannes	Mpumalanga Tourism and Parks Agency
Bothes	Elizabeth	Department of Tourism, Environment and Conservation
Brink	Fanie	Grain South Africa
Broderick	Maylene	Economic Development, Environment and Tourism
Burger	Alwyn	City of Tshwane Metropolitan Municipality
Chamda	Yunus	Sedibeng District Municipality
Chauke	Lucia	Eskom
Chauke	Sydney	Emfuleni Municipality
Chewe	Victor	City of Tshwane Metropolitan Municipality
Claassens	Johan	TCTA
Cloete	Riekie	Conningworth Economists
Cogho	Vik	Optimum Coal Holdings
Collins	Nacelle	Free State Department of Tourism, Environmental and Economi
Cornelius	Steven	Gauteng Department of Agriculture and Rural Development
Critchley	John	Rand Water
Cronje	Barry	Rural Foundation
de Fontaine	Marc	Rand Water Rietspruit Blesbokspruit Forum
de Jager	Steyn	Greater Taung Municipality
de Klerk	Albert	Midvaal Local Municipality
De Kock	Abe	Farm: Mooidraai
de Villiers	D W	Koppieskraal Irrigation Board
Dhluwayo	Boy	Sol Plaatjie Municipality (Kimberley)
Dini	John	South African National Biodiversity Institute
Diniza	Maria	Gamagara Local Municipality
Dippenaar	Gideon	Sedibeng Water
Dippenaar	Gideon	Sedibeng Water
Dlabantu	Mpumelelo	Working for Water
Dlamini	Mavela	City of Johannesburg Metropolitan Municipality
Dlamini	Thami	Msukwaligwa Local Municipality
Donaldson	R	Manganese Mines
Driver	Mandy	SANBI
du Plessis	Rickus	Department of Agriculture and RuraL Development
du Toit	Hanke	Department of Water Affairs (DWA)
Du Toit	Tienie	Renoster River Water Users Association
Eilard	J	Dikgatlong Local Municipality
Eilerd	Johannes	Dikgatlong Local Municipality
Els	Nic	City Council of Klerksdorp
Erasmus	Coenie	Department of Tourism, Environment and Economic Affairs
Erasmus	Frik	Durban Roodepoort Deep Limited
Florence	Achmat	Frances Baard District Municipality
Fourie	A J	Griqualand Exploration & Finance Co Ltd
Fourie	Wynand	Department of Environmental Affairs (DEA)
Gabriel	Mary-Jean	Department of Agriculture, Forestry and Fisheries (DAFF)
Galane	Malesela	Environmental Justice Networking Forum (EJNF)

Last Name	First Name	Company
Gamede	Andries	Gert Sibande District Municipality
Gaobusiwe	Benjamin	Kgalagadi District Municipality
Gincane	Ruben	Mamusa Local Municipality
Ginster	Martin	Sasol
Gondo	Joe	National African Farmers Union (NAFU)
Gopane	Ruth	Dikgatlong Local Municipality
Gosani	Ntsikelelo	TCTA
Greeff	Henry	Kgalagadi District Municipality
Greyling	Jan	Matjhabeng Local Municipality
Greyling	S P J	Schoonspruit Irrigation Scheme
Grobler	Willem	Department of Water Affairs (DWA)
Gungubele	Mondli	Ekurhuleni Metropolitan Municipality
Hadebe	Slindokuhle	Ekurhuleni Metropolitan Municipality
Hall	Peter	Sasol Infrachem (Leeu Spruit, Taaibosch Spruit Forum)
Hanekom	Dirk	Eskom
Harrison	Pienaar	Department of Water Affairs (DWA)
Hauman	Louis	Kuruman Agricultural Union
Hendriksz	Johan	East Rand Water Company (ERWAT)
Itholeng	Kebalepile	Gauteng Department of Agriculture and Rural Development
Itumeleng	Clement	Gamagara Local Municipality
Izaaks	Saul	Siyanda Water and Sanitation District
Jacobs	Gideon	Distrik Boere Unie
Jooste	Sebastian	Department of Water Affairs (DWA)
Joubert	Andre	Zitholele Consulting (Pty) Ltd
Kadiaka	Mamogala	Department of Water Affairs (DWA)
Keet	Marius	Department of Water Affairs (DWA)
Kekesi	Albert	Bophirima District Municipality
Khan	Rafat	Midvaal Water Company
Kleynhans	Neels	Department of Water Affairs (DWA)
Kokobela	Mosimanegape	House of Traditional Leaders
Komape	Martha	Department of Water Affairs (DWA)
Kruger	Marina	Midvaal Water Company
Leeto	Nokwanje	Lejweleputswa District Municipality
Leeuw	David	Sol Plaatjie Local Municipality
Lekoko	Simon	Directorate of Traditional and Corporate Affairs
Lethoko	Itumeleng	Ditsobotla Local Municipality
Letlhogile	Tshiamo	Ditsobotla Local Municipality
Letsoalo	Mokopane	Waterberg District Municipality
Leuschner	Andries	Gold Fields South Africa Ltd
Liefferink	Mariette	Federation for a Sustainable Environment (FSE)
Liphadzi	Stanley	Water Research Commission
Lobelo	Govan	Dr Ruth Segomotisi Mompati District Municipality
Lodewijks	Henk	Anglo Coal Environmental Services
Louw	Delana	Rivers for Africa
Louw	Lonnox	Tosca Dolomite Water User Association
Mabalane	Itumeleng	Chamber of Mines
Maboe	Paul	Sasolburg Transitional Local Council
Mabuda	Solly	Department of Water Affairs (DWA)
Mafejane	Ariel	Johannesburg Water
Magodi	Omphemetse	Kgalagadi District Municipality
Mahonde	Kay	Birdlife South frica
Mahusi	Christopher	Molopo Local Municipality
Makape	G G	Tsantsabane Municipality
Makena	Gladys	Magareng Local Municipality
Makgalemane	Itumeleng	Greater Taung District Municipality
Makodi	Rebecca	Leekwa Teemane Local Municipality
Makuapane	Andrew	Leekwa Teemane Local Municipality
Malaka	Tebogo	Department of Water Affairs (DWA)
Malebye	Patrick	Dipaliseng / Balfour Local Municipality
Manamela	Sadimo	Department of Water Affairs (DWA)
Manele	Sorrious	Sedibeng District Municipality
Mapholi	Masindi	Maquassi Hills Local Municipality

Last Name	First Name	Company
Maposa		Delportshoop TLC
Marx	Karin	Wildlife and Environment Society of South Africa (WESSA)
Maseng	Benardo	Kgatelopele Local Municipality
Masondo	Amos	City of Johannesburg Metropolitan Municipality
Maswuma	Zacharia	Department of Water Affairs (DWA)
Matseba	Mogale	Department of Water Affairs (DWA)
Mazwi	Nosie	Department of Water Affairs (DWA)
McCourt	Liz	Department of Environmental Affairs (DEA)
Meintjes	Louis	Transvaal Agricultural Union South Africa (TAUSA)
Mere	Shedrick	Magareng Local Municipality
Midgley	Ian	Eskom
Mlambo-Izquierdo-	Poppy	Kgatelopele Local Municipality
Mmarete	Charles	Department of Water Affairs (DWA)
Mmoiemang	Kenneth	Kgalagadi District Municipality
Mngomezulu	Willy	Pixley Ka Seme Local Municipality
Mnisi	Jones	Johannesburg Water (Pty) Ltd
Mochware	Ontlametse	Kagisano Local Municipality
Modisakeng	Busisiwe	Lesedi Local Municipality
Mofokeng	Mahole	Sedibeng District Municipality
Mofokeng	Mpho	Greater Taung District Municipality
Mofokeng	Puleng	Department of Agriculture, Forestry and Fisheries
Mogotlhe	Paul	North West Department of Agriculture, Conservation, Environment and Tourism
Mohapi	Ndileka	Department of Water Affairs (DWA)
Mokadi	Andrew	Vaal University of Technology
Mokgosi	Mantebo	Moqhaka Local Municipality
Mokgosi	Mantebu	Moqhaka Local Municipality
Molema	Kemonna	Tribal Authority
Molema	Shelley	Bophirima District Council
Mompati	Rose	Naledi Local Municipality
Mongake	Monty	Fezile Dabi District Municipality
Mongolola	Gift	Ga-Segonyane Municipality
Moraka	William	South African Local Government Association (SALGA)
Mosai	Sipho	Rand Water
Mothibi	Dimakatso	Department of Agriculture and Land Reform
Motlhale	Kelehile	Tswelopele Local Municipality
Motoko	Phihadu	Ratlou Local Municipality
Mshudulu	S A	Emfuleni Local Municipality
Mthimunye	George	Naledi Local Municipality
Mtsuku	Samuel	Department of Tourism, Environment and Economic Affairs
Mudau	Stephinah	Chamber of Mines South Africa
Mulangaphuma	Lawrence	Department of Water Affairs (DWA)
Muller	Anton	Bloemhofdam Kom
Mutyorauta	J J	Department of Agriculture
Mutyorauta	Julius	Department of Tourism, Environment and Conservation (DTEC)
Mvula	Obed	Department of Land Affairs
Mwaka	Beason	Department of Water Affairs (DWA)
Mweli	Zandisile	Maquassi Hills Local Municipality
Nagel	Marius	Government Communication and Information Systems (GCIS)
Naidoo	Shane	Department of Water Affairs (DWA)
Nakana	Lesego	Greater Taung Local Municipality
Namusi	Sedirilwe	Molopo Local Municipality
Nast	Timothy	Midvaal Local Municipality
Naude	Piet	Free State Agricultural Water Committee
Nengovhela	Rufus	Department of Water Affairs (DWA)
Ngamole	G	Masilonyana Municipality
Ngangelizwe	Sebenzile	Matjhabeng Local Municipality
Ngcobo	Mbuleleni	Gert Sibande District Municipality
Ngcobo	Sonwabo	Tswaing Local Municipality
Ngema	Khaya	Ekurhuleni Metropolitan Municipality
Ngila	Zelna	Siyanda District Municipality
Ngomane	Lulu	Gauteng Water Sector Forum
Ngxanga	Eric	Siyanda District Municipality

Last Name	First Name	Company
Nkonyane	Martha	
Nkwane	Oupa	City of Tshwane Metropolitan Municipality
Nosi	Thabo	Frances Baard District Municipality
Ntili	Tseliso	Department of Water Affairs (DWA)
Ntsepe	Sello	Mantsopa Local Municipality
Ntsizi	Thembile	Wes Vaal Chamber of Commerce
Ntwe	Francisco	Ratlou Local Municipality
Nyamande	Tovhowani	Department of Water Affairs (DWA)
Oagile	Mothus	Kagisano Local Municipality
Oosthuizen	Christo	Louwna/Coetzerdam Water User Association
Opperman	Dirk	Land Affairs
Opperman	Nic	Agri SA
Peek	Bobby	GroundWork - Friends of the Earth South Africa
Petersen	Thabo	Matjhabeng Local Municipality
Phukuntsi	Rosy	Tswelopele Local Municipality
Pienaar	Harrison	Department of Water Affairs (DWA)
Pienaar	P G	Vyf Hoek South Management Board
Pillay	Nava	Metsweding District Municipality
Potgieter	Ampie	Sasol Mining Rights Department (SMRD)
Potgieter	Jan	Department of Agriculture, Forestry and Fisheries
Potgieter	Sandra	Dow Plastics
Pretorius	Theuns	Kaalfontein Boerevereniging Distriks Landbou Unie
Pyke	Peter	Department of Water Affairs (DWA)
Radebe	Khulu	Male Development Agency
Rademeyer	Seef	Department of Water Affairs (DWA)
Ramaema	Lowrence	Department of Tourism, Enviroment and Economic Affairs
Ramokgopa	Kgosientsho	City of Tshwane Metropolitan Municipality
Ramokhoase	Jonas	Fezile Dabi District Municipality
Rampai	Constance	Mantsopa Local Municipality
Rampine	M K	South African National Civic Organisation (SANCO) Boikhotsong
Reinecke	C J	Potchefstroom Univ for CHE
Reitz	J J C	Kalahari East Water User Association
Rossouw	Lourens	Tokologo Local Municipality
Rust	Nelia	Matjhabeng Local Municipality
Sales	Malcolm	Lebalelo Water User Association
Samson	Paballo	Moshaweng Local Municipality
Sebusho	Sipho	Kgalagadi District Municipality
Seikaneng	Tefo	Moshaweng Local Municipality
Shabalala	Sam	Emfuleni Local Municipality
Shone	Steve	Grain SA
Sindane	Jabulani	Lekwa Local Municipality
Slabbert	Nadene	Department of Water Affairs
Smit	Hennie	Department of Water Affairs (DWA)
Snyders	Louis	Department of Water Affairs (DWA)
Stoch	Leslie	Geotech (Lower Wonderfonteinspruit Forum)
Stoltz	Gert	Molopo Farmers Union
Surendra	Anesh	Eskom
Sutton	Malcolm	Anglogold
Swart	Susan	WRP Consulting Engineers (Pty) Ltd
Takalo	Mmabatho	City of Tshwane Metropolitan Municipality
Terrè-Blanche	Riana	Namaqualand Water and Sanitation Support Group (NAWASAN)
Thakurdin	Manisha	Department of Water Affairs (DWA)
Theron	Danie	Christiana Farmers Association
Theron	J H	Vaalharts Water Users Association
Theron	Piet	Munisipaliteit van Delportshoop
Thirion	Christa	Department of Water Affairs
Thompson	Isa	Department of Water Affairs (DWA)
Tlhape	Manketse	Tswaing Local Municipality
Tshipelo	Kenneth	Mamusa Local Municipality
Tsotetsi	Mabalone	Dipaliseng Local Municipality
Ubisi	Makumu	Sedibeng Water
van Aswegen	Johann	Department of Water Affairs (DWA)

Last Name	First Name	Company
van den Berg	J W	Saamstaan Agricultural Union
van den Berg	Ockie	Department of Water Affairs (DWA)
van den Bon	Patrick	Vadex Consulting cc
van der Heever	Piet	Lesedi Local Municipality
van der Merwe	Ben	Emfuleni Local Municipality
van der Merwe	Danie	Ekurhuleni Metropolitan Municipality
van der Merwe	Johan	Rand Water
van der Walt	Philip	City of Tshwane Metropolitan Municipality
van der Westhuizen	Walther	Department of Water Affairs (DWA)
van Rooyen	Johan	Department of Water Affairs (DWA)
van Rooyen	Pieter	WRP Consulting Engineers (Pty) Ltd
van Schalkwyk	V	South African Rivers Association
van Tonder	Dean	Sasol Mining
van Vuuren	Hennie	Regina Farmers Union
van Vuuren	J L	Frankfort TLC
van Wyk	Francois	Rand Water
van Wyk	Jurgo	Department of Water Affairs (DWA)
van Wyk	Niel	Department of Water Affairs (DWA)
van Zyl	Andre	Fezile Dabi District Municipality
Van Zyl	Chris	TAU SA Agricultural Union
van Zyl	J F C	Bloemhof TLC
Venter	Gerda	Department of Water Affairs (DWA)
Venter	Petrus	Department of Water Affairs (DWA)
Vilakazi	Bheki	Msukwaligwa Local Municipality
Viljoen	Peter	Vereeniging Refractories Ltd
Vorster	Albert	Kimberley Agricultural Union
Watson	Marie	Centre for Environmental Management
Wepener	Lotter	River Property Owners' Association - Save the Vaal
Williams	Bruce	Klerksdorp Irrigation Board
Woodhouse	Philip	Goldfields (West Driefontein Gold Mine)
Yawitch	Joanne	Department of Environmental Affairs (DEA)

Appendix I:

Comments and Responses

COMMENTS RECEIVED	ADDRESSED IN REPORT?	COMMENT
A. J Jay comments		
Although there was no dedicated water quality status quo section in this report, the following sections do contain some descriptions of the water quality in the IVRS:		
1. Introduction (page 2):		
- Provides a very broad overview of water quality in the Vaal main stem.	Yes	Refer to Section 2.63 on Page 33 of report.
- This summary is congruent with the findings of the Vaal IWQMS as well as with the findings of the Planning Level Review of Water Quality in South Africa (a report by DA, WQP which is currently being finalised) .	Yes	
2. Status Quo of Upper, Middle and Lower Vaal (Section 4, 5 and 6): Ecological Assessments. **-** For each IUA, the water quality PES category is provided as well as a broad qualitative explanation. Although I assume the method used to derive the PES for water quality at this level is described in the "Quick Habitat Integrity" manual, it would be beneficial to know what data the findings were based on and thus what patsy used to determine the PES for water quality for this study. This could be included in a separate appendix, together with the table summarising the water quality PES categories and motivations. (If I recall correctly, it was stated in the PMC that a water quality PES table was available (score plus a description)).	Yes (explanation)	Note that the water quality PES table is in fact a map that Dr Scherman coloured by hand to depict problem areas. PES results are also included throughout the report in the relevant sections, with the non-flow related comments in the tables indicating where water quality issues are dominant. After further discussion with Ms Jay it was decided to include a water quality appendix in a subsequent deliverable. As stated by Ms Jay, this information would aid an understanding of where water quality trade-offs (protection vs. use, quality vs. quantity) and costs become relevant. In addition, Section 2.2.2 contains a paragraph on the method followed to assess the desktop water quality category for the IUAs.
3. Status Quo of Upper, Middle and Lower Vaal (Section 4, 5 and 6): EGS Assessments. - A broad description of the role of each reach in waste water dilution and assimilation is given (scored from low to high in most cases).	n/a	
- See page 45 -4.8.4 bullet 5 (shouldn't it be "in the main stem" where it says "in the main it is agricultural run-off"). This repeated through several entries (including pg 46, 48 etc)	Yes	Sentence is unclear and will be modified to read: It is mainly agricultural runoff that will be diluted. Note, this therefore did not refer to the main stem, but any reach applicable.
Other comments.		
Page 51, Table 4.19. Klip River and Wetland IUA: I do not think stating that achieving the REC is "not possible" is required and this should be removed (at least from the table). As I understand it, what is and is not possible in this catchment is what will be decided as part of this study. Similarly references to whether or not an action which is required is likely to happen or not (such as water quality improvement) should be removed from the table. If too much flow is a problem (which it is as it is eroding the wetland), then surely this should be mentioned in the "flow related" column (i.e as "discharges"). Also, given the awareness around this resource, it should be mentioned that large parts of the Klip consists of wetland habitat (floodplain).	Yes	Part of the EcoClassification approach is to assess the attainability or restoration potential when making recommendations. Therefore, recommendations that are made must be realistic and achievable. The: "but not possible" will be changed to "unlikely to be achieved" as possibly less contentious. It must be noted that the actions required leads to the decisions on whether flow improvements can achieve the REC. As has been clearly stated is that the water quality problems are dominant and nothing will be achieved by addressing the flow issues. Therefore, addressing the eroding wetland, will not improve the category of the river without improving quality. The statement regarding the fact that large parts of the Klip consists of wetland and that this should be mentioned: This fact will be mentioned in the EIS comments in the spreadsheets that will be provided to the client. Final Resolution regarding these statements are therefore as per the discussions held at the most recent PMC meeting.
Page 65. 5.4.1. Change "this rives" to "this river"	Yes	
Page 65. 5.4.2 An analysis of water quality monitoring data showed that the Koekemoerspruit is in a worse condition than the Skoonspruit. This is attributed to amongst other factors, the fact that the Koekemoerspruit is much drier than the Skoonspruit which is maintained by the SK eye. The PES seems to indicate that the Koekemoerspruit has a better water quality?	Yes	

<table>
<tr><th>COMMENTS RECEIVED</th><th>ADDRESSED IN REPORT?</th><th>COMMENT</th></tr>
<tr><td>Page 71 5.8 An analysis of water quality along the vet river shows that water quality for upper sand and vet as relatively similar. The Sand River below Allemanskraal is highly influenced by inputs from Mosterd Canal (which carries treated sewerage, mining wastewater and stormwater) and less so from the Doring River (which also carried waste water inputs). Inputs from the Doorn and Mosterd Canal and diversion of water from the sand river (from Allemanskraal into the sand canal) has deteriorated the water quality in the Sand River such that it has generally worse quality than the Vet. This is particularly true for EC, Sulphate, Nitates and Phosphates. Below Erfenis the salts and nutrient levels increase due to surrounding agricultural activity and a reduction in flows in the River itself.(most of the flow is transported via a canal). Below the confluence with the Sand: Sand River inputs causes an increase in Sulphate, Chloride, Phosphate and Ammonium concentrations in lower Vet. Lower down in the Vet River, at the Vet River floodplain a decrease in EC as well as PO4, SO4 and NH3 occurs. The reason for this is unclear, although this could be due to the buffering of the floodplain or ground water inputs (the farmers in the area suspect that the floodplain is groundwater fed) or the fact that more flows are present (sand and vet canals “decant” into the Vet just below the confluence with the sand to provide water for the riparian irrigations on the lower vet). Additional comment after discussion with the PSP: The aim was to indicate that although the recent water quality status anaysis of the system has confirmed Patsy's statements in terms of the fact that 1) the upper Vet is in a better water quality state than the upper sand and 2) the lower vet WQ is in a better state than the lower Sand, it does not support the statement that the lower Vet (section 5.8 - which on my report starts on page 71) is in the same largly natural state as the upper Vet (stated in the Report as follows: "The water quality category for this reach is a B category as there also seems to be an adequate riparian Buffer"). What the study showed was that the Vet river below Erfenis dam upto the confluence with the sand had a decline in water quality. Then when it flows into to the lower Vet below the confluence with the sand river we found that the vet river quality improved for some variables but declined for others (see summary in "comments recieved" section). The improvement was however generally not to the standard of water quality that was meansured abve the dam. I.e It is questionable whether the Vet can be a B category above as well as below the Dam. The Reserve at EWR 15 also showed the WQ PES to be a C, not a B.</td><td>Yes</td><td>After further discussion with Ms Jay, it was agreed to change the desktop present state of the Lower Vet River below Erfenis Dam to a C category. This alteration is in line with the results of the Reserve study for EWR 15, as well as recent output from the RWQO model. The table below was provided by Ms Jay, and illustrates the case with the Sand and Vet rivers. Ms Jay's recommendation for the Lower Vet River was therefore accepted and altered.

<table>
<tr><th>Section in Report</th><th>Reach</th><th>WQ PES (as per text in the Report)</th></tr>
<tr><td>S 5.5</td><td>Upper Sand (above Allemanskraal)</td><td>C</td></tr>
<tr><td>S 5.6</td><td>Lower Sand (Below Allemanskraal)</td><td>D</td></tr>
<tr><td>S 5.7</td><td>Upper Vet (Above Erfenis)</td><td>B</td></tr>
<tr><td>S 5.8</td><td>Lower Vet (Below Erfenis)</td><td>B – Recommend this be changed to a C for WQ PES (as per the comprehensive Reserve PAI results plus findings of the RWQO study)</td></tr>
</table></td></tr>
<tr><td>The point here is that WQ has been assigned as a C, which may be true for the lowest point, but is quite likely not true for the upper parts of the IUA (lower Vet), and some improvement may be necessary. If not considered to fine scale, it may be worth mentioning this in the report.</td><td>See comment</td><td>The C category is for the Upper Sand River, with the Upper Vet River being a B Category. A paragraph has also been included regarding the data sources and the desktop approach followed for the assessment.</td></tr>
<tr><td>Page 26. Section 3: IUA’s. It should be noted that the Modder Riet is not included and why (As I understand it, although it forms part of the lower Vaal catchment, only a portion of the catchment uses water from the catchment. The rest of the Modder Riet uses Orange River water which is transferred in. I’m assuming this is why it was excluded?). (Note: after evaluating the PSP comment, Ms Jay still feels that the reason for exclusion should be stated. If the report states that the Riet-Modder is not part of the study area, and why, it proves that the Riet-Modder was left out intentionally and not as an oversight).</td><td>Yes (See comment)</td><td>The Riet-Modder is not part of the study area. This is not an oversight as stated in report the TOR defined the study area as comprising of the three Vaal WMAs. The Riet-Modder catchment forms part of the Orange River WMA.</td></tr>
<tr><td>Section 2.2. See table 2.1. Where is the reference to this table in the text.</td><td>Yes</td><td>Reference was below the table and the table has been moved</td></tr>
</table>

COMMENTS RECEIVED	ADDRESSED IN REPORT?	COMMENT
Section 2.2.2. An explanation of how the REC was determined (criteria used) and how the SCI was determined should be included. The Title I feel, should rather be " Assessing EI (PES, EIS, SCI) and the REC" instead of "Assessing PES and EIS" as it includes more than just the PES and EIS method descriptions.	Yes	
General Comments: Maps		
Im assuming the maps we saw at the PMC (each reach was highlighted with the PES and REC) will be included in subsequent reports?	Yes	All maps were updated accordingly.
I would recommend that the maps to show the IUA's be refined. E.g by using different colours to show the IUA's. These maps will likely be used in a number of presentations / follow-up reports and could be improved upon. **(Note: Ms Jay agreed with the PSP comment).**	No	I don't agree as using different colours is going to turn the maps into a smartie box and cause confusions with the A to F colours representing Ecological Categories. Those have been tried and this format is linked to the standard output for the technical information. I would suggest that we leave it like this for the technical report and the stakeholder consultant, can, in conjunction with the client decide how best to present the maps at the stage of stakeholder documentation and meetings.
Figure 1.1 is of poor quality and does not print well. A high definition map is required.	N/A	Printing quality proved to be fine. Probably to do with printer resolution setting.
B. Sadimo comments:		
Determination of biophysical nodes		
It is evident that biophysical nodes were not established in terms of the guidelines for the Water Resource Classification System. The allocation nodes were not considered. Also there was no establishment of the ecosystem- specific units e.g wetlands. As a result of this' important aspects e.g. geomorphic zones were omitted. Groundwater nodes were also not considered.	Yes (See comments)	Allocation nodes were considered and was supplied and included upfront by WRP and are included. Regarding following the Water Resource Classification System. During a discussion with Ms Naidoo, and as stated in the accepted inception report (contract), the principles of the main steps of the WRCS must be followed, but the practicalities of the detail approaches recommended must be carefully considered. As the WRCS has not been tested on any system (apart from it being developed on the Olifants), many of the tools and approaches are impractical and not cost-effective considering the scale of the study area. Following the WRCS and the exact methods would have resulted in a cost of probably in the order of thirty million Rand. Furthermore, since the WRCS guidelines were finalised, the current PES and EI-ES study was initiated and the selection of these SQ reaches (and therefore the nodes) superceded the WRCS. This concept was presented by DWA RQS to Ms Naidoo during an Olifants Steering Committee and accepted. We have used these SQ reaches which indicate the locality of the nodes, but however could not use all of them as this would have added a million rand to the budget. The best compromise approach as agreed to by the client in the inception report was therefore reached. This has been described in the status quo report. Regarding the groundwater nodes, three areas namely Zuurbekom, Schoonspruit and Lichtenburg were identified. Desriptions of these groundwater areas were included in the report. Integrated surface-groundwater analyses will be done whereby alternative abstractions (present day and future development) will be simulated and the impact thereof on the baseflow/outflow from the eyes will be quantified. The effect of these on the relevant surface water Reserve nodes situated immediately downstream of these grounwater areas will then be evaluated.
Socio economic assessment		
Comments are based specifically on table 2.2 structure of production cost		
What is missing this table is the cost to the environment. If this cost is not given the necessary attention it deserves we will find ourselves in a situation where the real cost of production is underestimated and pave way for externalization of costs.		This structure disaggegregates the economic flow of production to the specific sectors in the economy. The cost of the environment is therefore out of the boundries of the production costs. The environmental components to be addressed will be included into the scoring system that makes provision for the externalities aspects.
C. Lawrence Mulangaphuma comments:		
Production Industry Model (PIM) is not detailed and does show what data required/input to support the model.	Yes	
The PIM doesn't show key output.	Yes	

COMMENTS RECEIVED	ADDRESSED IN REPORT?	COMMENT
What is wrong with the model such as SAFRIM? The combination of WIM and SAFRIM can take into consideration of the potential impacts of a particular development on the economic environment of a study area (which can be delineated according to impact intensity) which was the case during Vaal Reserve determination study.	Yes	
During the last PMC meeting the William Mullins said the evaluation of economic development (WIM) doesn't take into consideration the potential impacts of a particular development on the economic environment of the study area. For me that's worrying.	Yes	
The similar methodology (WIM and SAFRIM) was used to assess the ecosystem services in the Thukela Water Project: Reserve Determination Module.	Yes	Scoring system has been explained in more detail.
The models can also be used to calculate the micro-economic impacts of water use in the different zones.		The micro-economic aspects will be addressed as a macro-economic model application when the volume of water scenarios will be allocated in the different IUA for the next phase of the study.
The report doesn't clearly show socio-economic guidelines for the 7-step classification procedure (step by step as indicated in the WRCS guidelines).For example, doesn't talk anything about the decision-making framework, their methodology should use WRCS guideline as basis.		The economics performed in the Status Quo-report dealt with Task 3a (Step 1: Delineate units of analysis and describe the status quo) and Task 3b (Step 2: Link value and condition)
The SAMs that were used for the purposes of this study were for Mpumalanga, Gauteng and Free State provinces. Why not Northern Cape?	Yes	
Spelling check: page 21, paragraph 3, fourth sentence: upplied instead of supplied	Yes	
Spelling check: page 24, paragraph 4, seventh sentence: th instead of the.	Yes	
D. Tovho Nyamande comments:		
Socio-economic assessment or framework – Is Water Quality component fully addressed on the framework, for example, the negative value wastewater brings into the water resources or the cost of wastewater treatment. Is Waste Discharge Charge System incorporated on the framework?		The inception report didn't include water quality aspects and also didn't include the Waste Discharge System, however, where water quality is a cost item it will be addressed in the model.
Scoring system – The Evaluation Criteria of the Scoring System can be better presented by a table, in order to see which criteria has a big weight per IUA. According to the Inception Report Deliverable/Milestones, you have indicated that Analysis of Scoring System will be provided in Q2, so I take the Scoring System will be practically defined using Vaal area.	Yes	
P.56 –UV-L should have been provided and clearly demarcated in B-4, Appendix B	Yes	Not clear what this means as UV-L is demarcated in Figure B-4.
P.61, Paragraph 5.1, General – is Figure B-5 (Not B-2)	Yes	Correct references were made (should read Figure A-2).
P.76, Paragraph 5.1, General – Figure B-9 (not B-3)	Yes	Correct references were made (should read Figure A-3).
Groundwater assessment (e.g. P.60, 75 etc.):It is advisable to write some information, to show that one has applied a mind on the issue, rather than leaving the heading blank, for example: 1. Ecological assessment –Is there any groundwater / surface water interactions or baseflow contribution in relation to the aquifer:Any potential threats or impact/s on water quality?. 2. Socio-economic assessment – Is there no community or farming activities dependent on groundwater? Even if is insignificant, can be stated.	Yes	Information from Validation studies and other exissting reports was summarised as background information. To be evaluated as part of qualitative assessment The analysis concentrate on the use of water dispite their origin and wasn't addressed at this stage.
E. General comments from DWA received on 23 August 2011:		
Page ix: *the following assumptions have been accepted in the calculation of the possible socio-economic costs:* who accepted the assumption? And if they are coming from Reconcialtion study reference should be made.	Yes	Rephrased sentence.

COMMENTS RECEIVED	ADDRESSED IN REPORT?	COMMENT
Page 6: ……*Upper Waterval catchment resulting from the most recent BKS study* ……is not BKS study because the study was commissioned by DWA, reference should be DWA.	Yes	
Page 9: second last paragraph, last sentence: *….in excel format and code written* . Clarify code written.	Yes	
Page 10: the NFEPA was commissioned by the same ministry (Ministry of Water and Environmental Affairs). the criticism of NFEPA study is not justifiable. Find a way to incorporate NFEPA layer of Maps OR points.	Yes	
Page 18: *immersed inputs for WIM-model* . What are immersed inputs?	Yes	These immersed inputs consist of an array of multipliers deduced from the appropriate provincial SAM, and are crucial in calculating the macro-economic and socio-economic impacts emanating from water re-allocations across individual water users in the different sub-systems.
Page 23: what informs weight?	Yes	
Page 24*: the above table indicate that in this specific case the overall scoring in the zone does not change and that the proposed reallocation of water would probably be acceptable. The present classification system makes provision for a class change every 10%, therefore, a 10% score change will necessitate a changed classification* . The statement is confusing and clarity is required.	Yes	
Page 25: *that each EZ has already been allocated an environmental classification-class A – F* . the classification has REC A - D and Management class 1 – 3.	Yes	Corrected
Page 32, 2.6: reference it, if coming from Reconciliation study.	Yes	Reference shown in footnote on page 32.
Page 38, first paragraph: Sasol is not strategic water user only Eskom is.	Yes	Statement corrected.
Page 42, first paragraph: the heading is Proposed Action and the content is talking about corrective action, clarify.	Yes	The proposed action involves corrective action
Page 47, 54, 56, 58, 60, 63, 68: those areas are believed to have power generations, please confirm.	Yes	No, only in UV-A: Vaal River upstream of Grootdraai and UV-M incl. UV-J and UV-K
Page 53, last paragraph: *salinity balance done by Chris Herald* , instead done by Chris Herold.	Yes	Corrected
Page 66, first paragraph: clarity on *the EI is low and there is no motivation to improve the PES.*	Yes	
Page 69: spelling check: *the flow in this river reach is influence by various factors as listed below* , instead of influenced by……..	Yes	Corrected
Page 72: map doesn't have reference point.	No	The purpose of the map is to illustrate the location of the Zuurbekom area relative to quaternary catchments (the latter are indicated on the map as references). There is a Google Earth map on page 73 (Figure 4.2) showing a reference point for the Zuurbekom area.
Page 92: *the exact operation of this transfer is unknown (capacity of the transfer infrastrure etc) at this point in time and need to be investigated.* This falls outside the scope of work.	Yes	Stated that this is not part of current study's TOR.
Page 96, first bullet: spelling check, yellowfish.	Yes	Corrected