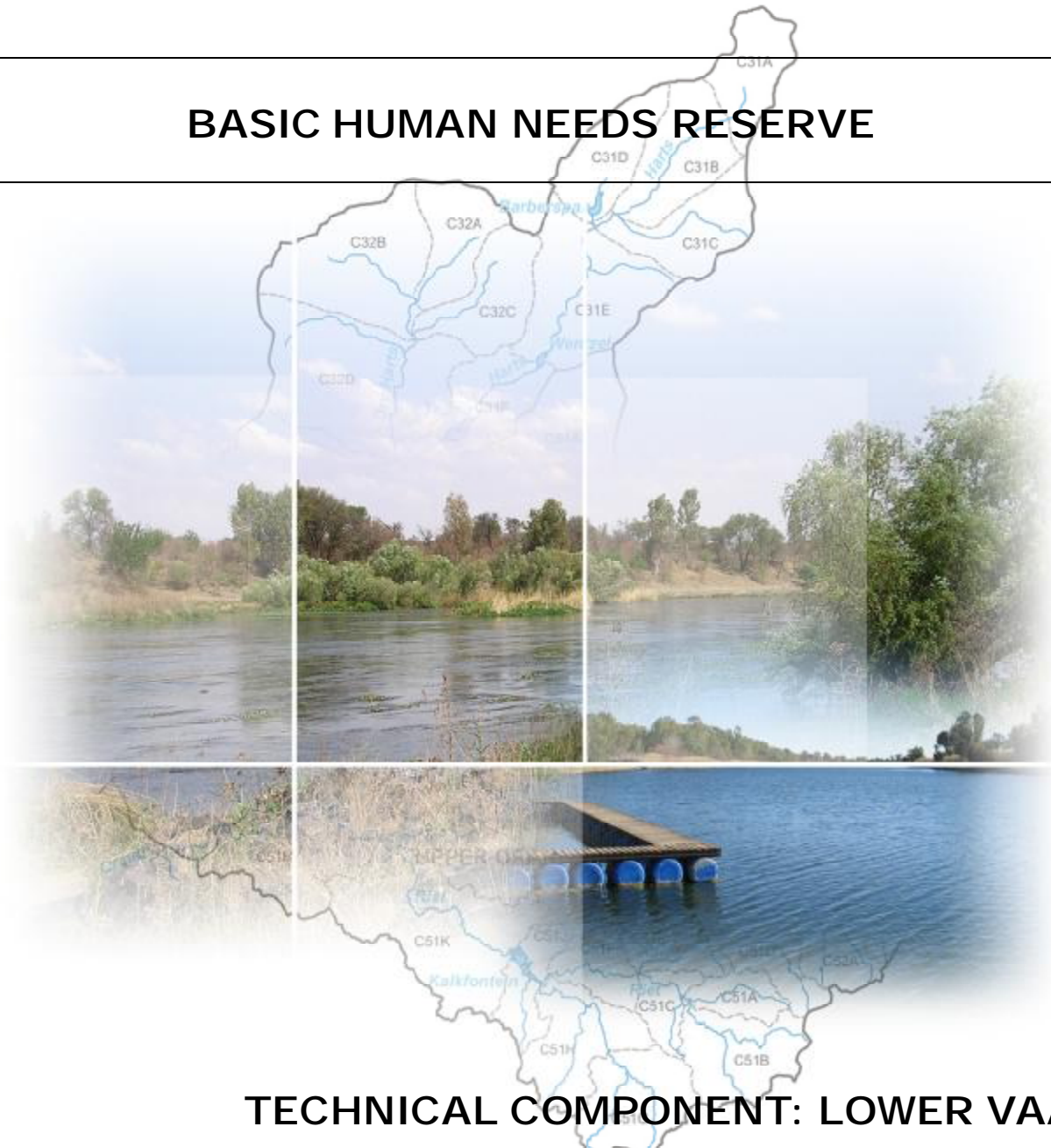


COMPREHENSIVE RESERVE DETERMINATION

INTEGRATED VAAL RIVER SYSTEM

SURFACE WATER

BASIC HUMAN NEEDS RESERVE



TECHNICAL COMPONENT: LOWER VAAL

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EXECUTIVE SUMMARY

The CD: RDM has initiated the Comprehensive Reserve Determination Study for the Integrated Vaal River System: Lower Vaal Water Management Area (WMA) surface water quantity. The purpose of the Comprehensive Reserve Determination Study for the water resources of the Lower Vaal WMA is to determine the ecological and basic human needs water quantity Reserve for the rivers and pans in the WMA

As part of the Reserve Determination process it is necessary that the Basic Human Needs Reserve (BHNR) requirements is determined to understand the likely direct users of the surface water resources of the catchment so these uses are quantified and accounted for in the Reserve. This report is therefore focused on understanding and determining for the water resources in Lower Vaal WMA the BHNR component.

The Lower Vaal WMA has a population of about 1,3 million, with approximately 0,7 million being urban and 0,6 million being rural population (DWAF, 2004). The largest concentration of urban population is in Kimberley. There are large rural populations in areas west of Mafikeng, around Kuruman, Pampierstad and Lichtenberg.

The economy of the Lower Vaal WMA is relatively small, with the WMA generating about 2% of the Gross Domestic Product of South Africa (DWAF, 2003). The economy is still dominated by mining, however much of the beneficiation is done in other areas. Kimberley is the largest urban centre in the area. Most of the economic activity is concentrated in Kimberley and at other major mining areas. Manufacturing activities in the WMA include cement and cheese factories and relate to the agriculture sectors as well as items for local consumption. The trade sector is concentrated in wholesale of primary products and related services to the community. No significant changes to the economy of the WMA are foreseen over the medium term. The agricultural and mining sectors in the region are strong and will continue to make an important contribution to the regional economy.

The Lower Vaal WMA also shows minimal potential for strong economic growth, and thus a low population growth is projected. Consequently, limited growth in water requirements is expected.

The process followed in determining the BHNR for the Lower Vaal WMA was as per that specified by the CD: RDM. The BHNR was analysed using the following factors:

- The population of those living within the catchment (per quaternary) was determined based on the 1991 census and extensive field verification done in 1994. The estimated growth in this population was determined up to 2020. This estimate is based on Census 2001 and updated with the DWAF, National Water Services project progress and project implementation from October 2001 to March 2007.

- The per capita requirements (litres/day) of the total population based on the life line amount of 25 litres per person per day was determined; and
- The mean annual runoff (MAR) of the catchment areas in question.

Based on the above the BHNR was calculated for the quaternary catchments in the Lower Vaal WMA and Modder Riet catchment is presented in this report.

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ACRONYMS

BHNR	Basic Human Needs Reserve
CD:RDM	Chief Directorate: Resource Directed Measures
DWAF	Department of Water Affairs and Forestry
ISP	Internal Strategic Perspective
MCM	Million cubic meters
WMA	Water Management Area
RDM	Resource Directed Measures
RDP	Reconstruction and Development Programme
nMAR	Naturalised Mean Annual Runoff
WRC	Water Research Commission

***Comprehensive Reserve Determination Study for the Integrated Vaal River System:
Lower Vaal Water Management Area***

BASIC HUMAN NEEDS RESERVE REPORT

1 INTRODUCTION

The National Water Act (Act No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without seriously affecting the functioning of the water resource systems. In order to achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of resource directed measures (RDM). As part of the RDM, a Reserve has to be determined for a significant water resource, as means to ensure a desired level of protection.

The Chief Directorate: Resource Directed Measures (CD:RDM) is tasked with the responsibility of ensuring that the Reserve requirements, which have priority over other uses in terms of the Act, are determined before any new water uses are authorised.

In this the CD: RDM has initiated the Comprehensive Reserve Determination Study for the Integrated Vaal River System: Lower Vaal Water Management Area (WMA) surface water quantity (technical component). The purpose of the Comprehensive Reserve Determination Study for the water resources of the Lower Vaal WMA is to determine the ecological and basic human needs water quantity Reserve for the rivers and pans in the WMA at the highest possible level of confidence given data, budget and time constraints.

The study area to be covered as part of this study is part Lower Vaal WMA and part of the Upper Orange (

Figure 1). The Comprehensive Reserve Determination Study for the Integrated Vaal River System: Lower Vaal Water Management Area (WMA) comprises eight tasks which are depicted in **Figure 2**.

As part of the Reserve Determination process it is necessary that the Basic Human Needs Reserve (BHNR) requirements is determined to understand the likely direct users of the surface water resources of the catchment so these uses are quantified and accounted for in the Reserve.

This task is therefore focused on understanding and determining for the water resources in Vaal River System within the Lower Vaal and Upper Orange WMAs the BHNR component.

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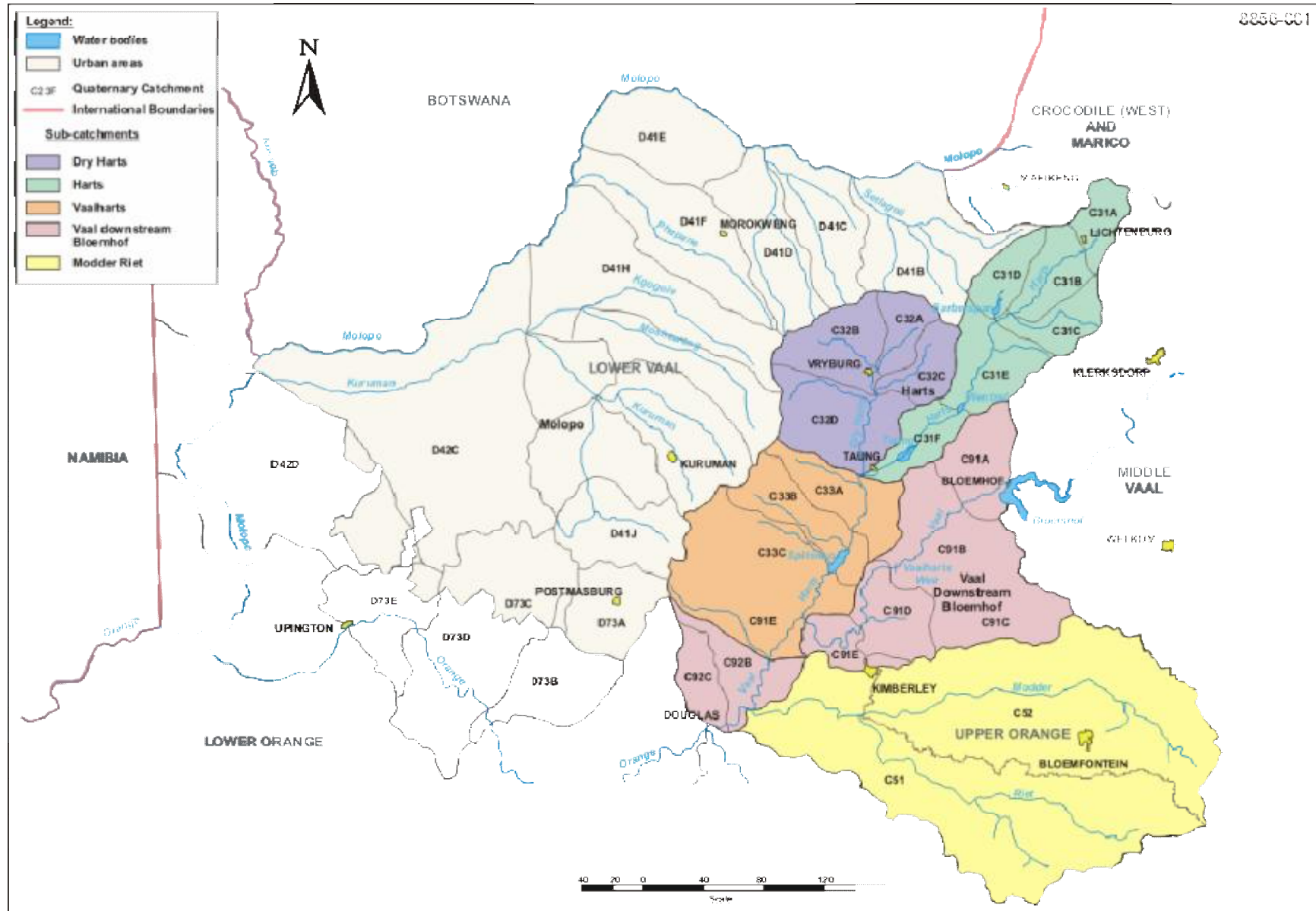


Figure 1: Study area: Vaal River system in Lower Vaal WMA and Upper Orange WMA

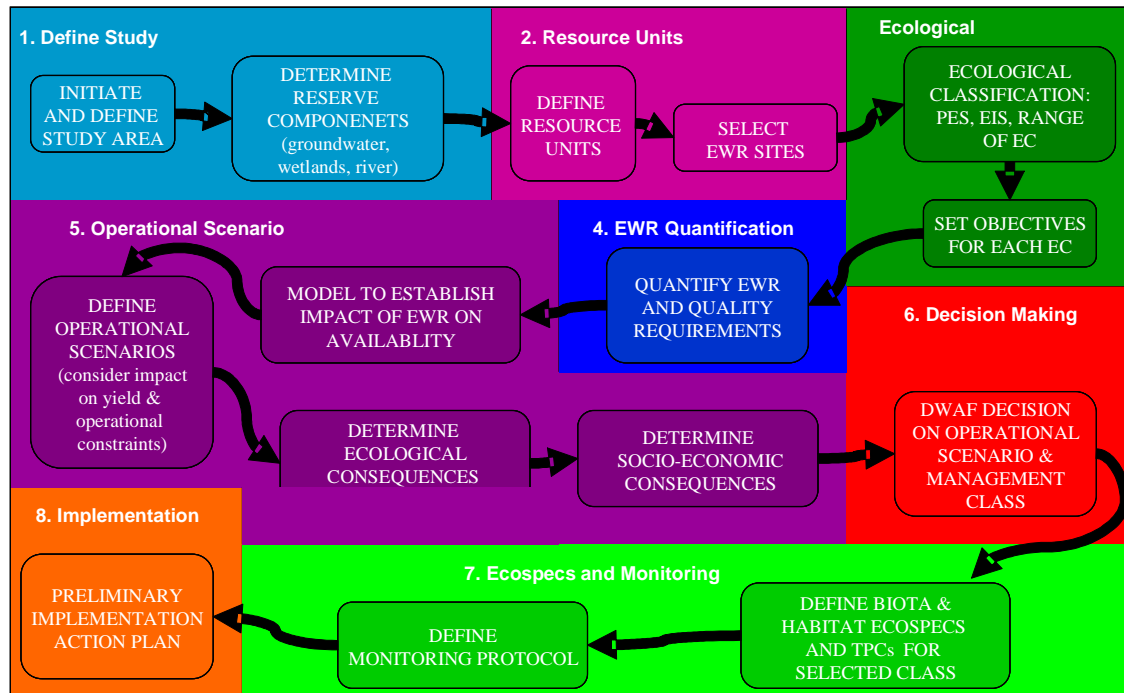


Figure 2: The generic 8-step Ecological Reserve Procedure (from DWAF 2003).

2 OVERVIEW AND BACKGROUND TO THE LOWER VAAL WMA

The Lower Vaal WMA is situated in the north-western part of the country and forms part of the Orange River watercourse. It covers a catchment area of 133 354 km², and includes parts of the Northern Cape and North-West Provinces, and a small part of the Free State Province. The Vaal River is the only major river in the WMA, as it flows in a westerly direction from Bloemhof Dam to the confluence with the Orange River. The largest part of the WMA falls within the catchment of the Molopo River, a tributary of the Orange River. The Molopo, Nossob and Kuruman rivers drain the remainder of the WMA but due to the very low rainfall in the WMA, these rivers are insignificant. The WMA consists of the D41 (excluding D41A), parts of D42C and D42D, parts of D73A and D73C, C31, C32, C33, C91, and C92 tertiary catchments. For the purpose of this study only the C drainage region is of relevance as it forms part of the Vaal River System, which includes the Harts River catchment and the Vaal River catchment. These two catchments as part of the Vaal River System cover a catchment area of 53 500km² within the Lower Vaal WMA. The C drainage region of the Lower WMA comprises four sub-catchments as listed in **Table 1**.

Table 1: Sub-catchments and related quaternary drainage regions within the C Drainage tertiary Catchment within the Lower Vaal WMA (DWAF, 2006)

PRIMARY CATCHMENT	SUB-CATCHMENT	QUARTENARY CATCHMENTS	AVERAGE GROSS AREA (Km ²)
C	Dry Harts	C32A-D	10 205
	Harts	C31A-F	11 023
	Vaalharts	C33A-C	9843
	Vaal downstream Bloemhof	C91A-E, C92A-C	22 427

This WMA has relatively flat terrain with no distinct topographic features. The WMA has no climatic barriers and thus climate varies gradually according to the larger regional patterns, and is fairly uniform from east to west. The average temperature for the WMA is 16°C. The rainfall is strongly seasonal occurring mainly in the summer months. The overall feature of the mean annual precipitation over the WMA is that it decreases fairly uniformly westwards from the western parts of the North West Province to the eastern parts of the Northern Cape Province. Mean annual rainfall precipitation ranges between 100mm in the west and 500mm to the east of the WMA. Mean annual evaporation can reach as high as 2800 mm per year which is in excess of rainfall.

As a result of the arid climate, vegetation over the WMA is sparse, consisting mainly of grassland and some thorn trees (notably the majestic camel thorns). The WMA is dominated by tropical bush and savannah with small areas of pure grassveld to the east.

Virtually all the surface flow of the Vaal River, the main source of water in the Lower Vaal WMA, originates from the Upper and Middle Vaal WMAs. Very little surface run-off originates within the WMA itself due to the low rainfall, flat topography and sandy soils. The groundwater resource is more substantial, supplying an estimated 128 million m³/annum. The Vaal River is fed by the only tributary, the Harts River which drains a catchment area of 31 000km², with the Dry Harts being the major tributary of the Harts River, joining it just downstream of Taung. The only lake and wetlands of note are at Barberspan in the Upper Harts River catchment which has been given Ramsar status as a wildlife conservation area.

The development of the surface water resources occurring in the WMA has reached its potential, however all water is not being fully utilised. The water in Taung Dam and Spitskop Dam are currently not utilised and further studies are required to determine best how to utilise the water contained in these dams. There are several large dams that have been developed in the WMA. The main dams are listed in **The Lower Vaal WMA** is dependant on the Upper Vaal and Middle Vaal WMAs for supply of utilisable surface water resources, with over 90% of the water required being sourced through releases from the Upper Vaal WMA and from Bloemhof Dam. More than 50% of the yield from natural water resources in the tributary catchments within the WMA is supplied from groundwater.

Table 2.

The Lower Vaal WMA is dependant on the Upper Vaal and Middle Vaal WMAs for supply of utilisable surface water resources, with over 90% of the water required being sourced through releases from the Upper Vaal WMA and from Bloemhof Dam. More than 50% of the yield from natural water resources in the tributary catchments within the WMA is supplied from groundwater.

Table 2: Major Dams in the Lower Vaal WMA (DWAF 2006)

Dam name	Quaternary catchment	River	Purpose	Full Storage Capacity million m ³
Boegoeberg	D73B	Oranje	Irrigation	20.3
Douglas Weir	C92B	Vaal	Information	16.7
Spitskop	C33B	Harts	Irrigation	56.6
Taung Dam	C31F	Harts	Irrigation	6.6
Vaalharts Weir	C91B	Vaal	Domestic	48.7
Wentzel	C31E	Harts	Irrigation	6.6

Most of the water is used for urban, agricultural and mining purposes within the WMA. Water is also transferred into the WMA from the Upper Orange WMA into Douglas Weir.

The water quality of the rivers in the WMA is of acceptable quality, but do exhibit high turbidity at times.

3 DEMOGRAPHY

The Lower Vaal WMA has a population of about 1,3 million, with approximately 0,7 million being urban and 0,6 million being rural population (DWAF, 2004). The largest concentration of urban population is in Kimberley. There are large rural populations in areas west of Mafikeng, around Kuruman, Pampierstad and Lichtenberg.

4 DEVELOPMENTAL ATTRIBUTES

The economy of the Lower Vaal WMA is relatively small, with the WMA generating about 2% of the Gross Domestic Product of South Africa (DWAF, 2003). The economy is still dominated by mining, however much of the beneficiation is done in other areas. Kimberley is the largest urban centre in the area. Most of the economic activity is concentrated in Kimberley and at other major mining areas. Manufacturing activities in the WMA include cement and cheese factories and relate to the agriculture sectors as well as items for local consumption. The trade sector is concentrated in wholesale of primary products and related services to the community. No significant changes to the economy of the WMA are foreseen over the medium term. The agricultural and mining sectors in the region are strong and will continue to make an important contribution to the regional economy.

The Lower Vaal WMA also shows minimal potential for strong economic growth, and thus a low population growth is projected. Consequently, limited growth in water requirements is expected.

5 LAND USE

Early development in the Lower Vaal WMA began in the early 1800's with large scale cultivation, and was later influenced by the discovery of diamonds near Kimberly and later in Bloemhof/Christiana. Another major development which influenced the present character of development was the establishment of the Vaalharts irrigation scheme in the mid 1930s. Current land use in the WMA, due to the arid climate is characterised by extensive livestock farming as the main activity and large scale dry land cultivation in the north eastern part of the WMA. Intensive irrigation (about 80% of water use) is practised at Vaalharts, as well as at locations along the Vaal River. The most significant urban area in the WMA is Kimberley to the South, which borders on the Upper Orange WMA as well. Several towns as well as scattered rural settlements are found mainly in the central and eastern part of the WMA. Iron ore, diamonds and manganese are mined in the WMA.

About 1 220 km² of the land in the Lower Vaal WMA is currently used. Of this urbanisation accounts for 23% of that use, irrigation 40% and alien vegetation 37% (DWAF, 2002b).

5.1 Agricultural activities

Agricultural land use within the Lower Vaal WMA is dominated by stock farming. The reason for this is that most of the area is too dry to support dry-land crops. Livestock farming includes beef and dairy cattle, goats, non-wooled sheep, pigs and ostriches. In the east of the WMA, especially in the vicinity of Lichtenberg and Delareyville, dry-land crops (maize, sunflower, cotton, groundnuts and vegetables) are grown, but it is debatable whether or not this is commercially viable due to the low and erratic rainfall. There are large areas under irrigated crops in the Vaalharts area, but compared to the total area of the WMA, this area is small. The largest irrigation scheme is the Vaalharts Government Water Scheme, which is supplied via the Vaalharts weir with support from Bloemhof Dam.

It is generally recognised that future growth in irrigation will be severely limited by the availability of water. In more water-scarce areas it may even become necessary to curtail some irrigation to meet the growing requirements of domestic and urban water use.

5.2 Urban Areas

The urban areas occurring with the Lower Vaal WMA are listed in **Table 3** and shown in **Figure 3****Error! Reference source not found..** The WMA exhibits very little urbanisation with the significant urban areas being Kimberley in the South, which lies only partly in the WMA, Lichtenburg in the north-east and Kuruman in the central part of the WMA. Other towns include Schweizer Reineke, Jan Kempdorp, Pampierstad, Christiana, Warrenton, Riverton, Delpportshoop, Olifantshoek and Postmasburg. The Kalahari East Water Board and the North West Supply Authority are two water

boards responsible for supplying bulk water to the users in the areas in the WMA. The large urban users are heavily dependent on water transferred into this WMA from the Upper Vaal WMA.

Table 3: Major towns in the Lower Vaal WMA (DWAF, 2006)

Quaternary	Towns
Dry Harts sub-catchment area:	
C32A	Stella
C32B	Vryburg
Harts sub-catchment area:	
C31A	Lichtenburg
C31E	Delareyville
C31F	Taung
Vaalharts sub-catchment area:	
C33A	Pampierstad
C33B	Jan Kempdorp
Vaal downstream Bloemhof sub-catchment area:	
C91A	Bloemhof
C91B	Christiana & Hertzogville
C91C	Boshof
C91D	Warrenton
C91E	Kimberley
C92C	Douglas

6 OVERVIEW OF THE MODDER RIET CATCHMENT

The Modder Riet catchment is situated in the Free State and Northern Cape Provinces. It is part of the Upper Orange WMA, but forms part of the C drainage region (Vaal River System). It covers a catchment area of 35 000 km². The Modder and Riet Rivers are the only major rivers in the catchment, which drain into the Vaal River which subsequently flows into the Orange River. The catchment includes Kalkfontein, Rustfontein, Tierpoort, Groothoek and Krugersdrift Dams. The catchment comprises two sub-catchment areas as listed in Table 4.

Table 4: Sub-catchments within the C drainage tertiary catchment of the Upper Orange WMA (DWAF, 2006)

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PRIMARY CATCHMENT	SUB-CATCHMENT AREA	QUARTENARY CATCHMENTS	AVERAGE GROSS AREA (km ²)
C	Modder	C52A-L	17 366
	Riet	C51A-M	17 449

The Riet River generally flows in a north-westerly, to the confluence with the Vaal River. The Tierpoort dam which is used for irrigation purposes is situated on the tributary of the Riet River, and the Kalkfontein Dam which supplies water to the Riet River Government Water Scheme, is located just downstream of the confluence of the Kromellenboogspruit and Riet Rivers. The Modder River is the main tributary of the Riet River and joins the Riet River just upstream of Ritchie. The Modder River has its source in the high hills at the watershed near Dewetsdorp (1600m above mean sea level). The Krugersdrift Dam is located on the Modder River. Most of the natural runoff into the Modder River is from above the confluence of the Modder and Klein Modder Rivers. The rest of the Modder River catchment is very flat and very little runoff occurs (DWAF, 2002a).

6.1 Developmental attributes and Land Use

Current land use in the catchment is related agricultural activities, urbanisation and mining and industrial activities. In the Modder and Riet River catchments agricultural use comprises primarily the irrigation of crops. Agricultural activities are concentrated around the dams in the catchment. Livestock watering also occurs, but to a lesser extent (DWAF, 2002).

The major urban centres in the catchment are Bloemfontein, Botshabelo and Thabu Nchu whose collective population is 1.2 million people. The Modder River is a major source of water to these urban areas. Most industries in the Modder and Riet catchments are centred around Bloemfontein and use treated water from the municipal supply system. Only one industry that uses water directly out of the river is known. This is the diamond mining operation at Koffiefontein. The diamond mine at Koffiefontein is an underground mine that mines Kimberlite from a pipe. Aside from the ecological and domestic needs of the rivers, both rivers support recreational use at the dams.

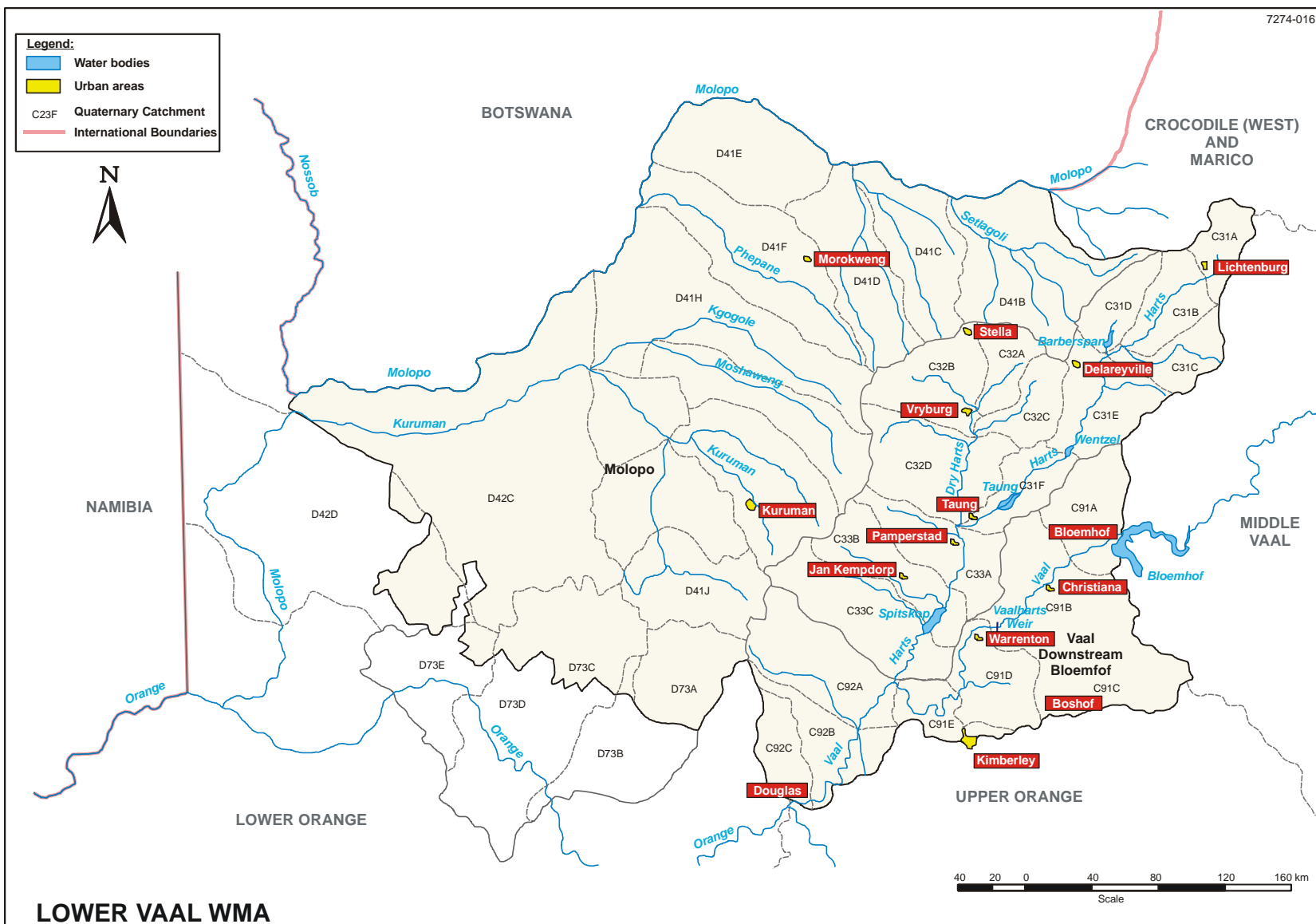


Figure 3: Major towns in Lower Vaal WMA

7 THE BASIC HUMANS NEED RESERVE FOR THE LOWER VAAL WMA

7.1 Introduction

The Reserve is defined in terms of the National Water Act, Act No. 36 of 1998 as: “The quantity and quality of water required to satisfy basic human needs and to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource”.

In terms of the above definition the Reserve comprises two distinct components viz.:

- The Basic Human needs Reserve (BHNR), and
- The Ecological Reserve.

The focus of this task is to determine the BHNR for the Lower Vaal WMA and Modder Riet catchment.

The BHNR provides for the essential needs of individuals served by the water resource in question and includes water for drinking, food preparation and for personal hygiene. A life-line amount of 25 litres per person per day has been adopted for the BHNR by DWAF (Water Supply and Sanitation Policy White Paper, 1994) which is aligned to the Reconstruction and Development Programme (RDP) targets of Government of 25 litres per person per day, as well as the World Health Organisation minimum standards.

7.2 Methodology

The process followed in determining the BHNR for the Lower Vaal WMA and Modder Riet catchment was as per that specified by the CD: RDM. The BHNR was analysed using the following factors:

- The population of those living within the catchment (per quaternary);
- The per capita requirements (litres/day) of the total population based on the life line amount of 25 litres per person per day; and
- The mean annual runoff (MAR) of the catchment areas in question.

In terms of the above factors the following applied terms of the Lower Vaal WMA and Modder Riet catchment.

7.2.1 Population

The basic human needs Reserve was calculated from population water requirements provided by Chief Directorate: Water Services, Directorate: Community Water Planning. The population figures used were based on the 1991 census and extensive field verification project initiated in 1994. The total population of the quaternary catchment was used to calculate the basic human needs Reserve at the

outlet of the quaternary catchment. Population figures were not available for all quaternary catchments. This was either due to lack of information or the area not being populated.

Although the population figures from the 2001 National census are available, these figures are only available at a municipal demarcation boundary level. The DWAF has not yet disaggregated the population figures to quaternary catchment boundary level as per personal communication of the Sub-directorate Systems Analysis.

The Water Services National Information System database (DWAF website, 2008) also provides an estimated growth in population per province. This estimate is based on Census 2001 and updated with the DWAF, National Water Services project progress and project implementation from October 2001 to March 2007. The average annual growth in population for Northern Cape Province is 0.57%, for North West Province is 0.52% and for the Free State Province is 0.60% growth. This projected growth was used as estimates for the population growth in Lower Vaal WMA and Upper Orange up to 2020.

7.2.2 Per capita requirements

The next step in the analysis is to multiply total population figures by possible BHNH water quantity targets. As such, from the population figures available a BHNH can be calculated. It should be noted that there is no “official” BHNH figure. The RDP target (Target 1), of 25 litres per person per day is conventionally used by DWAF as the basic human need requirement (DWAF, 1994).

7.2.3 Percentage of Mean Annual Runoff

The final step of the process is to determine what percentage of virgin Mean Annual Runoff (MAR) BHNH comprises. While the virgin MAR is preferred in the case of the Lower Vaal and Modder Riet catchment, the virgin MAR for each quaternary catchment was not available as the system hydrology has not been determined to quaternary catchment level. The hydrology has been grouped into blocks and it was not possible to disaggregate it to quaternary catchment level. The gross MAR per quaternary catchment was thus used (WRC, 1994).

7.4 The Results

The BHNH calculated for the Lower Vaal WMA and Modder Riet catchment is presented below in **Table 5**. The results of the analysis are also presented in **Figure 4** and **Figure 5**.

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Table 5: BHNR required for the Lower Vaal WMA and Modder Riet catchment

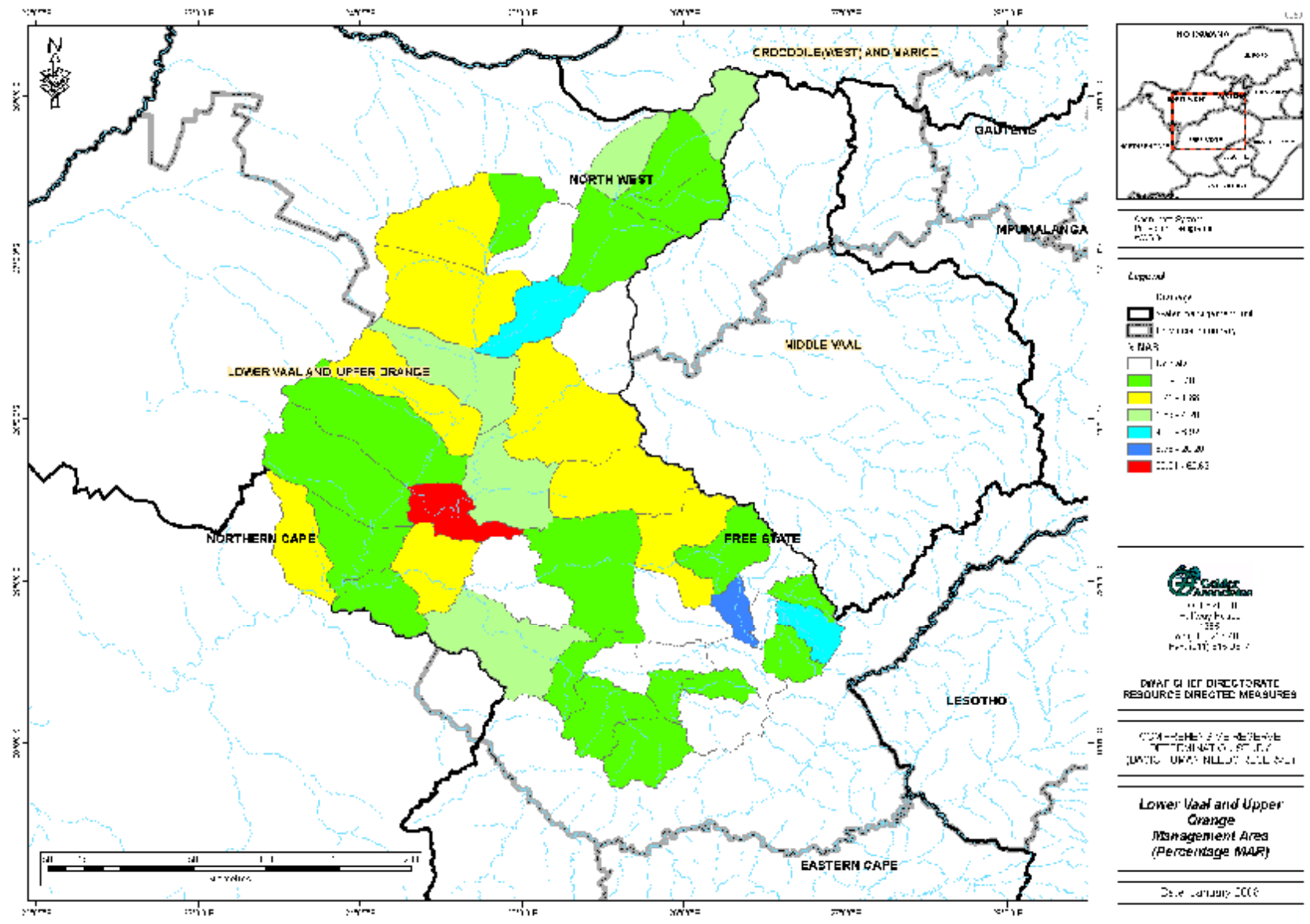
QUATERNARY CATCHMENT	TOTAL POPULATION	Annual % Growth	Population 2020	Per Capita need (liters/day)	Per Capita need (MCM/ Annum): Current	Per Capita need (MCM/ Annum): 2020	Gross MAR	%MAR
C91B	35,570	0.6	41,556	25	0.32	0.38	17.3	1.88
C91C	14,440	0.6	16,870	25	0.13	0.15	13.1	1.01
C91D	30,285	0.6	35,381	25	0.28	0.32	8	3.45
C91E	240,350	0.57	278,627	25	2.19	2.54	3.5	62.66
C31A	38,940	0.52	44,562	25	0.36	0.41	15	2.37
C31B	5,790	0.52	6,626	25	0.05	0.06	14.1	0.37
C31C	1,140	0.52	1,305	25	0.01	0.01	15.1	0.07
C31D	41,877	0.52	47,923	25	0.38	0.44	9.1	4.2
C31E	6,910	0.52	7,908	25	0.06	0.07	23.1	0.27
C31F	87,030	0.52	99,594	25	0.79	0.91	10.2	7.79
C32A	1,330	0.52	1,522	25	0.01	0.01	11.5	0.11
C32B	28,310	0.52	32,397	25	0.26	0.30	21.2	1.22
C32C	30	0.52	34	25	0	0.00	15	0
C32D	54,830	0.52	62,746	25	0.5	0.57	30.9	1.62
C33A	79,013	0.52	90,420	25	0.72	0.83	24.4	2.95
C33B	24,372	0.57	28,253	25	0.22	0.26	22	1.01
C33C	3,400	0.57	3,941	25	0.03	0.04	25.1	0.12
C92A	11,895	0.57	13,789	25	0.11	0.13	30.7	0.35
C92B		0.57					11.1	
C92C	15,738	0.57	18,244	25	0.14	0.17	10.2	1.41
C51A	4,365	0.6	5,100	25	0.04	0.05	18.9	0.21
C51B		0.6					43.4	
C51C	7,783	0.6	9,093	25	0.07	0.08	12.7	0.56
C51D		0.6					27	
C51E		0.6					17	
C51F		0.6					12.7	
C51G	7,535	0.6	8,803	25	0.07	0.08	34.8	0.2
C51H	13,412	0.6	15,669	25	0.12	0.14	31.7	0.39

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QUATERNARY CATCHMENT	TOTAL POPULATION	Annual % Growth	Population 2020	Per Capita need (liters/day)	Per Capita need (MCM/ Annum): Current	Per Capita need (MCM/ Annum): 2020	Gross MAR	%MAR
C51J	5,130	0.6	5,993	25	0.05	0.05	17.3	0.27
C51K	23,012	0.6	26,884	25	0.21	0.25	8.9	2.36
C51L	9,787	0.57	11,346	25	0.09	0.10	5	1.79
C51M	93	0.57	108	25	0	0.00	2.7	0.03
C52A	9,773	0.6	11,418	25	0.09	0.10	27.9	0.32
C52B	360,903	0.6	421,636	25	3.29	3.85	36.9	8.92
C52C	6,378	0.6	7,451	25	0.06	0.07	18.6	0.31
C52D		0.6					13.1	
C52E		0.6					20	
C52F	360,775	0.6	421,487	25	3.29	3.85	16.3	20.2
C52G	19,900	0.6	23,249	25	0.18	0.21	43.9	0.41
C52H	13,250	0.6	15,480	25	0.12	0.14	10.9	1.11
C52K	10,031	0.6	11,719	25	0.09	0.11	13.1	0.7

MCM: million cubic metres, MAR: mean annual runoff

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8 CONCLUSION

From the above analysis it is apparent that certain gaps exist with regard to the data which does impact on the BHNR to some extent. The limitations of the above results must be understood:

- The most up to date population data is not available at a quaternary catchment level of detail. The 1991 National census data (verified in 1994) is the most accurate that can be obtained at that level of resolution. While estimations can be made from the 2001 census data this does not reflect the realistic situation as this data may be disaggregated as required and is not accepted by DWAF. In addition the projected population growth is based on a provincial estimation and is not readily available for the WMA as a whole. This again is an estimation.
- Population statistics are not available for all the quaternary catchments. While the BHNR is available for the Vaal main stem, data is absent for parts of the Modder Riet catchment.
- The MAR used for the calculation is the gross MAR for the quaternary catchments. The virgin MAR for each of the quaternary catchments was not available. Virgin MAR is defined as the MAR present prior to any development of the catchment (pre-development / virgin landscape). Virgin MAR would thus not be a true reflection of the current situation in the catchments as the entire Vaal catchment has been developed to some extent by anthropogenic activities.

In consideration of the above the following conclusions can be drawn:

- The highest density of population is in the catchments that include urban areas (Figure 4): C91E (Kimberley), C33A and C31F (Taung), C52B (Thaba Nchu), C52F (Bloemfontein).
- The requirements of the BHNR in terms of the catchments' MAR is indicated in Table 6 and Figure 5:

Table 6: The Lower Vaal requirements of the BHNR in terms of the catchments' MAR.

BHNR: % of MAR	% of catchments
0.1 - 1.0	50
1 - 2.0	23.5
2.0 - 5.0	14.7
5.0 - 15	5.9
> 15	5.9

- From Table 6 it is apparent that 94% of the catchment area of the Lower Vaal/Modder Riet catchment area has a BHNR of less than 15% of the MAR. 50% of the catchments require a BHNR of less than 1% of the MAR.
- The catchments that do have some stress in terms of the BHNR requirements are:
 - C91E: Kimberley area – BHNR is approximately 63% of MAR,
 - C52F: Bloemfontein area – BHNR is approximately 20% of the MAR.

However these areas are urban areas and are serviced by potable water supply.

The BHNR is implemented to ensure that the basic needs of those persons who rely directly on the water resources are met. In order to quantify this to some extent in the WMA an estimate of the current population with no access to any form of formal water infrastructure was determined. This includes all people drinking "unsafe" water from a dam, spring, stream, river, etc. This estimate is based on Census 2001 and updated with the DWAF, National Water Services project progress and project implementation from October 2001 to March 2007 and is presented per province. The population without any basic services (no water infrastructure) for Northern Cape Province is 1.0%, North West Province is 7.0% and for the Free State Province is 1.0%.

The per capita requirements (litres/day) of the current estimate population with no access to any form of formal water infrastructure was determined (Table 7).

Table 7: The per capita requirements (litres/day) of the current estimate population with no access to any form of formal water infrastructure

BHNR: % of MAR	% of catchments
0.001 - 0.1	79.4
0.1 - 0.5	1.7
0.5 - 1.0	5.9

- From the above it is apparent that if the water requirements of the unserved population is only considered than the BHNR requirements are reduced significantly. In most parts of the Lower Vaal and Modder Riet catchment area the BHNR is less than 0.1% of the MAR.

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