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DETERMINATION OF ECOLOGICAL WATER REQUIREMENTS FOR SURFACE WATER (RIVER, ESTUARIES AND WETLANDS) AND GROUNDWATER IN THE LOWER ORANGE WMA

BASIC HUMAN NEEDS RESERVE REPORT

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

OCTOBER 2016

DETERMINATION OF ECOLOGICAL WATER REQUIREMENTS FOR SURFACE WATER (RIVER, ESTUARIES AND WETLANDS) AND GROUNDWATER IN THE LOWER ORANGE WMA

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DOCUMENT INDEX

Index Number	DWS Report Number	Report Title
1	RDM/WMA06/00/CON/COMP/0115	Inception report
2	RDM/WMA06/00/CON/COMP/0116	Resource Unit report
3	RDM/WMA06/00/CON/COMP/0216	River EWR report
4	RDM/WMA06/00/CON/COMP/0316	Buffels, Sout, Swartlintjies, Spoeg, Groen Estuary EWR report
5	RDM/WMA06/00/CON/COMP/0416	Groundwater EWR report
6	**RDM/WMA06/00/CON/COMP/0516**	**BHNR report**
7	RDM/WMA06/00/CON/COMP/0616	Wetland EWR report
8	RDM/WMA06/00/CON/COMP/0117	Report on consequences of scenarios
9	RDM/WMA06/00/CON/COMP/0217	Ecological specifications and monitoring report
10	RDM/WMA06/00/CON/COMP/0317	Main Summary report
11	RDM/WMA06/00/CON/COMP/0417	Close-out report
12	RDM/WMA06/00/CON/COMP/0517	Electronic data

DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

DETERMINATION OF ECOLOGICAL WATER REQUIREMENTS FOR SURFACE WATER (RIVER, ESTUARIES AND WETLANDS) AND GROUNDWATER IN THE LOWER ORANGE WMA

BASIC HUMAN NEEDS RESERVE REPORT

Approved for RFA by:

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Delana Louw
Project Manager

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Date

DEPARTMENT OF WATER AND SANITATION (DWS)
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First draft	October 2016
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EXECUTIVE SUMMARY

BACKGROUND

The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study for the provision of professional services to undertake the 'Determination of Ecological Water Requirements for Surface Water (Rivers, Estuaries and wetlands) and Groundwater in the Lower Orange Water Management Area (WMA). Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

There is a need to undertake detailed Ecological Water Requirement (EWR) and Basic Human Needs (BHN) studies for various water resource components due to mainly:

- Hydraulic fracturing (HF) that could be undertaken in the Water Management Area (WMA).
- Various water use licence applications.
- The conservation status of various Resources in this catchment; and
- The associated impacts of proposed developments will have on the availability of water.

STUDY AREA

The focus area of the study comprises only the South African portion of the Lower Orange River Catchment. The Eastern Boundary starts where the Vaal River enters the Orange River, and the Western Boundary is the Atlantic Ocean. The study area is downstream of the Upper Orange, Senqu, and the Integrated Vaal River System and as such, affected by the upstream activities in the highly-developed river basin. The Orange River forms the border between the Republic of South Africa (RSA) and Namibia to the west of 20 degrees longitude over a distance of approximately 550 km.

PURPOSE OF REPORT

The National Water Act (36 of 1998) ensures that everyone has access to sufficient water by setting aside a certain amount of water to meet everyone's basic needs. This amount of water set aside for basic human needs is called the Basic Human Needs (BHN). The BHN is based upon the current and projected population of those either living within the catchment and directly dependent on the catchment or, critically, not being supplied with water from a recognised formal source. It does not include the population outside of the catchment who may be utilising the water. This report sets out the results of the analysis of the population within the study area with respect to the BHN.

APPROACH

In order to calculate the BHN the following steps were specifically undertaken:

- Analysis was based on quaternary division. There are 145 quaternary divisions each of which were analysed by source of water and by households and individuals who are dependent on these sources. While the national census asks respondents about their water source it reports these in an amalgamated fashion using its own geographical conglomeration. As these do not coincide with quaternary divisions the results were reanalysed to ensure that the population is allocated to the relevant quaternary. This was done using Geographical Information System (GIS) technology.
- Quaternary catchment boundaries were superimposed upon the smallest aggregations of census data available. For the 2011 National census these are known as "sub-place names". All "sub-place names" either wholly or partially within the quaternary catchments were captured. Where "sub-place names" were partially within the quaternary catchments then the percentage area that fell within was applied to the population. As such, where a "sub-place name" was only 50%

within a quaternary catchment then only 50% of the population was deemed to fall within the area. The total population for the Lower Orange River WMA, as recorded by the 2011 Census, was 451,620. Extrapolated to 2016 using an average growth rate of 0.25%[1] for the years for 2011 to current a population figure for 2016 of 457,324 is derived.

- Those receiving water from a recognised formal water source and therefore not likely to be dependent direct river abstraction were excluded. Given the nature of the WMA, as set out in Section 2, most the population fall within the ambit of those likely to be receiving a formal water supply. The remainder are deemed to be part of the "qualifying population".
- For the purposes of the BHN calculation, estimating the population likely to be BHN dependent were classified as those dependent on boreholes, springs, dams and pools, rivers and streams, water tankers and other means of supply but excluding formal water schemes. The 2016 population in this category was estimated at 95,957[2].
- Those dependent on boreholes were excluded from the BHN calculations as these were deemed to be part of the Groundwater Reserve and covered in report RDM/WMA06/00/CON/COMP/0416. As such the final population that was included in the BHN amounted to 55,901 people or 95,957 if those reliant on non formal water scheme groundwater are included.
- The BHNR was initially calculated at 25l per day per person. The number was aligned with initial RDP targets set as minimum standards for the South African population. During 2002 (Thukela Reserve study) and confirmed during the description of the method (DWAF, 2008) the DWS suggested that more acceptable volumes of water per day such as 55 or 60 liters was also to be investigated. This was confirmed and stated as part of the recent study providing frameworks for the Reserve and describing available tools (DWS 2016). It must therefore be noted that the BHN during this step of a Reserve study is calculated for various scenarios that includes 25 and 60 litres and as for the Ecological Reserve, the DWS will then determine which is suitable for the Reserve or Preliminary Reserve to be accepted.

RESULTS

The BHN for this portion of the population, with models assuming allocations of 25l of water per capita (person) per day (l/c/d) were then calculated as per Table below. This is also reported at the quaternary division level (see Appendix A).

Summary of BHN at 25 litres per person per day

Total Population	457,324	**Cubic metres per day**	**Million m³/a**
Population not serviced	95,957		
Population not serviced excluding borehole	55,901		
Population borehole dependent	40,056		
Surface water BHN 1: @ 25 l/c/d - excluding those on a formal scheme	1,378,947	1,378	0,503
Groundwater BHN 1@ 25 l/c/d - excluding those on a formal scheme	1,019,980	1,019	0,373
BHN 1: @ 25 l/c/d including borehole dependent -- excluding those on a formal scheme	2,398,926	2,399	0,876

In terms of million m³/a the surface water volume (obviously excluding groundwater) would be 0,503 at BHNR1 levels at 25l per person per day. The bulk of surface water abstraction is from the Orange

[1] The population of the WMA is growing at a slower rate than the national average of 1.00% per annum and reflects lack of economic opportunities in the general area and out migration.
[2] The figure for 2016 is virtually identical for 2011 as little no growth is expected in this sector of the population.

River although there is other ad hoc and seasonal abstraction of surface water from other sources. Including groundwater usage, and in terms of million m^3/a the volume would be 0,876 at BHNR1 levels at 25l per person per day. At 60 litres per person per day the figures are as per the table below

Summary of BHNR at 60 litres per person per day

Total Population	457,324	**Cubic metres per day**	**Million m^3/a**
Population not serviced	95,957		
Population not serviced excluding borehole	55,901		
Population borehole dependant	40,056		
Surface water BHNR 1: @ 25 l/c/d - excluding those on a formal scheme	3,354,059	3,354	1.216
Groundwater BHNR 1@ 25 l/c/d - excluding those on a formal scheme	2,403,363	2,403	0.877
BHNR 1: @ 25 l/c/d including borehole dependant -- excluding those on a formal scheme	5,757,423	5,757	2.101

The BHNR can be split into the surface and groundwater component of the BHNR to avoid double accounting. The Groundwater component of the BHNR utilised in this study was the proportion of people reliant on groundwater without a formal source of supply.

The BHN for the Lower Orange WMA at quaternary level

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	GW dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
C51M	627	342	53.898	0.006	0.003	0.003
C92B	1641	1106	51.725	0.015	0.010	0.005
C92C	3496	1359	6.180	0.032	0.012	0.019
D33K	157	100	7.564	0.001	0.001	0.001
D42A	365	284	84.533	0.003	0.003	0.001
D42B	425	323	91.938	0.004	0.003	0.001
D42C	3192	1918	72.419	0.029	0.018	0.011
D42D	3356	1622	75.921	0.031	0.015	0.015
D42E	2408	804	27.591	0.022	0.007	0.014
D51A	171	158	99.636	0.002	0.001	0.000
D51B	89	80	92.136	0.001	0.001	0.000
D51C	53	47	92.022	0.000	0.000	0.000
D52A	39	36	92.149	0.000	0.000	0.000
D52B	65	59	92.149	0.001	0.001	0.000
D52C	47	42	92.101	0.000	0.000	0.000
D52D	70	62	91.860	0.001	0.001	0.000
D52E	66	58	91.860	0.001	0.001	0.000
D52F	125	109	91.860	0.001	0.001	0.000
D53A	711	186	34.142	0.006	0.002	0.005
D53B	626	174	55.761	0.006	0.002	0.004
D53C	1522	175	77.491	0.014	0.002	0.012
D53D	1299	142	28.581	0.012	0.001	0.010
D53E	602	64	28.339	0.005	0.001	0.005
D53F	1115	512	51.464	0.010	0.005	0.005
D53G	2984	356	28.942	0.027	0.004	0.024

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	GW dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
D53H	1149	121	28.339	0.010	0.001	0.009
D53J	884	76	6.212	0.008	0.001	0.007
D54A	180	155	86.689	0.002	0.001	0.000
D54B	907	715	97.845	0.008	0.007	0.002
D54C	159	137	86.689	0.001	0.001	0.000
D54D	752	522	73.185	0.007	0.005	0.002
D54E	354	316	90.572	0.003	0.003	0.000
D54F	430	373	89.191	0.004	0.003	0.001
D54G	1091	499	48.523	0.010	0.005	0.005
D55A	560	519	94.326	0.005	0.005	0.000
D55B	132	119	91.734	0.001	0.001	0.000
D55C	175	155	92.092	0.002	0.001	0.000
D55D	382	324	96.328	0.003	0.003	0.001
D55E	347	303	98.779	0.003	0.003	0.000
D55F	393	335	87.207	0.004	0.003	0.001
D55G	192	165	88.267	0.002	0.002	0.000
D55H	118	107	92.149	0.001	0.001	0.000
D55J	202	184	92.149	0.002	0.002	0.000
D55K	127	115	92.149	0.001	0.001	0.000
D55L	263	220	98.844	0.002	0.002	0.000
D55M	184	167	92.137	0.002	0.002	0.000
D56A	52	47	92.149	0.000	0.000	0.000
D56B	54	49	92.057	0.000	0.000	0.000
D56C	95	86	92.149	0.001	0.001	0.000
D56D	62	56	92.149	0.001	0.001	0.000
D56E	69	62	92.149	0.001	0.001	0.000
D56F	105	95	92.149	0.001	0.001	0.000
D56G	65	59	92.149	0.001	0.001	0.000
D56H	46	41	92.149	0.000	0.000	0.000
D56J	95	86	92.149	0.001	0.001	0.000
D57A	91	80	91.975	0.001	0.001	0.000
D57B	232	210	92.149	0.002	0.002	0.000
D57C	126	92	97.943	0.001	0.001	0.000
D57D	770	577	91.996	0.007	0.005	0.002
D57E	1115	178	32.247	0.010	0.002	0.008
D58A	83	73	91.918	0.001	0.001	0.000
D58B	156	133	94.882	0.001	0.001	0.000
D58C	275	242	91.895	0.003	0.002	0.000
D61A	1031	407	89.109	0.009	0.004	0.005
D61B	240	195	85.451	0.002	0.002	0.000
D61C	211	178	86.661	0.002	0.002	0.000
D61D	117	99	86.419	0.001	0.001	0.000
D61E	704	378	96.356	0.006	0.004	0.003
D61F	158	132	86.419	0.001	0.001	0.000
D61G	136	114	86.419	0.001	0.001	0.000
D61H	198	166	86.419	0.002	0.002	0.000
D61J	243	206	86.508	0.002	0.002	0.000
D61K	247	213	87.452	0.002	0.002	0.000

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	GW dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
D61L	187	167	90.364	0.002	0.002	0.000
D61M	172	152	89.541	0.002	0.001	0.000
D62A	962	817	97.510	0.009	0.008	0.001
D62B	648	546	94.182	0.006	0.005	0.001
D62C	562	498	96.043	0.005	0.005	0.001
D62D	1269	923	98.969	0.012	0.009	0.003
D62E	357	321	90.759	0.003	0.003	0.000
D62F	350	297	86.279	0.003	0.003	0.000
D62G	2298	2130	95.210	0.021	0.019	0.001
D62H	342	238	70.152	0.003	0.002	0.001
D62J	416	289	70.521	0.004	0.003	0.001
D71A	414	243	61.223	0.004	0.002	0.002
D71B	1396	828	92.625	0.013	0.008	0.005
D71C	432	271	64.613	0.004	0.003	0.001
D71D	645	382	87.249	0.006	0.004	0.002
D72A	464	234	10.324	0.004	0.002	0.002
D72B	1166	580	4.466	0.011	0.005	0.005
D72C	934	564	89.099	0.009	0.005	0.003
D73A	5098	1504	100.000	0.047	0.014	0.033
D73B	1466	807	57.826	0.013	0.008	0.006
D73C	1754	1150	82.721	0.016	0.011	0.005
D73D	3339	713	5.470	0.030	0.007	0.024
D73E	2352	524	2.256	0.021	0.005	0.017
D73F	9112	1148	1.300	0.083	0.011	0.073
D81A	4225	523	5.770	0.039	0.005	0.034
D81B	501	51	36.847	0.005	0.001	0.004
D81C	1401	211	34.836	0.013	0.002	0.011
D81D	1313	139	28.339	0.012	0.001	0.011
D81E	707	110	9.023	0.006	0.001	0.005
D81F	1143	169	61.055	0.010	0.002	0.009
D81G	560	134	2.505	0.005	0.001	0.004
D82A	411	107	69.435	0.004	0.001	0.003
D82B	556	195	40.139	0.005	0.002	0.003
D82C	774	235	8.514	0.007	0.002	0.005
D82D	635	176	4.062	0.006	0.002	0.004
D82E	126	42	47.288	0.001	0.000	0.001
D82F	184	45	8.094	0.002	0.000	0.001
D82G	199	43	6.294	0.002	0.000	0.001
D82H	37	20	96.873	0.000	0.000	0.000
D82J	8	3	34.831	0.000	0.000	0.000
D82K	296	102	81.849	0.003	0.001	0.002
D82L	439	86	2.637	0.004	0.001	0.003
F10A	7	2	34.831	0.000	0.000	0.000
F10B	17	5	34.831	0.000	0.000	0.000
F10C	19	6	34.831	0.000	0.000	0.000
F20A	54	17	43.407	0.000	0.000	0.000
F20B	29	9	44.291	0.000	0.000	0.000
F20C	168	99	81.666	0.002	0.001	0.001

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	GW dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
F20D	112	15	54.956	0.001	0.000	0.001
F20E	14	5	67.545	0.000	0.000	0.000
F30A	401	280	93.266	0.004	0.003	0.001
F30B	207	69	58.267	0.002	0.001	0.001
F30C	330	142	93.525	0.003	0.001	0.002
F30D	457	118	97.249	0.004	0.001	0.003
F30E	543	191	4.411	0.005	0.002	0.003
F30F	151	50	46.628	0.001	0.000	0.001
F30G	290	85	94.227	0.003	0.001	0.002
F40A	134	53	88.891	0.001	0.001	0.001
F40B	48	18	49.539	0.000	0.000	0.000
F40C	155	89	82.120	0.001	0.001	0.001
F40D	56	30	62.303	0.001	0.000	0.000
F40E	250	111	93.373	0.002	0.001	0.001
F40F	494	478	97.311	0.005	0.004	0.000
F40G	40	28	97.782	0.000	0.000	0.000
F40H	25	18	73.684	0.000	0.000	0.000
F50A	729	163	70.911	0.007	0.002	0.005
F50B	30	21	73.684	0.000	0.000	0.000
F50C	125	39	64.672	0.001	0.000	0.001
F50E	106	73	96.703	0.001	0.001	0.000
F50F	128	53	96.375	0.001	0.001	0.001
F50G	38	27	73.684	0.000	0.000	0.000
F60A	143	47	81.591	0.001	0.000	0.001
TOTAL	**95957**	**40056**		**0.876**	**0.373**	**0.503**

1 Surface water

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ARTP JMB	/Ai-/Ais-Richtersveld Transfrontier Park Joint Management Board
BHN	Basic Human Needs
CD: WE	Chief Directorate: Water Ecosystems
DWS	Department of Water and Sanitation
DWA	Department of Water Affairs
DWAF	Department of Water and Forestry
EWR	Ecological Water Requirements
GIS	Geographical Information System
HF	Hydraulic fracturing
l/c/d	Litres per capita per day
MCM	Million cubic metres
PSP	Professional Service Provider
TOR	Terms of Reference
WMA	Water Management Area

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study for the provision of professional services to undertake the 'Determination of Ecological Water Requirements for Surface Water (Rivers, Estuaries, and Wetlands) and Groundwater in the Lower Orange Water Management Area (WMA).The appointed Professional Service Provider (PSP) to undertake this study was Rivers for Africa.

As per the Terms of Reference (TOR), there is a need to undertake detailed Ecological Water Requirement (EWR) and Basic Human Needs (BHN) studies for various water resource components due to mainly:

- Planned hydraulic fracturing (HF) undertaken in the WMA.
- Various water use licence applications.
- The conservation status of various Resources in this catchment; and
- The associated impacts of proposed developments will have on the availability of water.

1.2 STUDY AREA

As indicated in the TOR, the study area is the Lower Orange River WMA (previous WMA 14). It is the largest WMA in the country and covers almost the entire Northern Cape Province. This core area forms part of the Orange-Senqu River Basin, which straddles four International Basin States with the Senqu River originating in the highlands of Lesotho, Botswana in the north-eastern part of the Basin, the Fish River in Namibia and the largest area situated in South Africa. The focus area of the study comprises only the South African portion of the Lower Orange River Catchment. The Eastern Boundary starts where the Vaal River enters the Orange River, and the Western Boundary is the Atlantic Ocean. The study area is downstream of the Upper Orange, Senqu, and the Integrated Vaal River System and as such, affected by the upstream activities in the highly-developed river basin. The Orange River forms the border between the Republic of South Africa (RSA) and Namibia to the west of 20 degrees longitude over a distance of approximately 550 km

1.3 PURPOSE OF THIS REPORT

The National Water Act (36 of 1998) ensures that everyone has access to sufficient water by setting aside a certain amount of water to meet everyone's basic needs. This amount of water set aside for basic human needs is called the Basic Human Needs (BHN). The BHN is based upon the current and projected population of those either living within the catchment and directly dependent on the catchment or, critically, not being supplied with water from a recognised formal source. It does not include the population outside of the catchment who may be utilising the water. This report sets out the results of the analysis of the population within the study area with respect to the BHN.

1.4 OUTLINE OF THIS REPORT

The report outline is provided below.

Chapter 1: Introduction
This Chapter provides a general background to the project, study area and purpose of the report.

Chapter 2: Overview of the Study Area
Chapter 2 provides an overview of the of the study area in terms of main land use and general demographic information.

Chapter 3: Basic Human Needs
The approach for determining the BHN of the Lower Orange WMA is provided and a summary of the BHN for this WMA is provided.

Chapter 4: References

Chapter 5: Appendix A: The BHN for the Lower Orange WMA at Quaternary Level
The BHN, assuming allocation of 25 litres of water per capita (person) per day (l/c/d) are provided at the quaternary division level for the Lower Orange WMA.

Chapter 6: Appendix B: Comments Register
Comments from the Client are provided.

2 OVERVIEW OF THE STUDY AREA

2.1 CATCHMENT DESCRIPTION

The geographic extent of the Lower Orange WMA largely corresponds to that of the Northern Cape Province. It is situated in the western extremity of South Africa and borders on Botswana, Namibia and the Atlantic Ocean. The region is harsh semi-desert to desert. Rainfall is minimal, ranging from 400 mm/a to a low of 20 mm/a and is characterised by prolonged droughts. Except for sparse and highly intermittent runoff from local tributaries and occasional inflows from the Fish River in Namibia, the Lower Orange WMA is almost totally dependent on flow in the Orange River from upstream WMAs. Because of the low rainfall, groundwater resources are also limited, although this source is extensively used for water supplies. Important conservation areas in the WMA include the Kgalagadi Transborder National Park, the Augrabies National Park, the Richtersveld National Park and a transboundary Ramsar wetland site at the Orange River mouth.

The Lower Orange River is unique in that it is over 1000 km long, from the confluence of the Orange with the Vaal to its point where it becomes and estuary at Alexandra Bay and eventually meets the South Atlantic Ocean. For about half this distance if forms the main border with Namibia which necessitates a careful look at international obligations. Near the mouth of the river is a wetland which was declared a Ramsar Site in 1991.

The largest contributions to the region's economy are made by mining and irrigated agriculture. Mining activities consist mainly of the extraction of alluvial diamonds and a variety of other mineral resources from locations both inland and along the coast. Extensive irrigation occurs along the Orange River, where the tendency is increasingly towards the growing of high-value orchard crops. Namibia also abstracts water from the river for domestic, mining and irrigation purposes. Sheep and other livestock farming is practised where the climate is favourable. For a more detailed overview of the WMA, and for the purposes of discussion, the Orange River course within the WMA has been divided into four sub areas. These are as follows:

- Douglas to Boegoeberg.
- Boegoeberg to Kanoneiland.
- Kanoneiland to Pella.
- Pella to Alexander Bay.

2.2 DOUGLAS TO BOEGOEBERG

This area begins close to the town of Douglas. From here, the Orange River has its confluence with the Vaal River – a highly utilised river, supplying the densely populated province of Gauteng. The town of Douglas is situated just upstream of this confluence on the banks of the Vaal River and is a small but significant agricultural and stock farming town. The river continues to flow in a south-westerly direction for approximately 160 km before reaching the next small town of Prieska. From Prieska, the river curves to flow in a north westerly direction, where 115 km downstream from Prieska, the large Boegoeberg Weir is situated.

Both Douglas and Prieska exist mainly due to irrigated agricultural activities along the banks of the Orange River. Agriculture and stock farming remain the dominant land uses for this project management area. Agricultural activities are particularly concentrated along the main stem of the Orange River and are made up of variable crop production, including maize, wheat, potatoes, and some lucerne. Abstractions take place mainly at the Douglas and Boegoeberg weirs. Irrigation canals feeding off from Boegoeberg Weir provide irrigation water for farmers downstream. Towns

situated a distance from the main stem of the Orange River and which rely primarily on groundwater resources include Marydale, Niekerkshoop, Griekwastad, Strydenburg, Vosburg, Britstown, De Aar, Victoria West, Hutchinson and Richmond.

2.3 BOEGOEBERG TO KANONEILAND

This area begins just below the water quality monitoring below Boegoeberg Weir. The river continues in a north westerly direction until just before one of the major towns in the Northern Cape, Upington, where it curves to flow in a south westerly direction. This area is largely arid and desolate with the only key agricultural activities taking place on the highly irrigated banks for the Orange River. Upington has a population of approximately 72 000 people.

From Upington, the river continues to flow in a south-westerly to a westerly direction. From Upington onwards, the river becomes heavily braided, forming a series of highly irrigated islands. The largest is Kanoneiland. Agricultural activities in this sub-area are dominated by the production of grapes for both, table grapes and wine production, as well as dried fruit. Other farming activities include game farms and stock farming (mainly cattle and goats), and thus several abattoirs are located in the area. On a smaller scale, Koi farming, subsistence farming, and small scale diamond prospecting can also be observed. Sections within this sub-area also contain popular tourism and recreation areas with canoeing, rafting, boat cruises, fishing and birding proving to be popular activities.

Grape production for table grapes and wine as well as dried fruit production are the dominant agricultural produces in this area. Stock farming (sheep and goats) is also common in the area with the Uitkoms feedlots situated just outside Upington which also supplies a large local meat market and a small export market.

2.4 KANONEILAND TO PELLA

This is the first area to border with Namibia north of the Orange River. From Kanoneiland the Orange River continues towards the small farming towns of Keimoes and then Kakamas, approximately 50 km downstream. After Kakamas, the Hartbees River has its confluence with the Orange River. From here the river then flows in a north westerly direction before yielding the Augrabies Falls, 50 km downstream from Kakamas. Downstream from the falls the Molopo River has it confluence also with the Orange River and the river continues in a north westerly direction before then flowing in a south westerly direction towards the small farming community of Pella, 180 km downstream from the falls,

Agricultural activities along the banks of the Orange River in this sub-area are dominated by dried fruit production and the farming of grapes for both table grapes and wine production. Other products farmed in this sub-area include citrus fruit, cotton, lucerne, olives and nuts. Subsistence and resource-poor farming is also evident and produce include Hoodia and pelargonium (for scent purposes). Other activities in this area include stock farming (cattle and goats), game farming and tourism.

Just before the small farming town of Pella is the Anglo American Blackmountain mine which is mining base metals. Prospective mining activities take place at Gamsberg in the nearby area. Non-proclaimed conservation management is also occurring at Gamsberg.

The Kgalagadi Transfrontier Park is situated in the far most northern parts and is the largest conservation areas in the world – 3.7 million ha. This part of the WMA also supports a sizeable private game farm industry and a salt industry associated with the Witpan and Grootwitpan salt pans situated 115 km and 95 km northwest of Upington respectively. Extensive livestock farming is

evident where the carrying capacity of the land is favourable, with the presence of some agricultural activities including grapes, watermelons and spanspek. Towns in this area which are situated a distance from the main stem of the Orange River and which rely primarily on groundwater resources include Kenhardt, Brandvlei, Vanwyksvlei, Williston, Fraserburg, Loxton, Sutherland and Carnarvon

2.5 PELLA TO ALEXANDER BAY

In this area, the Orange River forms the border with Namibia. Klein Pella, situated immediately adjacent to Pella, is characterized by extensive date plantations. From Pella the river continues in a general westerly direction towards Vioolsdrift Weir. Downstream from Vioolsdrift Weir is the small farming town of Vioolsdrift situated on the South side of the river. Little water use and active land use activity can be observed in the dry, arid and often rocky terrain between Pella and Vioolsdrift Weir. Smaller scale agriculture includes grapes, hoodia and tomatoes.

Shortly after Vioolsdrift, a road bridge also serving as a border crossing, crosses the river into Noordoewer on the Northern, Namibian side of the river. Approximately 145 km after Vioolsdrift the Fish River meets the Orange River and is one of the major tributaries to the Lower Orange River. Included in the area is the Richtersveld. The Richtersveld is a UNESCO World Heritage Site.

The river then veers in a westerly direction, before travelling in a southerly direction towards Brand Karos, 120 km downstream of the confluence with the Fish River.

A further 35 km downstream the river discharges into the Atlantic Ocean at Alexander Bay, situated on the southern bank of the Orange River. Water is piped from Alexander Bay to Port Nolloth. The town of Port Nolloth was historically used as a port for exporting copper but is now, a coastal town dominated by diamond mining activities.

On the northern bank of the river is Oranjemund, a town with restricted access due to diamond mining activities in the area. The estuary at the mouth of the Orange River (Figure 2.1) was declared a RAMSAR site which signifies that it is a wetland of international importance, especially for providing habitat to water birds. However, this site was placed on the Montreaux Record because of a severely degraded state of the salt marsh on the south bank (/Ai-/Ais-Richtersveld Transfrontier Park Joint Management Board (ARTP JMB, 2008).

Mining and prospecting for alluvial diamonds on the banks of the Orange River increases as the river moves towards the West Coast, and activities are concentrated near Alexander Bay.

The Orange River also plays a significant role in supporting eco-tourism in this area with guest houses and bush camps situated along river banks and eco adventure companies offering activities such as river rafting and canoeing on both the South African and Namibian sides of the river. Towns in this area which are situated a distance from the main stem of the Orange and which rely primarily on groundwater resources include Kamieskroon, Garies and the coastal town of Hondeklipbaai.

2.6 REMNANT OF AREA DISLOCATED FROM THE ORANGE RIVER

The remnant of the area that is not adjacent to the Orange River is, with a few exceptions, heavily dependent on groundwater for their water resources. The following summarises the main communities in the areas.

Tertiary Catchments D 33, C51, C92

The population is estimated at 29,476 people. The town of Douglas is present in the area and water is primarily obtained via the orange River, as indicated above. There is some, albeit limited reliance on groundwater abstraction in areas that are more remote from the Orange River.

Tertiary Catchment D42

The population is estimated at 16,470 people. The Rietfontein and Mier cluster of communities are reliant on groundwater.

Tertiary Catchments D51, D52

This is a very sparsely populated area with a population estimated a 3,500 people. The only settlement of any size is Sutherland that is almost completely reliant on groundwater.

Tertiary Catchments D53, 54, 55,56, 57, 58

This is a geographically large area but also sparsely populated. The population is estimated at 46,443. Settlements include Kenhardt, Fraserburg, Loxton, Carnarvon, Van Wyks Vlei, Willistion, and Brandvlei. All of these towns are dependent on groundwater form aquifers and all have formalised water supply schemes. Outside of the towns there is very sparse population that is also heavily dependent on groundwater via private boreholes. There is some irrigation use from groundwater and limited industrial use, notably in Brandvlei, also from groundwater.

Tertiary Catchments D61, 62

This is also a geographically large area but also sparsely populated. The population is estimated at 59,383. De Aar, Richmond, and Victoria West, Strydenburg, Vosburg are the main settlements in this portion of the WMA. As with similar areas, these towns are dependent on groundwater form aquifers and all have formalised water supply schemes. Outside of the towns there is very sparse population who are also heavily dependent on groundwater via private boreholes.

Tertiary Catchments D71, D72, D73

This are quaternaries including Upington as the most populated town and the settlements of Niekerkshoop, Marydale, Groblaarshoop, Kakamas, Keimos. Grootdraaai and Prieka. The population is estimated at slightly in excess of 200,000. Conditions associated with the towns have been described above and most rely on formal water schemes either abstracted from the Orange River or supplemented from boreholes. Outside of the towns the population is sparse and reliant largely on direct abstraction from the Orange River or private boreholes.

Tertiary Catchments D 81, D82

This is largely the quaternaries concerning or adjacent to the Orange River from Upington to the Mouth and has been described above. The population is estimated at 38,290. Major towns and settlements located on or adjacent to the orange River include Augrabies, Onseepkans, Sanddrif and Alexander Bay. These towns primary rely on direct abstraction of water from the river. Pofadder and Aggenys are located away from the river and Pofadder has a degree of dependence on groundwater.

Tertiary Catchments F10, F20, F30. F40, F50, F60

These are the quaternaries that run along the Atlantic Seaboard or are in the adjacent hinterland. The population is estimated at 58,038. Concentrated settlements include Port Nolloth, Springbok, Garies, Lekkersing. Eksteensfontein, Bulletrap, Buuffeslriveierm Komaggas, Kelinzee, Hondeklipbaai, Kamieskroon, Karkams, Klipfontein, Kammassies, Nourivier and Kheis. These settlements are all heavily dependent on groundwater for their immediate needs

Figure 2.1 depicts the Lower Orange WMA study area.

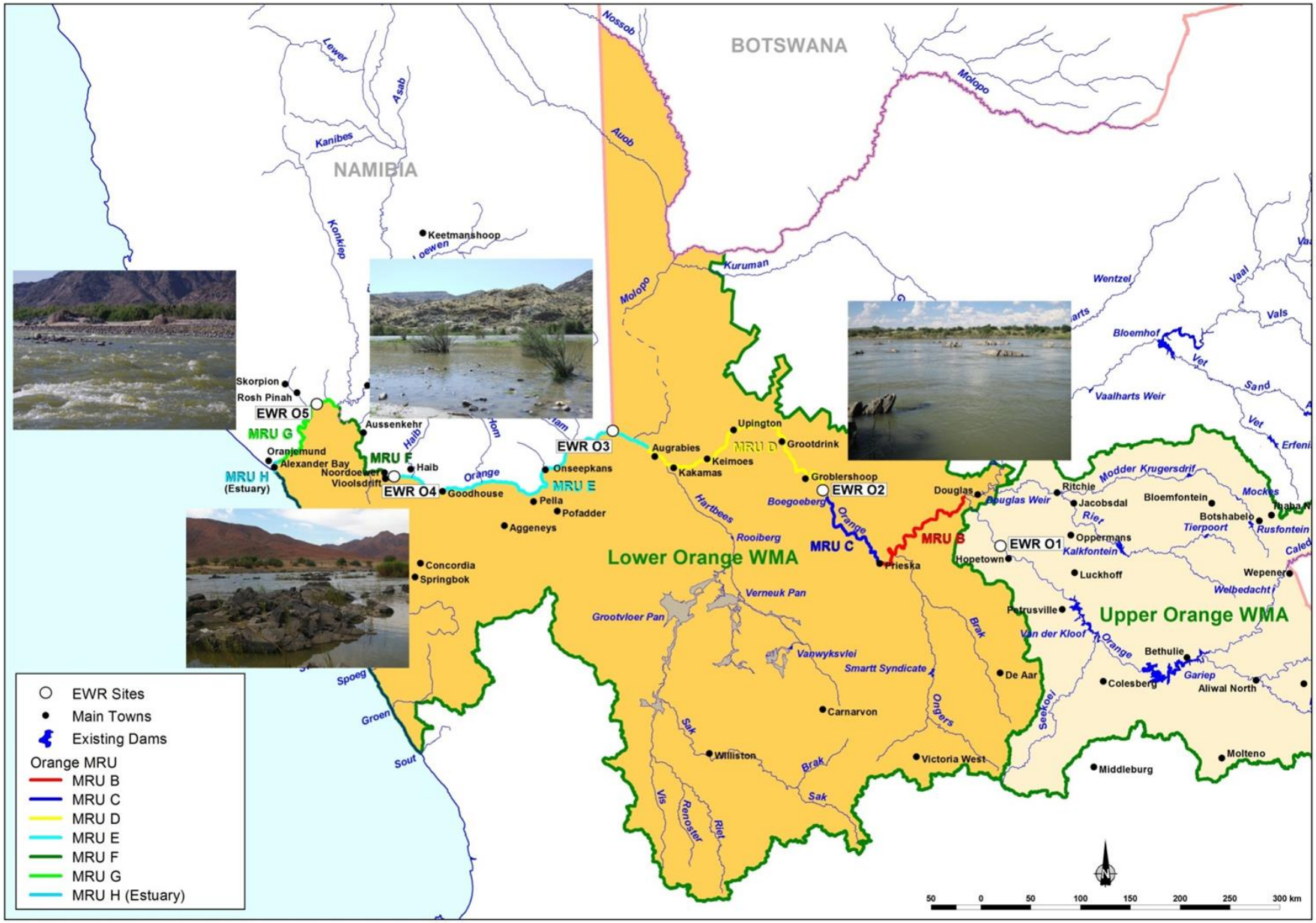

Figure 2.1 Study Area - Lower Orange WMA

3 BASIC HUMAN NEEDS

As per the TOR the BHN associated with all resources has been determined, using guidelines as set out in DWAF (1999; 2007 and 2008). To do this an analysis of the current demographic profile of the Lower Orange River WMA was undertaken. The results of Census 2011 were used as the departure point. This was supplemented with available data that is either more recent or the result of dedicated studies undertaken to link the population in the WMA with water resources and usage. The population figures have been adjusted from the 2011 base to a 2015 figure using the currently accepted population growth figures for the applicable districts within the WMA. The data was matched with the profiles of reliance on water resources as provided by the Census 2011. Figure 3.1 captures population density.

The BHN report follows a standard typology developed for DWS. The typology was first used for the Vaal Reserve and is an evolution of the method used previously. The Census 2011 gives a breakdown of reliance on water sources and was key in determining the sources used by the population. Sources typically specified in the census include Regional Water supply schemes, boreholes, springs, rainwater dams, rivers or streams, water vendors, and water tanks. The WMA was analysed in terms of these types of services provided as well as source of supply. This allows for the geographical spread of service types within the WMA. As such the BHN is based upon the current and projected population of those either living within the catchment and directly dependent on the catchment or, critically, not being supplied with water from a recognised formal source. It does not include the population outside of the catchment who may be utilising the water.

To calculate the BHN the following steps were specifically undertaken:

- Analysis was based on quaternary division. There are 145 quaternary divisions each of which were analysed by source of water and by households and individuals who are dependent on these sources. While the national census asks respondents about their water source it reports these in an amalgamated fashion using its own geographical conglomeration. As these do not coincide with quaternary divisions the results were reanalysed to ensure that the population is allocated to the relevant quaternary. This was done using Geographical Information System (GIS) technology.
- Quaternary catchment boundaries were superimposed upon the smallest aggregations of census data available. For the 2011 National census these are known as “sub-place names”. SSA collects information and then amalgamates in a manner that is not geographically consistent with the analysis required for the BHN. SSA makes data available at sub-place name level. Each sub-place name has to be allocated to a quaternary. As such all “sub-place names” either wholly or partially within the quaternary catchments were captured. Where “sub-place names” were partially within the quaternary catchments then the percentage area that fell within was applied to the population. As such, where a “sub-place name” was only 50% within a quaternary catchment then only 50% of the population was deemed to fall within the area. The total population for the Lower Orange River WMA, as recorded by the 2011 Census, was 451,620. Extrapolated to 2016 using an average growth rate of 0.25%[3] for the years for 2011 to a current population figure for 2016 of 457,324 is derived.
- Those receiving water from a recognised formal water source and therefore not likely to be dependent on direct abstraction from the rivers were excluded. Given the nature of the WMA,

[3] The population of the WMA is growing at a slower rate than the national average of 1.00% per annum and reflects lack of economic opportunities in the general area and out migration.

as set out in Section 2, most of the population fall within the ambit of those likely to be receiving a formal water supply. The remainder are deemed to be part of the "qualifying population".

- For the purposes of the BHN estimating the population likely to be BHN dependent were classified as that dependent on boreholes, springs, dams and pools, rivers and streams, water tankers and other means of supply but excluding formal water schemes. The 2016 population in this category was estimated at 95,957[4].
- Those dependent on boreholes were in terms of calculations as these were deemed to be part of the Groundwater Reserve (and schedule 1 users) and covered in report RDM/WMA06/00/CON/COMP/0416. Towns that are heavily dependent on groundwater with their usage are listed in Table 3.1 and illustrated in Figure 3.1. It should be noted that the bulk of the geographical spread of the population in the area is either supplied out of a formal water supplied for groundwater or have their own boreholes and are thus directly groundwater dependent. The distribution of dependency is illustrated in Figure 3.2.
- As such the final population that was included in the non-groundwater dependent BHN amounted to 55,901 people or 12.2% of the recorded population. If those that are reliant on boreholes and not serviced by formal schemes is retained within the calculation the figure remains at 95,957 as above.
- The BHNR was initially calculated at 25l per day per person. The number was aligned with initial RDP targets set as minimum standards for the South African population. During 2002 (Thukela Reserve study) and confirmed during the description of the method (DWAF, 2008) the DWS suggested that more acceptable volumes of water per day such as 55 or 60 litres was also to be investigated. This was confirmed and stated as part of the recent study providing frameworks for the Reserve and describing available tools (DWS 2016). It must therefore be noted that the BHN during this step of a Reserve study is calculated for various scenarios that includes 25 and 60 litres and as for the Ecological Reserve, the DWS will then determine which is suitable for the Reserve or Preliminary Reserve to be accepted.

[4] The figure for 2016 is virtually identical for 2011 as little no growth is expected in this sector of the population.

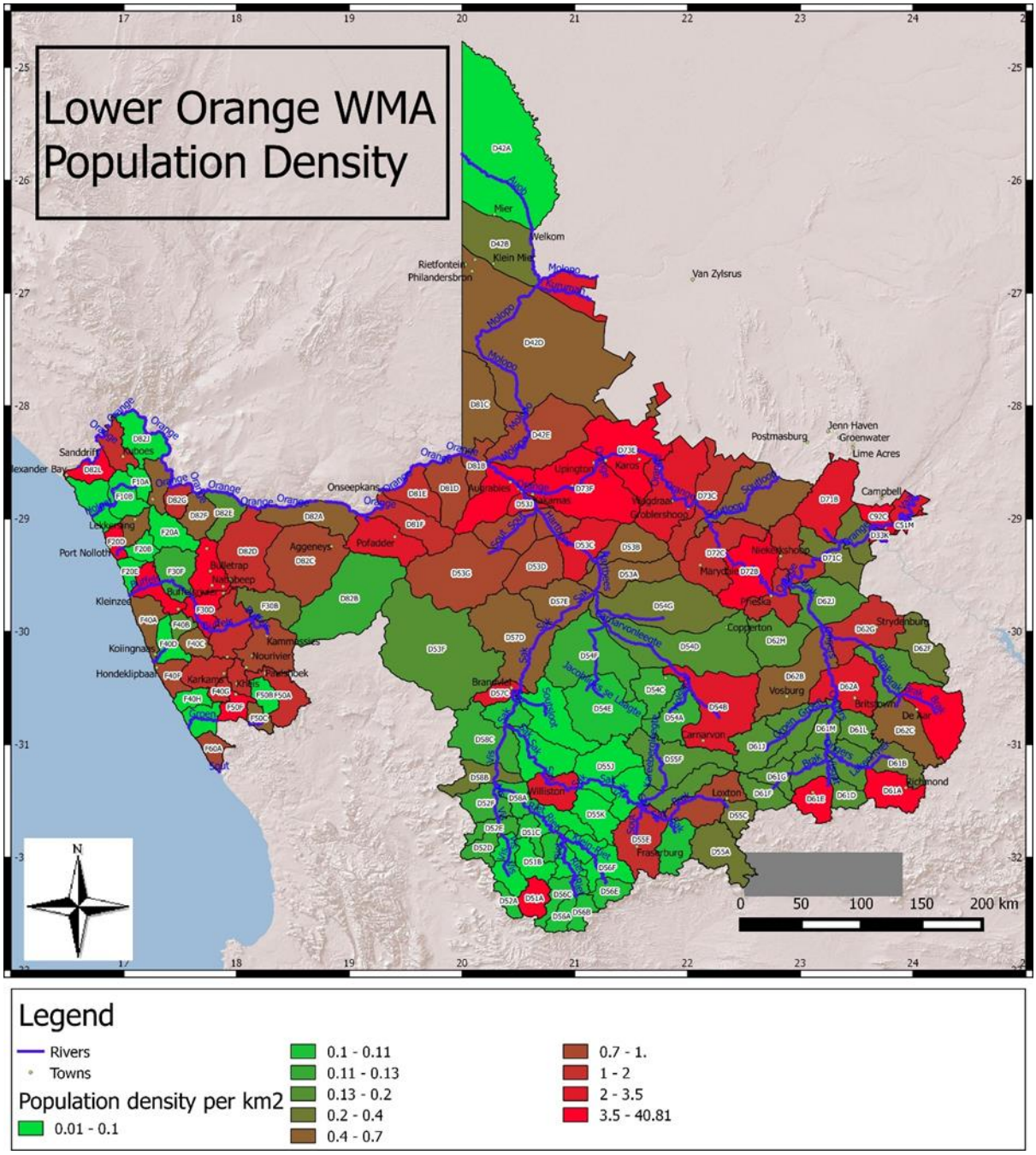

Figure 3.1 Catchment Population Density

Table 3.1 Towns Served by Groundwater[5]

Town	Assumed Use (MCM/a)
Campbell	0.473
Mier LM Combined Clusters Groot Meir	0.15
Klein Mier	0.01898
Welkom	0.01241
Van Zylsrust	0.132
Loubos	0.01825
Rietfontein	0.078475
Philandersbron	0.04015
Sutherland	0.15
Kenhardt	0.248
Carnarvon	0.485
Vanwyksvlei	0.1
Loxton	0.445
Fraserburg	0.192355
Williston	0.221
Brandvlei	0.137
Richmond	0.564
Victoria West	0.722
Britstown	0.349
Vosburg	0.146
De Aar	2.798
Strydenburg	0.146
Griekwastad	0.5
Niekerkshoop	0.148
Marydale	0.245
Groenwater	0.01533
Jenn Haven	0.01022
Postmasburg	1.12
Pofadder	N/A
Eksteenfontein	0.01533
Khubus	0.064605
Lekkersing	0.02044
Port Nolloth	0.409
Kammassies	0.01898
Leliefontein	0.026
Nourivier	0.01095
Kamieskroon	0.16
Buffelsrivier	0.03504

[5] See Report RDM/WMA06/00/CON/COMP/0416: Determination Of Ecological Water Requirements For Surface Water (River, Estuaries And Wetlands) And Groundwater In The Lower Orange WMA - Groundwater EWR Report.

Town	Assumed Use (MCM/a)
Bulletrap	0.0219
Kleinsee	0.09125
Komaggas	0.170455
Koingnaas	0.077015
Karkhams	0.091615
Hondeklip	0.066795
Klipfontein	0.002555
Paulshoek	0.00584
Kheis	0.009125
Garies	0.348
Springbok	0.851
TOTAL	12.16107

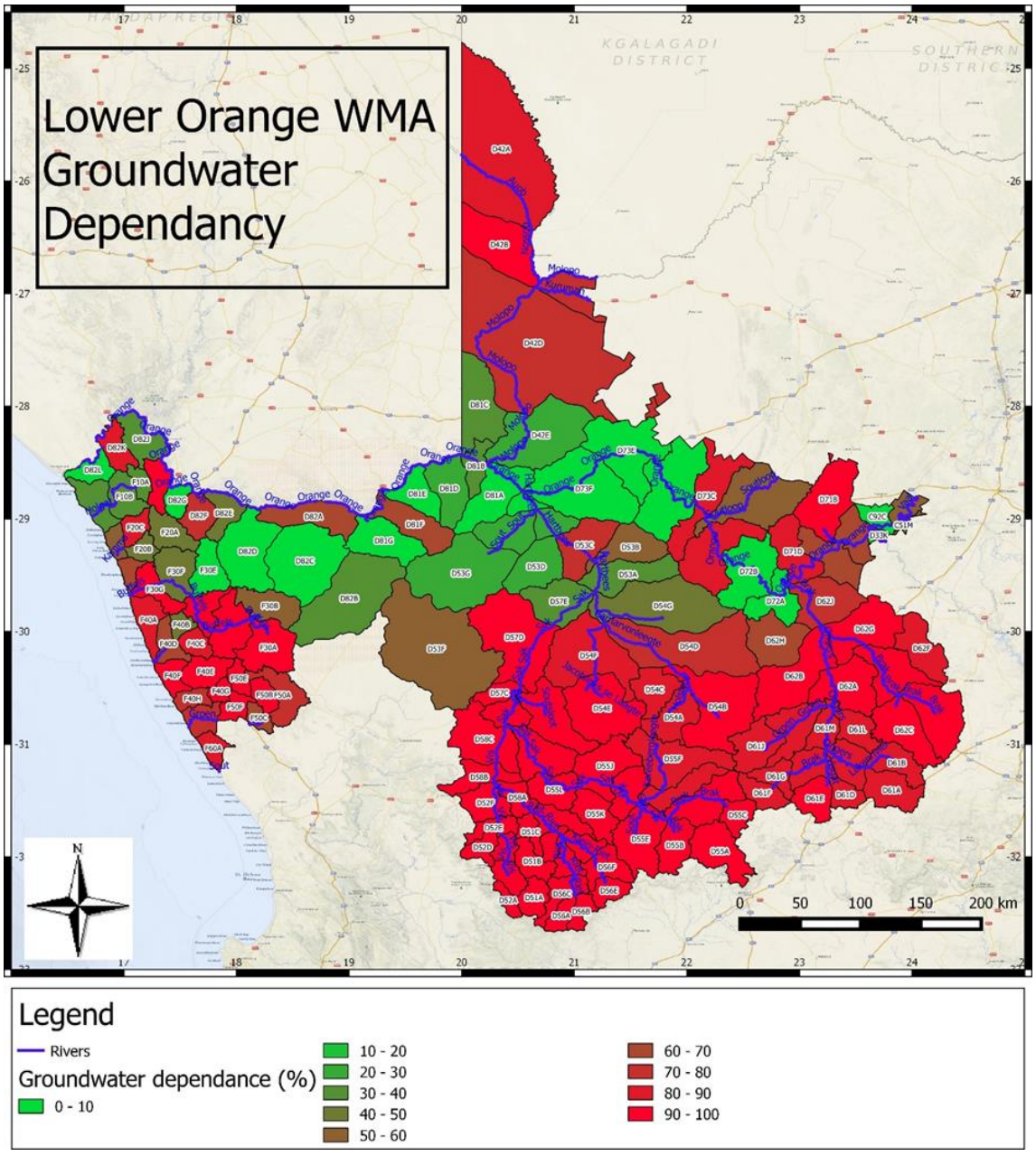

Figure 3.2 Groundwater Dependency

The BHN for this portion of the population, with models assuming allocations of 25 litres of water per capita (person) per day (l/c/d) were then calculated as per Table 3.2 below. This is also reported at the quaternary division level and with estimated volume in million m^3/a at 25 l per day in Appendix A.

Table 3.2 Summary of BHN at 25 litres per person per day

Total Population	457,324	**Cubic metres per day**	**Million m^3/a**
Population not serviced	95,957		
Population not serviced excluding borehole	55,901		
Population borehole dependent	40,056		
Surface water BHN 1: @ 25 l/c/d - excluding those on a formal scheme	1,378,947	1,378	0.503
Groundwater BHN 1@ 25 l/c/d - excluding those on a formal scheme	1,019,980	1,019	0.373
BHN 1: @ 25 l/c/d including borehole dependent -- excluding those on a formal scheme	2,398,926	2,399	0.876

In terms of million m^3/a the surface water volume (obviously excluding groundwater) would be 0,503 at BHN 1 levels at 25 l per person per day. The bulk of surface water abstraction is from the Orange River although there is other ad hoc and seasonal abstraction of surface water from other sources. Including groundwater usage, and in terms of million m^3/a the volume would be 0,876 at BHN 1 levels at 25 l per person per day. At 60 litres per person per day the figures are as per Table 3.3.

Table 3.3 Summary of BHN at 60 litres per person per day

Total Population	457,324	**Cubic metres per day**	**Million m^3/a**
Population not serviced	95,957		
Population not serviced excluding borehole	55,901		
Population borehole dependant	40,056		
Surface water BHNR 1: @ 25 l/c/d - excluding those on a formal scheme	3,354,059	3,354	1.216
Groundwater BHNR 1@ 25 l/c/d - excluding those on a formal scheme	2,403,363	2,403	0.877
BHNR 1: @ 25 l/c/d including borehole dependant -- excluding those on a formal scheme	5,757,423	5,757	2.101

The BHN component of the Reserve is readily calculated by multiplying the number of people living within the confines of a resource unit AND WITHOUT A CURRENT FORMAL SOURCE OF WATER SUPPLY by 25 l/d. Where a large proportion of the population already has access to a formal regional water system, setting aside a BHN for this portion and adding it to existing lawful groundwater use would result in a double accounting of water allocations. Hence this study took the approach of only calculating a BHN for the population without access to a formal regional water supply. However, since the bulk of users included in the Reserve are Schedule 1 users, a per capita consumption of 200 l/c/d was utilised to calculate current water use. This use incorporates 25 l/c/d which fall under the BHN Reserve.

The BHNR can thereafter be split into the surface and groundwater component of the BHNR to avoid double accounting. The Groundwater component of the BHNR utilised in this study was the proportion of people reliant on groundwater without a formal source of supply (Appendix A).

4 REFERENCES

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5 APPENDIX A: THE BHN FOR THE LOWER ORANGE WMA AT QUATERNARY LEVEL

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	Ground Water dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
C51M	627	342	53.898	0.006	0.003	0.003
C92B	1641	1106	51.725	0.015	0.010	0.005
C92C	3496	1359	6.180	0.032	0.012	0.019
D33K	157	100	7.564	0.001	0.001	0.001
D42A	365	284	84.533	0.003	0.003	0.001
D42B	425	323	91.938	0.004	0.003	0.001
D42C	3192	1918	72.419	0.029	0.018	0.011
D42D	3356	1622	75.921	0.031	0.015	0.015
D42E	2408	804	27.591	0.022	0.007	0.014
D51A	171	158	99.636	0.002	0.001	0.000
D51B	89	80	92.136	0.001	0.001	0.000
D51C	53	47	92.022	0.000	0.000	0.000
D52A	39	36	92.149	0.000	0.000	0.000
D52B	65	59	92.149	0.001	0.001	0.000
D52C	47	42	92.101	0.000	0.000	0.000
D52D	70	62	91.860	0.001	0.001	0.000
D52E	66	58	91.860	0.001	0.001	0.000
D52F	125	109	91.860	0.001	0.001	0.000
D53A	711	186	34.142	0.006	0.002	0.005
D53B	626	174	55.761	0.006	0.002	0.004
D53C	1522	175	77.491	0.014	0.002	0.012
D53D	1299	142	28.581	0.012	0.001	0.010
D53E	602	64	28.339	0.005	0.001	0.005
D53F	1115	512	51.464	0.010	0.005	0.005
D53G	2984	356	28.942	0.027	0.004	0.024
D53H	1149	121	28.339	0.010	0.001	0.009
D53J	884	76	6.212	0.008	0.001	0.007
D54A	180	155	86.689	0.002	0.001	0.000
D54B	907	715	97.845	0.008	0.007	0.002

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	Ground Water dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
D54C	159	137	86.689	0.001	0.001	0.000
D54D	752	522	73.185	0.007	0.005	0.002
D54E	354	316	90.572	0.003	0.003	0.000
D54F	430	373	89.191	0.004	0.003	0.001
D54G	1091	499	48.523	0.010	0.005	0.005
D55A	560	519	94.326	0.005	0.005	0.000
D55B	132	119	91.734	0.001	0.001	0.000
D55C	175	155	92.092	0.002	0.001	0.000
D55D	382	324	96.328	0.003	0.003	0.001
D55E	347	303	98.779	0.003	0.003	0.000
D55F	393	335	87.207	0.004	0.003	0.001
D55G	192	165	88.267	0.002	0.002	0.000
D55H	118	107	92.149	0.001	0.001	0.000
D55J	202	184	92.149	0.002	0.002	0.000
D55K	127	115	92.149	0.001	0.001	0.000
D55L	263	220	98.844	0.002	0.002	0.000
D55M	184	167	92.137	0.002	0.002	0.000
D56A	52	47	92.149	0.000	0.000	0.000
D56B	54	49	92.057	0.000	0.000	0.000
D56C	95	86	92.149	0.001	0.001	0.000
D56D	62	56	92.149	0.001	0.001	0.000
D56E	69	62	92.149	0.001	0.001	0.000
D56F	105	95	92.149	0.001	0.001	0.000
D56G	65	59	92.149	0.001	0.001	0.000
D56H	46	41	92.149	0.000	0.000	0.000
D56J	95	86	92.149	0.001	0.001	0.000
D57A	91	80	91.975	0.001	0.001	0.000
D57B	232	210	92.149	0.002	0.002	0.000
D57C	126	92	97.943	0.001	0.001	0.000
D57D	770	577	91.996	0.007	0.005	0.002
D57E	1115	178	32.247	0.010	0.002	0.008

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	Ground Water dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
D58A	83	73	91.918	0.001	0.001	0.000
D58B	156	133	94.882	0.001	0.001	0.000
D58C	275	242	91.895	0.003	0.002	0.000
D61A	1031	407	89.109	0.009	0.004	0.005
D61B	240	195	85.451	0.002	0.002	0.000
D61C	211	178	86.661	0.002	0.002	0.000
D61D	117	99	86.419	0.001	0.001	0.000
D61E	704	378	96.356	0.006	0.004	0.003
D61F	158	132	86.419	0.001	0.001	0.000
D61G	136	114	86.419	0.001	0.001	0.000
D61H	198	166	86.419	0.002	0.002	0.000
D61J	243	206	86.508	0.002	0.002	0.000
D61K	247	213	87.452	0.002	0.002	0.000
D61L	187	167	90.364	0.002	0.002	0.000
D61M	172	152	89.541	0.002	0.001	0.000
D62A	962	817	97.510	0.009	0.008	0.001
D62B	648	546	94.182	0.006	0.005	0.001
D62C	562	498	96.043	0.005	0.005	0.001
D62D	1269	923	98.969	0.012	0.009	0.003
D62E	357	321	90.759	0.003	0.003	0.000
D62F	350	297	86.279	0.003	0.003	0.000
D62G	2298	2130	95.210	0.021	0.019	0.001
D62H	342	238	70.152	0.003	0.002	0.001
D62J	416	289	70.521	0.004	0.003	0.001
D71A	414	243	61.223	0.004	0.002	0.002
D71B	1396	828	92.625	0.013	0.008	0.005
D71C	432	271	64.613	0.004	0.003	0.001
D71D	645	382	87.249	0.006	0.004	0.002
D72A	464	234	10.324	0.004	0.002	0.002
D72B	1166	580	4.466	0.011	0.005	0.005
D72C	934	564	89.099	0.009	0.005	0.003

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	Ground Water dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
D73A	5098	1504	100.000	0.047	0.014	0.033
D73B	1466	807	57.826	0.013	0.008	0.006
D73C	1754	1150	82.721	0.016	0.011	0.005
D73D	3339	713	5.470	0.030	0.007	0.024
D73E	2352	524	2.256	0.021	0.005	0.017
D73F	9112	1148	1.300	0.083	0.011	0.073
D81A	4225	523	5.770	0.039	0.005	0.034
D81B	501	51	36.847	0.005	0.001	0.004
D81C	1401	211	34.836	0.013	0.002	0.011
D81D	1313	139	28.339	0.012	0.001	0.011
D81E	707	110	9.023	0.006	0.001	0.005
D81F	1143	169	61.055	0.010	0.002	0.009
D81G	560	134	2.505	0.005	0.001	0.004
D82A	411	107	69.435	0.004	0.001	0.003
D82B	556	195	40.139	0.005	0.002	0.003
D82C	774	235	8.514	0.007	0.002	0.005
D82D	635	176	4.062	0.006	0.002	0.004
D82E	126	42	47.288	0.001	0.000	0.001
D82F	184	45	8.094	0.002	0.000	0.001
D82G	199	43	6.294	0.002	0.000	0.001
D82H	37	20	96.873	0.000	0.000	0.000
D82J	8	3	34.831	0.000	0.000	0.000
D82K	296	102	81.849	0.003	0.001	0.002
D82L	439	86	2.637	0.004	0.001	0.003
F10A	7	2	34.831	0.000	0.000	0.000
F10B	17	5	34.831	0.000	0.000	0.000
F10C	19	6	34.831	0.000	0.000	0.000
F20A	54	17	43.407	0.000	0.000	0.000
F20B	29	9	44.291	0.000	0.000	0.000
F20C	168	99	81.666	0.002	0.001	0.001
F20D	112	15	54.956	0.001	0.000	0.001

Catchment	Population not on formal scheme	Population on bore hole (Schedule 1)	Ground Water dependency % of population	Total BHN (MCM/a @25l/p/d)	GW BHN (MCM/a @25l/p/d)	SW[1] BHN (MCM/a @25l/p/d)
F20E	14	5	67.545	0.000	0.000	0.000
F30A	401	280	93.266	0.004	0.003	0.001
F30B	207	69	58.267	0.002	0.001	0.001
F30C	330	142	93.525	0.003	0.001	0.002
F30D	457	118	97.249	0.004	0.001	0.003
F30E	543	191	4.411	0.005	0.002	0.003
F30F	151	50	46.628	0.001	0.000	0.001
F30G	290	85	94.227	0.003	0.001	0.002
F40A	134	53	88.891	0.001	0.001	0.001
F40B	48	18	49.539	0.000	0.000	0.000
F40C	155	89	82.120	0.001	0.001	0.001
F40D	56	30	62.303	0.001	0.000	0.000
F40E	250	111	93.373	0.002	0.001	0.001
F40F	494	478	97.311	0.005	0.004	0.000
F40G	40	28	97.782	0.000	0.000	0.000
F40H	25	18	73.684	0.000	0.000	0.000
F50A	729	163	70.911	0.007	0.002	0.005
F50B	30	21	73.684	0.000	0.000	0.000
F50C	125	39	64.672	0.001	0.000	0.001
F50E	106	73	96.703	0.001	0.001	0.000
F50F	128	53	96.375	0.001	0.001	0.001
F50G	38	27	73.684	0.000	0.000	0.000
F60A	143	47	81.591	0.001	0.000	0.001
TOTAL	**95957**	**40056**		**0.876**	**0.373**	**0.503**

1 Surface water

6 APPENDIX B: COMMENTS REGISTER

	Section	Report statement	Comments	Changes made?	Author comment
Comments: Draft 1					
1	Executive Summary	Table at end of Executive Summary	The way the volume highlighted in the report is expressed gives the impression that the volume is in cubic centimetres per day but I think the author meant cubic metres per capita per day. So the author needs to express his units correctly and scientifically. • Even based on the reviewer's understanding that the author meant cubic metres per capita per day it is wrong. The fact that the author has multiplied by the population it ceases to be per capita. So the author needs to get his units right there. • The BHN needs to be finally expressed in Mm^3/yr not per day.	Yes	Changes made in text cm written out. Mm3/yr calculated
2	Chapter 2	General comment	Looking at the topic of the author (Overview of the Study area or Catchment Description), this chapter is supposed to look at the whole catchment. However it focuses rather on the Orange river and even divided the Orange river into 4 sections. This study is not focusing on the Orange river only…groundwater is part of the study. Furthermore the BHN component that this report goes on to focus on is groundwater driven yet this chapter focuses on the Orange and only talks about groundwater in passing in 2 or 3 paragraphs.	Yes	Chapter updated and revised with new sections added.
3	Chapter 3	General Chapter comment	I would have expected Chapter 3 to be more detailed justifying the BHN figures throughout the WMA e.g. how the author arrived at the population figure for the BHN (55 901) and the distribution of that population in the study area. It would be relevant having maps showing the distribution of the population being catered for under the BHN. An example is how Karim did Chapter 3 of the Groundwater EWR Report.	Yes	Chapter updated and maps added.
4	Chapter 3		Does it mean that there are no people who rely on the Orange river directly and don't belong to formal schemes? Visualise the people settled along the Orange and are far away from the towns and rely on the Orange river.	Yes	Test updated and chapter changed.
5		Appendices	In Appendix A in the BHN Report, please consider the following modifications. Your scenarios of the BHN should be an annual volume not a daily volume.	Yes	Appendices removed and merged.

	Section	Report statement	Comments	Changes made?	Author comment
			Add the last column named BHN Reserve with the volume in Mm^3/yr. This one should be based on the scenario of the 25 litres per person per day volume since that's the BHN volume that the Department currently uses.		
6		Appendices	The appendices should be clear in terms of the groundwater BHN and the surface water BHN instead of referring the reader to the Groundwater EWR Report. This is because the Groundwater BHN is relevant in this report first before it is used in the Groundwater EWR report.	Yes	Appendix A updated and groundwater included in calculation.
Comments: Draft 2					
1	Executive Summary	Comment on Table	Partially addressed in the sense that B and C have an annual volume in m3/yr but not Mm^3/yr. This is the standard unit in the RDM templates that get approved and also in licensing where our Chief Directorate provides support. I recommend on top of the m3/yr already reported add the Mm^3/yr and round to 3 decimal places; most of those values should come alright. Otherwise someone has to do that this side when we are preparing the templates for approval yet the PSP would have been paid for that.	Yes	Changes made in text cm written out. Mm^3/yr calculated.
2	Section 3 and Appendix	General comment	The appendices should be clear in terms of the groundwater BHN and the surface water BHN instead of referring the reader to the Groundwater EWR Report. This is because the Groundwater BHN is relevant in this report first before it is used in the Groundwater EWR report.		Appendix A removed and Appendix B merged and updated.
3	Appendix	General comment	Appendix A should be removed because all of its information is contained in Appendix B. And again Appendix A has daily volumes which need further processing.	Yes	As above - Appendix A removed and Appendix B merged and updated.
Comments: Draft 3					
1		General comment	Split Surface Water and Groundwater Reserve figures and show both as separate amounts	Yes	Done and captured in summary text tables and Appendix