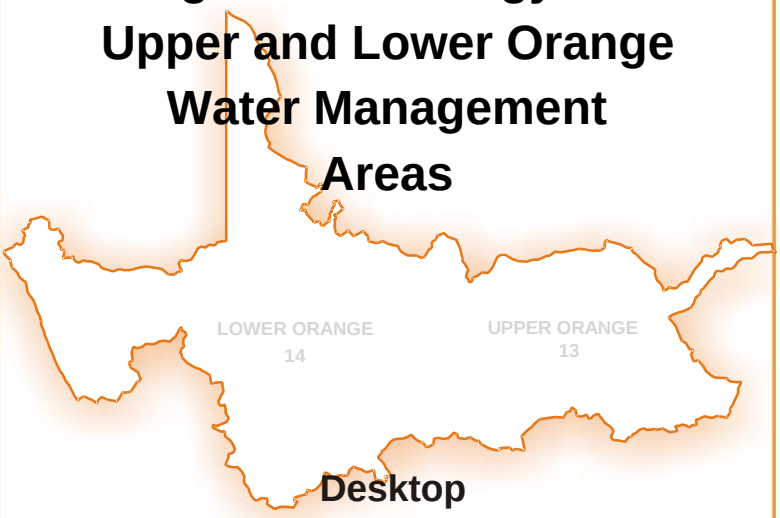
Water Resource Planning Systems

Water Quality Planning

Development of an Integrated Water Quality Management Strategy for the Upper and Lower Orange Water Management Areas



Desktop Catchment Assessment Study: Lower Orange Water Management Area (WMA 14)

Report No:. 2.2
(P RSA D000/00/7909/3)

August 2009

Edition 1

water & forestry
Department:
Water Affairs & Forestry
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER AFFAIRS

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Reports as part of this project:

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2.1*	Desktop Catchment Assessment Study: Upper Orange Water Management Area (WMA 13)
2.2*	Desktop Catchment Assessment Study: Lower Orange Water Management Area (WMA 14)
3**	Water Quality Monitoring and Status Quo: Upper and Lower Orange Water Management Areas (WMAs 13 and 14)
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5**	Resource Water Quality Objectives (RWQOs): Upper and Lower Orange Water Management Areas (WMAs 13 and 14)
6**	Towards A Monitoring programme: Upper and Lower Orange Water Management Areas (WMAs 13 and 14)

* Reports produced by the Directorate, Water Resource Planning Systems, Sub-Directorate Water Quality Planning as part of the study titled *"Development of an Integrated Water Quality Management Strategy for the Upper and Lower Orange Water Management Areas".*

** Reports produced by Zitholele Consulting on behalf of the Department of Water Affairs as part of the study titled *"Assessment of Water Quality Data Requirements for Water Quality Planning Purposes in the Upper and Lower Orange Water Management Areas".*

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TITLE: Development of an Integrated Water Quality Management Strategy for the Upper and Lower Orange Water Management Areas – Desktop Catchment Assessment Study: Lower Orange Water Management Area (WMA 14)

DATE: June 2009

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EXECUTIVE SUMMARY

This report documents a desktop level assessment of the Lower Orange Water Management Area (LOWMA). Due to this Water Management Area (WMA) covering a large area, the WMA was divided into four sub-areas: [1] Douglas to Boegoeberg; [2] Boegoeberg to Kanoneiland; [3] Kanoneiland to Pella; and [4] Pella to Alexander Bay. The guidelines for these demarcations are provided.

The climate, geology, soils and characteristic vegetation of the LOWMA are discussed, emphasising the very dry nature of this WMA described by low precipitation rates, high evaporation rates, and three unique desert systems. A preliminary examination of the hydrology of the system reveals that the tributaries to the main stem of the Orange River have very low mean annual runoffs with erratic, non-perennial flows. This has provided a strong motivation for the setting of Level 1 Resource Water Quality Objectives only, i.e. for the main stem of the Orange River.

The Orange River feeds several water supply schemes, which provide the livelihood for a range of activities in the catchment, which would otherwise not be possible in such dry and harsh conditions. These include rural, domestic, industrial and mining activities. Furthermore, an extensive network of irrigation canals provides water for intensive agricultural activities for large sections along the banks of the Lower Orange River. The existence of protected areas, national parks and trans-frontier parks is also noted and the implications of these for water quality managers is discussed.

Unique characteristics for each of the sub-areas are discussed. These include water quality monitoring points, main towns, major weirs, dams or natural water features, key water uses and water users, and land use activities. Photographs and Google Earth images are provided to afford a visual overview of the WMA.

A discussion on the socio-economic profile and demographics of the region reveal that the LOWMA is a scarcely populated area, contributing a small percentage towards the Gross Domestic Product of South Africa. The LOWMA has an unemployment rate higher than the national average with a low percentage of households having access to clean, piped water and sanitation services. Key interest groups and stakeholders for each of the four sub-areas were identified and summarized.

A summary of completed Reserve determination studies is provided, revealing that most Reserve studies for the LOWMA have only been done on either a desktop or rapid level. The need for a comprehensive Reserve determination study is emphasised, especially in light of the Alexander Bay estuary, a RAMSAR wetland on the Montreaux record, and also to increase the confidence of future water quality planning initiatives.

The fact that the Lower Orange River is shared with Namibia and Botswana necessitates a careful consideration of international obligations and bilateral agreements. Key international stakeholders are identified in the Overarching Catchment Context (Report No. 1) and the need for international stakeholder engagement for future, higher confidence work is described.

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LIST OF ACRONYMS

ARTP JMP	Ai-Ais Richtersveld Transfrontier Park Joint Management Board
CAS	Catchment Assessment Study
DTEC	Department of Tourism, Environment and Conservation
DME	Department of Minerals and Energy
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
GDP	Gross Domestic Product
LOWMA	Lower Orange Water Management Area
MAR	Mean Annual Runoff
MCM	Million Cubic Metres
NCTA	Northern Cape Tourism Association
QUAT	Quaternary catchment
RWQO	Resource Water Quality Objective
SANPARKS	South African National Parks
WMA	Water Management Area
WUA	Water Users Association

1 INTRODUCTION

The Lower Orange WMA forms the lower reaches of the larger Orange River Basin but excludes the Vaal River Basin. The Orange River originates in the highlands of Lesotho, where it is known as the Senqu River. It exits Lesotho in a west south-westerly direction into South Africa where it forms a natural border between the Eastern Cape and the Orange Free State before reaching Gariep Dam, situated within WMA 13 (Upper Orange). The area below Gariep Dam marks the boundary between the Eastern Cape, Free State and Northern Cape (Figure 1A). The Orange River continues to flow in a north-westerly direction reaching Vanderkloof Dam, bordering the Free State and Northern Cape provinces. Downstream of the Vanderkloof Dam the Orange River crosses the boundary between the Upper Orange and Lower Orange WMAs. It then passes the small town of Hopetown, where after it reaches Douglas weir. Approximately 13 km west of Douglas, the Vaal River forms the main tributary to the Orange River, which marks the approximate boundary between the Upper and Lower Orange.

The Lower Orange River is unique in that it is over 1000km 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. It is home to a rich birdlife, including the endemic Barlow's Lark.

The LOWMA is also the largest of all the WMAs and for this purpose has been divided into four sub-areas for the purposes of this study (Figure 1B):

[Sub-Area 1] Just upstream of the confluence of the Orange River with the Vaal River to Boegoeberg Weir (including just upstream of both the Orange and Vaal Rivers)

[Sub- Area 2] Boegoeberg Weir to Kanoneiland

[Sub-Area 3] Kanoneiland to Pella

[Sub-Area 4] Pella to Alexander Bay

The following were used as guidelines for generating these four sub-areas:

- Homogenous resource units
- Ecological considerations
- Resource users and uses
- Man-made divisions, such as dams or weirs
- Natural divisions, such as waterfalls
- The size of the sub-areas
- Logistical practicality

Thereafter, quaternary catchments and rivers draining within these four areas were used to demarcate the areas further. By nature of the fact that the LOWMA is the largest WMA, the sub-areas themselves are large units. The initial approach of demarcation was to focus on the main stem of the Orange River, with a vision to accommodate extended groundwater areas and re-assess these sub-areas in future work.

2 CLIMATE

The area comprising the Lower Orange WMA is largely arid and experiences a harsh climate. It has the lowest mean annual rainfall in the country, varying from 400mm in the east to 50 mm per annum on the west coast. Area 1 receives between 200 and 300 mm of rainfall per annum, whereas, moving westwards, Sub-Areas 2, 3 and 4 largely receive between 0 and 100m per annum. Potential evaporation can reach 3 000 mm per year.

3 GEOLOGY, SOILS AND VEGETATION

The topography of the Lower Orange WMA is such that it is largely flat, with large pans or endoreic areas that do not contribute significant runoff to the Orange River system. For this reason, communities and activities that exist out of logistical reach of the main stem of the river rely heavily on groundwater supplies. In the west of the WMA are the rocky and barren Richtersveld Mountains and the north is covered by Kalahari sands. A complex geology exists south and westwards of the Orange River, with a variety of rich mineral deposits and shallow, rocky soils. The area in and around the Lower Orange WMA is typically characterised by four desert systems, three of which drain into the Orange (UNDP, 2007): the Succulent Karoo, Nama Karoo (receiving mainly summer rainfall and comprising numerous vegetation types) and the Southern Kalahari (consisting of a deep layer of wind-blown sand with little run-off from rainfall). The Namib desert system which does not drain into the Orange River Basin, is the driest of the four, forming a narrow strip along the Atlantic coast (GDC, 2009).

4 HYDROLOGY

The Vaal River is the main tributary to the Orange River, joining the main stem of the Orange River approximately 13km west of Douglas. Other tributaries include the Ongers, Hartebeest, Molopo and Fish, however, most of these flows infrequently, if ever, due to the low rainfall generated in this WMA and hence, little surface runoff exists. This makes it impractical to set management goals such as Resource Water Quality Objectives (RWQOs) for the surface water resources during the first iteration of the RWQO determination process.

Hence, this necessitated a careful evaluation of the flow of these tributaries to aid future decision making. Table 1 summarises the key tributaries, per quaternary catchment (quat), draining into the main stem of the Lower Orange River. For each quat the following key indicators were considered and quantified:

FIGURE 1A

Orange River Basin

LEGEND

- Major City / Town
- Town
- dam_orange
- River
- Drainage Basin
- International Boundary
- Provincial Boundary

Elevation

- < 0 ft a.m.s.l
- 0 - 1000 ft a.m.s.l
- 1000 - 3000 ft a.m.s.l
- 3000 - 7000 ft a.m.s.l
- 7000 - 11000 ft a.m.s.l
- > 11000 ft a.m.s.l

Data sources:
Department: Land Affairs, Chief Directorate: Surveys and Mapping (Towns, Rivers, Dams and International Boundaries)
Municupal Demarcation Board (Provincial Boundaries)
Department: Water Affairs & Forestry

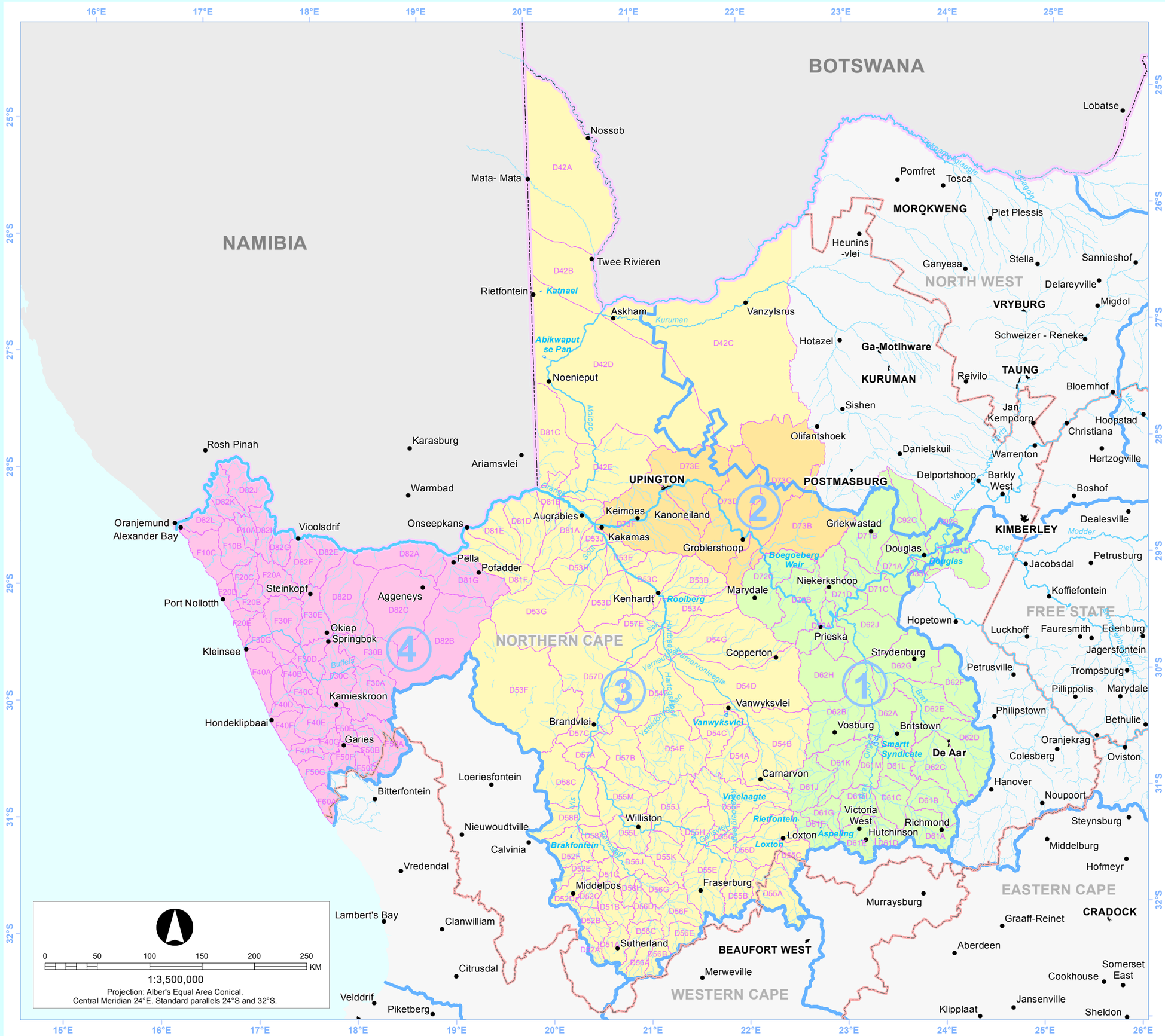
Locality Map: Orange River Basin

Map produced by:
Department: Water Affairs
Directorate: Spatial & Land Information Management
September 2009 (Ref: GM09_151)

FIGURE 1B

WMA 14 : LOWER ORANGE

Sub - Areas



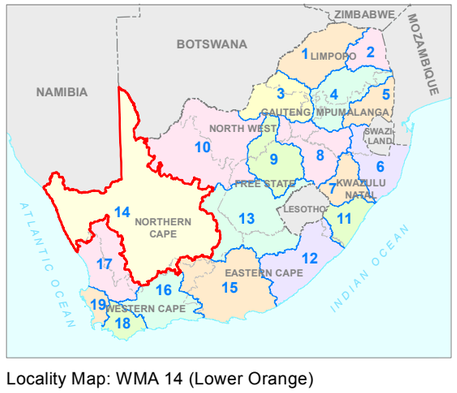
LEGEND

- Major City / Town
- Town
- Dam
- River
- Quaternary Drainage Region
- Water Management Areas
- Provincial Boundary
- International Boundary

Sub - Areas

1. [Sub - Area 1] Douglas to Boegoeberg Dam
2. [Sub - Area 2] Boegoeberg Dam to Kanoneiland
3. [Sub - Area 3] Kanoneiland to Pella
4. [Sub - Area 4] Pella to Alexander Bay

Data sources:
Department: Land Affairs, Chief Directorate: Surveys and Mapping
(Towns, Rivers, Dams and International Boundaries)
Municipal Demarcation Board (Provincial Boundaries)
Department: Water Affairs & Forestry
(Water Management Areas and Drainage Boundaries)



Locality Map: WMA 14 (Lower Orange)

Map produced by:
Department: Water Affairs and Forestry,
Directorate: Spatial & Land Information Management
June 2009 (Ref: GM09_077)

- The Mean Annual Runoff (MAR) contribution of each tributary (either incrementally where the tributary was contained within a single quat, or cumulatively where the tributary extended beyond more than one quat).

- The % contribution of this MAR to the Total MAR for the Orange River Basin.

- The Q75 in m^3 which is the flow that is equalled or exceeded 75% of the time.

- The annual coefficient of variation (CV) for modelled flow data. The CV which is a statistical measure of the dispersion of data points in a data series around the mean, is useful for quantifying the degree of variation in the data, i.e. a tributary may have a reasonable MAR, but if the annual CV is high, this will indicate that within a year, the flow is erratic with a high degree of variation.

With the exception of the Vaal River which, although it is a main tributary to the Lower Orange River, is a major river system of its own, the following can be observed from Table 1:

- The majority of the quats (74%) had a unit MAR of 0-2.5 mm.

- The % contribution of the MAR to the total MAR for the Orange River Basin was less than 1% for 97% of the quats.

- The MAR varied between 0.01 and 143.42 mil m^3 (MAR range for the Upper Orange tributaries: 41-669 mil m^3, Report 2.1), with 53% of the quats having a MAR of 2 mil m^3, and the average MAR being 12 mil m^3.

- For 75% of the time or more, all tributaries had a zero flow.

- CV values ranged from 1.29 to 5.74, comparatively high to the range of CV values for the main tributaries in the Upper Orange, i.e. 0.4 to 0.82 (refer to Report 2.1).

In summary, Table 1 confirms that tributaries in the Lower Orange River are mostly non-perennial, with very low MARs contributing a very small, and in most cases an insignificant surface flow to the main stem of the Orange River. Furthermore, where small surface flows exist, these are highly erratic and variable. These factors have implications for the setting of RWQOs, and hence, RWQOs in the LOWMA will mostly likely only be set for the main stem of the Orange River at level 1 (See Report No. 5).

Table 1: Summary of Tributaries per quaternary catchment draining into the main stem of the Orange River

Sub-Area	River	Order of river	Cumulative at Quaternary Catchment:	Cumulative/ Incremental Area (km^2)*	Unit MAR[1] (mm)	Cumulative/ Incremental MAR	Mean Annual Runoff (MCM)*	% of MAR for Total Orange R Basin	Standard Deviation*	Q75[2] (m^3)*	Annual CV[3, *]
1	Vaal	5	C92C	196294.28	5-10	Cumltv.	4032.82	34.09	2938.62	46.97	0.73
1	Unnamed	1	D71A	1207.81	2.5-5	Increm.	5.69	0.05	13.34	0.00	2.34
1	Unnamed	2	D71B	2871.27	5-10	Increm.	20.01	0.17	45.84	0.00	2.29
1	Unnamed	2	D71C	1590.16	2.5-5	Increm.	4.75	0.04	11.47	0.00	2.42
1	Diep	1	D71D	1711.89	2.5-5	Increm.	4.96	0.04	12.01	0.00	2.42
1	Unnamed	2	D72A	1395.94	0-2.5	Increm.	3.09	0.03	7.57	0.00	2.45
1	Brak	5	D62J	33688.71	0-2.5	Cumltv.	84.58	0.71	161.08	0.00	1.90
2	Soutloop	3	D73B	3718.88	5-10	Increm.	26.34	0.22	48.46	0.00	1.84
2	Unnamed	2	D73D	4290.43	2.5-5	Increm.	15.3	0.13	31.78	0.00	2.08
2	Matjies	2	D73E	3866.68	2.5-5	Increm.	13.29	0.11	27.68	0.00	2.08
2	Kareeboom	2	D73F	4629.92	0-2.5	Increm.	9.62	0.08	20.65	0.00	2.15
3	Molopo	5	D42E	4207.49	0-2.5	Cumltv.	143.42	1.21	292.62	0.00	2.04
3	Bak	2	D81C	2681.73	0-2.5	Increm.	2.53	0.02	6.2	0.00	2.45
3	Bul	2	D81B	851.04	0-2.5	Increm.	0.65	0.01	1.61	0.00	2.49
3	Narries se loop	2	D81D	1825.61	0-2.5	Increm.	2	0.02	5.02	0.00	2.51
3	Samoep	1	D81E	1289.96	0-2.5	Increm.	0.82	0.01	2.12	0.00	2.58
3	Kaboep	2	D81F	1839.88	0-2.5	Increm.	0.93	0.01	2.42	0.00	2.61
4	Goob se Laagte	2	D81G	2005.97	0-2.5	Increm.	0.85	0.01	1.84	0.00	2.15
4	Hartbees	2	D82A	1914.98	0-2.5	Increm.	0.28	0.00	0.66	0.00	2.35
4	Brak	2	D82D	2961.53	0-2.5	Increm.	1.72	0.01	3.63	0.00	2.11
4	Unnamed	2	D82E	941.86	0-2.5	Increm.	0.66	0.01	2.27	0.00	3.45
4	Kosies	2	D82F	1036.28	0-2.5	Increm.	0.89	0.01	3.04	0.00	3.40
4	Groen	2	D82G	592.73	0-2.5	Increm.	0.18	0.00	0.65	0.00	3.67
4	Bak	2	D82H	819.32	0-2.5	Increm.	0.09	0.00	0.35	0.00	4.00
4	Gannakouriep	3	D82J	1380.48	0-2.5	Increm.	0.01	0.00	0.04	0.00	5.72
4	Annis	2	D82K	913.67	0-2.5	Increm.	0.01	0.00	0.03	0.00	5.74
4	Unnamed	1	D82L	750.26	0-2.5	Increm.	0.02	0.00	0.09	0.00	4.72
4	Holgat	3	F10C**	2714.48	0-2.5	Cumltv.	0.19	0.00	0.09	0.00	2.01
4	Buffels	4	F30G**	9734.43	0-2.5	Cumltv.	10.79	0.09	24.52	0.00	2.27
4	Swartlintjies	3	F40D**	1748.48	0-2.5	Cumltv.	1.45	0.01	1.86	0.00	1.29
4	Groen	3	F50G**	4863.59	0-2.5	Cumltv.	7.34	0.06	11.25	0.00	1.53

1	Unit MAR (Mean Annual Runoff) is the MAR proportioned according to the catchment area (Data Source: Midgley, *et. al.*, 1994)
2	Q75 is the flow that is equalled or exceeded 75% of the time
3	CV = Co-efficient of variation
*	Data source: SPATSIM Software Package, 2004
**	Quaternary catchments draining directly into the sea

5 TRANSFER SCHEMES

Due to the arid climate of this WMA, water is abstracted from the Orange River and supplied to various initiatives via several different water supply and irrigation schemes throughout the LOWMA (Figure 2). The main supply pipelines include the following:

1. Kalahari West rural water supply scheme where approximately 05. mil m^3 per annum is abstracted from Upington and supplies areas far north through a pipeline network.

2. Karos-Geelkppan rural water supply scheme abstracting water from before Upington, supplying areas in the north via a single pipeline.

3. Pelladrift water supply scheme where 4.7 mil m^3 per annum of water is abstracted and transported by two pipelines, one supplying local farmers and the towns of Pofadder and Pella, and the other supplying domestic use for the small town of Aggenys, but more importantly for industrial use for the base metals mine, Black Mountain at Aggenys.

4. Springbok regional water supply scheme which abstracts 4.2 mil m^3 of water at Henkriesmond and is transferred via a long pipeline to supply domestic use and small-scale livestock watering in the farming communities of Springbok, Steinkompf, Nababeep, Okiep and Kleinsee.

5. Namibian pipelines. Before Alexander Bay, close to Sendelingsdrift, Karas, on the Namibian side, there are two pipelines leading from the main stem of the Lower Orange River that supply the mining activities of Rosh Pinah and Skorpian Zinc.

6. Port Nolloth is supplied by a pipeline leading off from the Orange River at Alexander bay for the purpose of domestic use, a small fishing harbour and small-scale diamond mining.

In addition to the water-supply schemes, the banks of the Lower Orange are highly irrigated and uniquely characterised by extensive irrigation canals in the areas of Douglas, Boegoeberg, Upington, Kakamas and Vioolsdrift (Figure 2). These areas mark a green, fertile strip in this otherwise arid and desolate area. This has implications for water quality management as agricultural return flows are typically characterised by high salinities, and in some cases are high in phosphates and nitrates due to fertiliser use. Furthermore, abstractions from the main stem of the river could exacerbate water quality problems by reducing flow, while the abstracted water should also be fit for the intended use.

WMA 14 : LOWER ORANGE

Irrigation Canals and Supply Pipelines

Pipelines

- Kalahari East & West Water Supply Pipelines
- Karos-Geelkoppan Water Supply Pipeline
- Khubus Water Supply Pipeline
- Namaqualand Pipeline
- Pelladrift Water Supply Pipelines
- Port Nolloth Water Supply Pipelines
- Rosh-Pinah Skorpian Zinc Water Supply Pipeline
- Vaal/Gamagara Water Supply Pipeline

Canals

- Upington Canals
- Boegoeberg Canals
- Douglas Canals
- Kakamas Canals
- Vioolsdrift Canals

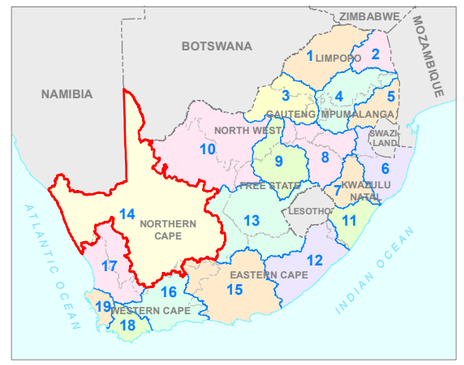
LEGEND

- Major City / Town
- Town
- Dam
- River
- Water Management Areas
- Provincial Boundary
- International Boundary

Visioning Areas

- [Area 1] Douglas to Boegoeberg Dam
- [Area 2] Boegoeberg Dam to Kanoneiland
- [Area 3] Kanoneiland to Pella
- [Area 4] Pella to Alexander Bay

Data sources:
Department: Land Affairs, Chief Directorate: Surveys and Mapping
(Towns, Rivers, Dams and International Boundaries)
Municupal Demarcation Board (Provincial Boundaries)
Department: Water Affairs & Forestry
(Water Management Areas and Drainage Boundaries)
DWAF Northern Cape GIS Unit
(Pipelines and Canals)
Orange/Vaal Water User Association
(Douglas Canals)



Locality Map: WMA 14 (Lower Orange)

Map produced by:
Department: Water Affairs and Forestry,
Directorate: Spatial & Land Information Management
March 2009 (Ref: GM09_033)

0 50 100 150 200 250 KM

1:3,500,000

Projection: Alber's Equal Area Conical.
Central Meridian 24°E. Standard parallels 24°S and 32°S.

6 PROTECTED AREAS

The unique landscape of the lower half of the LOWMA is home to three significant conservation areas: The Augrabies Falls National Park, the Kgalagadi Transfrontier Park and the |Ai|Ais/Richtersveld Transfrontier Park. The Augrabies Falls National Park comprises 55 383 hectares on both the northern and southern sides of the river but is completely contained within South African boarders. It is managed by the South African National Parks Board and is home to a diversity of species, including succulents, birds, reptiles, springbok and gemsbok and giraffe (SANPARKS, 2007).

The Kgalagadi Transfrontier Park is situated in the far most northern parts of the LOWMA and is one of the largest conservation areas in the world – 3.7 million ha (NCTA, 2007). It is the product of a joint initiative of South Africa, Nambia and Botswana, to unify the former South African Kalahari Gemsbok Park and Botswana's Gemsbok National Park, with border access points to the park available in all three countries. The Ai-Ais/Richtersveld Transfrontier Park, is another transfrontier initiative brought about by the signing of an international treaty by the presidents of Namibia and South Africa (NCTA, 2007). It is a combination of the former Ai-Ais Hot Springs Game Park in Namibia and the |Ai|Ais/Richtersveld National Park in South Africa.

The existence of protected areas in the LOWMA has implications for water quality managers as the focus of the management goal shifts from one of domestic or human health, to ecological health. Management goals may become more or less stringent as this focus shifts. Furthermore, variables of concern might change as the main users are comprised of recreational and ecological users, as opposed to agricultural and domestic users in other parts of the LOWMA.

7 CATCHMENT CHARACTERISATION

7.1 [Sub-Area 1] Douglas to Boegoeberg

This area begins with DWAF's water quality monitoring station D3H008, which is situated on the main stem of the Orange River at Marksdrift (Figure 3a). 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. Upstream from Douglas is Douglas Weir, a large weir which provides water for abstractive use, mostly for agricultural activities.

Figure 3a: The Orange River at Marksdrift water quality monitoring point, D3H008 (RQS, 2007).

Downstream from the confluence is water quality monitoring station D7H012, situated just before the Brak and Ongers Rivers flow into the Orange River. The river continues to flow in a south-westerly direction for approximately 160 km before reaching the next small town of Prieska. The third water quality monitoring station for this sub-area, D7H002, is also situated here. From Prieska, the river curves to flow in a north westerly direction, where 115km downstream from Prieska, the large Boegoeberg Weir is situated. The fourth and last water quality monitoring point for this sub-area, D7H002, is situated just downstream of Boegoeberg Weir (Figure 3b).

Figure 3b: Orange River downstream Boegoeberg Weir

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 (Figure 3c and 3d) and are made up of variable crop production, including mielies, 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.

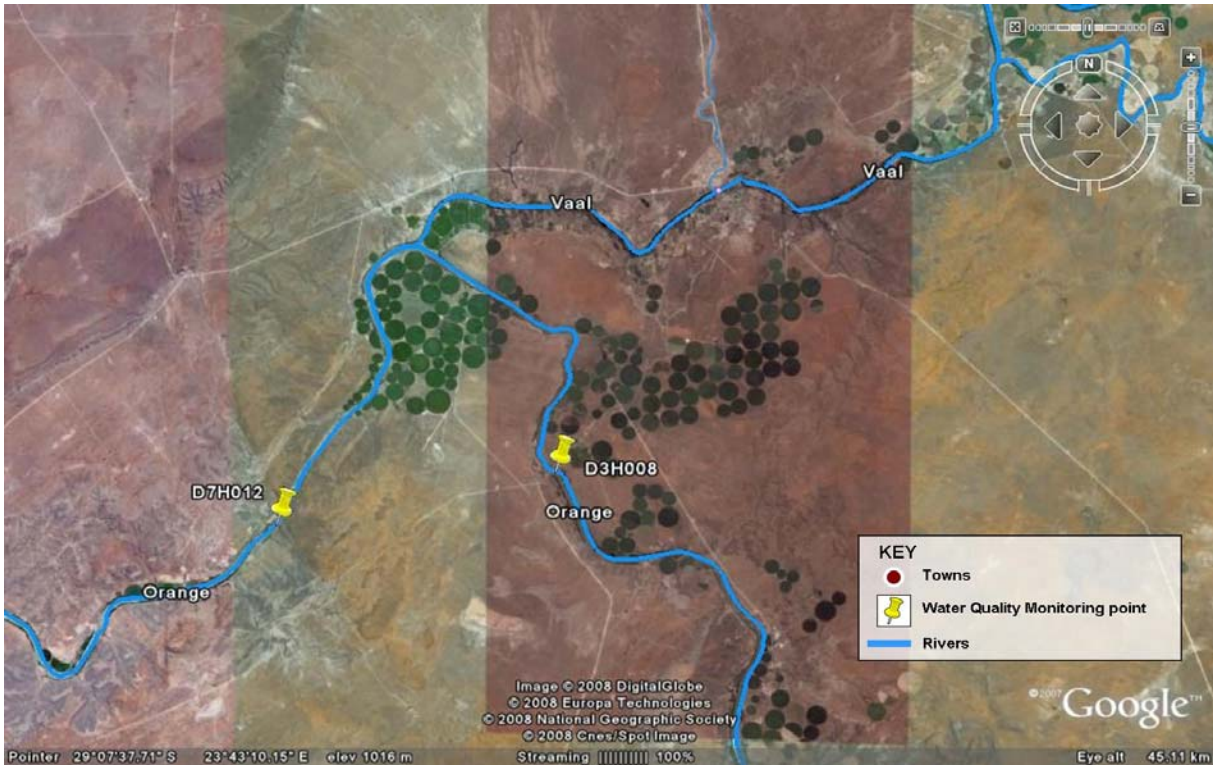


Figure 3c: Google Earth image illustrating intensive agricultural activity in the area surrounding the confluence of the Orange with the Vaal River. (Google Earth, 2009)

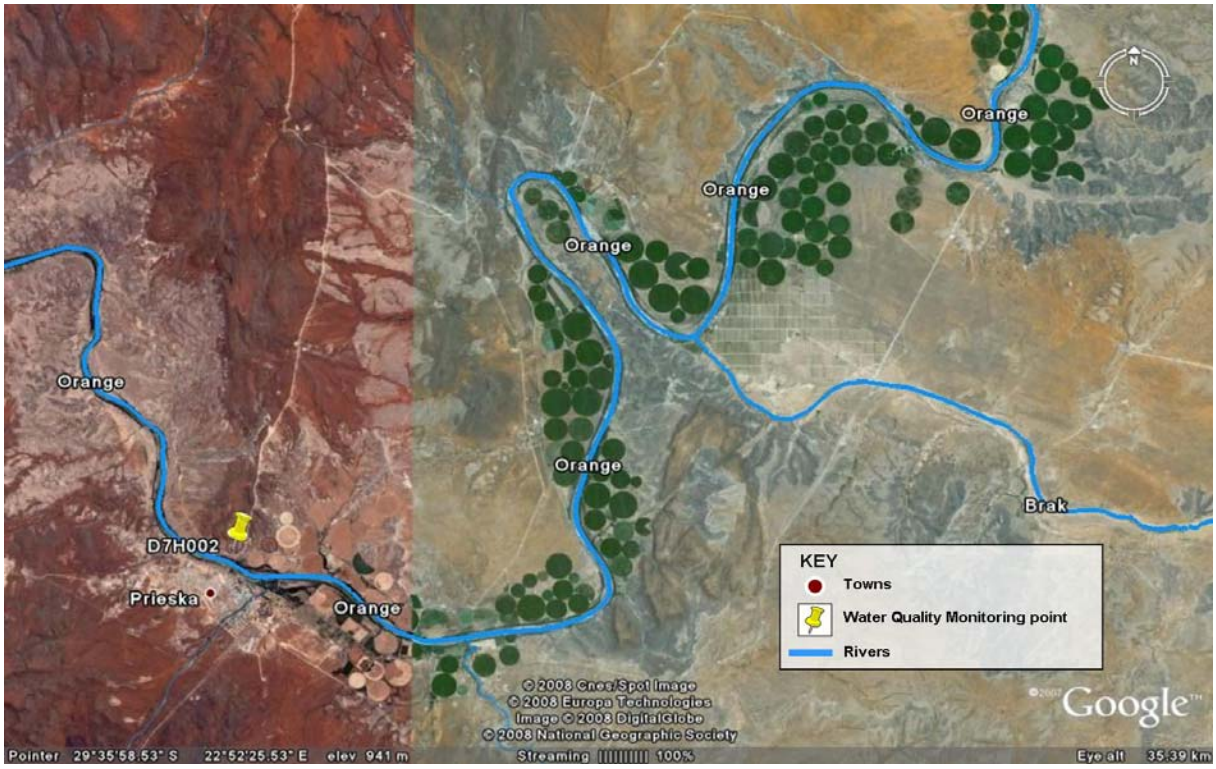


Figure 3d: Google Earth image illustrating intensive agricultural activity in the area of the confluence of the Brak River with the Orange River, and Prieska. (Google Earth, 2009)

7.2 [Sub-Area 2] 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. The distance of the river between Boegoeberg Weir and the next water quality monitoring point with feature ID 184055 at the intake to the Upington Water Works, is approximately 162 km. This area is largely arid and desolate with the only key agricultural activities taking place on the highly irrigated banks for the Orange River (Figure 4a). Upington has a population of approximately 72 000 people and its airport boasts one of the longest commercial runways in the world (4.9km long). It is also a popular stopover destination for tourists travelling to Aurgabies Falls National Park (Figure 4b), the Fish River Canyon, the Kgalagadi Transfrontier Park and for South African tourists travelling to Namibia. This section of the Orange River is typically very wide and often characterised by large road bridges to provide access to local towns (Figure 4c).

Figure 4a: Google Earth image showing arid area between Boegoeberg Weir (situated upstream to the East of this image) and Upington (situated downstream to the west of this image), with the highly irrigated banks of the Orange River.

Figure 4b: Augrabies Falls situated in the Augrabies Falls National Park (Roos, 2008)

Figure 4c: The main road bridge and pedestrian bridge spanning the width of the Orange River at Upington

From Upington, the river continues to flow in a south-westerly to a westerly direction. From Upington onwards, the river becomes heavily braided (Figure 4d), forming a series of highly irrigated islands. The largest, Kanon Eiland (Island), is typically characterised by many road bridges linking a series of smaller islands. The next water quality monitoring point, D7H004, is located here.

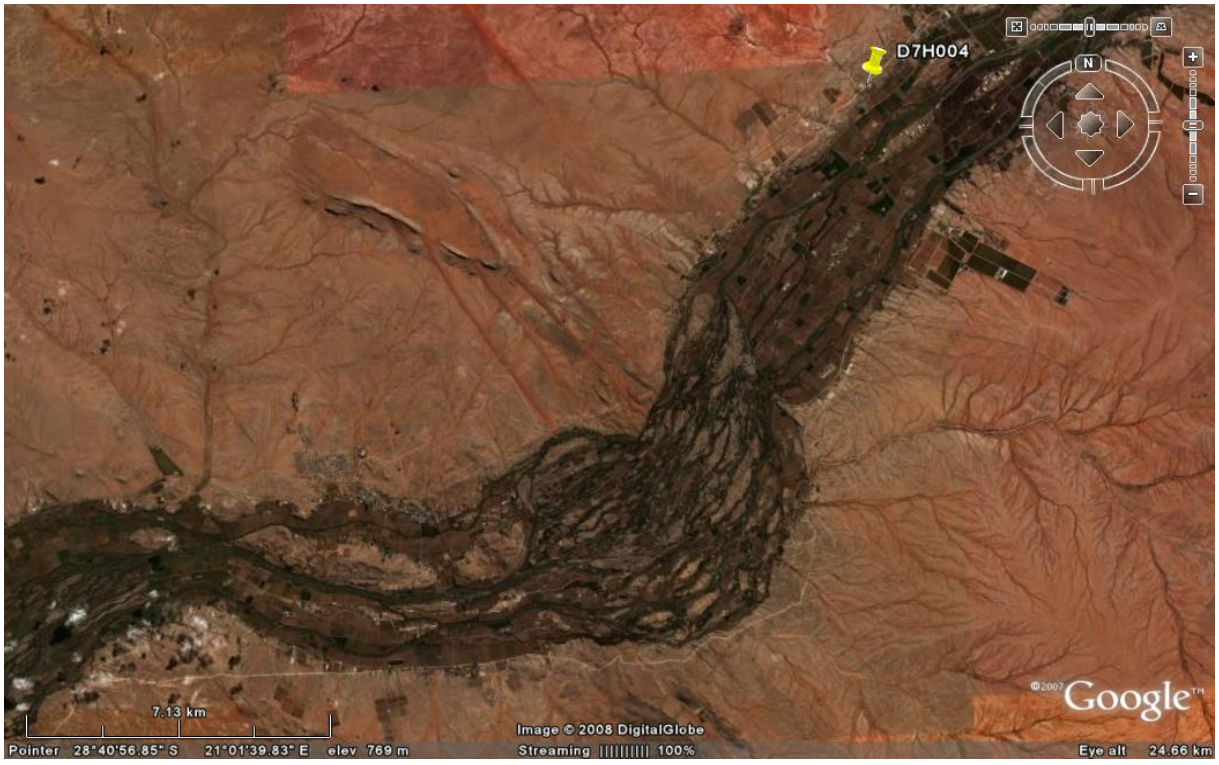


Figure 4d: Google Earth image showing the heavily braided Orange River in the area of Kanon Eiland, downstream of Upington

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 as a result 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.

Upington is the town that supports the most infrastructures in the Lower Orange WMA. This includes Upington International Airport supported by a large fuel depot, a golf course and casino, and some small-scale industries such as the salt works and the Orange River wine co-op (the largest wine co-op in the country), which receives grapes for wine production from all neighbouring vineyards. Upington has also been classified as a core economic area according to the National Spatial Development Perspective (NSDP, 2006). Hence, it is characterised by a high level of economic potential, with a diverse economy and relatively high levels of formal infrastructure, transport nodes, education and health services. Nature conservation plays a lesser role in this area compared to Sub-Area 3, with the smaller-sized Spitskop Nature Reserve situated just outside of Upington. No significant groundwater use occurs in this area.

7.3 [Sub-Area 3] Kanoneiland to Pella

This is the first area to border with Namibia north of the Orange River. It also borders with the Gouritz and Olifants/Doorn water management areas far south of the Orange River. From Kanon Eiland the Orange River continues towards the small farming towns of Keimoes and then Kakamas, approximately 50km downstream. Before reaching these towns water is abstracted at Neusberg Weir and fed into two main canal systems, one which runs north of the river and the other south. These canals are part of a historical irrigation scheme which provide water for irrigation farming along the banks of the river, but particularly within the near vicinity of Keimoes and Kakamas. Water quality monitoring point D7H014 is situated just below Neusberg Weir (Figure 5a and 5b).

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, 50km downstream from Kakamas. The falls, situated within the Augrabies Falls National Park, is 56m high and creates a river gorge for a distance of approximately 18km downstream. 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,

Figure 5a: Google image showing section of the Orange River between Kanon Eiland and its confluence with the Hartbees River

Figure 5b: Site photo at the location of water monitoring point, D7H014 (RQS, 2007)

Agricultural activities along the banks of the Orange River in this sub-area are dominated by dried fruit production (Figure 5c) 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).

Figure 5c: Workers just outside of Kakamas harvesting grapes for raisin production

Other activities in this area include stock farming (cattle and goats), game farming and tourism. Eco-tourist adventures are popular offering off-road biking and vehicle activities and white-water rafting. The Augrabies Falls National Park comprises 55 383 hectares on both the northern and southern sides of the river and is home to a diversity of species, including succulents, birds, reptiles, springbok, gemsbok and giraffe (SANPARKS, 2007). The park, together with the Orange River is also host to eco-adventure tourism ventures such as canoeing and white water rafting, hiking, game drives and mountain bike riding.

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 Pelladrift Water Supply Scheme (Figure 2) pipes water from the Orange River to provide water for the small farming town of Pofadder and to Blackmountain Mine as well as to Aggenys, the small town supporting the mine.

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 (NCTA, 2007). Sub-Area 3 also supports a sizeable private game farm industry and a salt industry associated with the Witpan and Grootwitpan salt pans situated 115km and 95km northwest from 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.

7.4 [Sub-Area 4] Pella to Alexander Bay

In this area the Orange River forms the border with Namibia. The town of Pella marks the boundary between Sub-Area 3 and 4 and is where the next monitoring point, D8H008 is located. Klein Pella, situated immediately adjacent to Pella, is characterized by extensive date plantations. These plantations are irrigated using flood irrigation and supply dates to both local and export markets. From Pella the river continues in a general westerly direction towards Vioolsdrift Weir, approximately 166km downstream from monitoring station D8H008 at Pella. At Vioolsdrift Weir, water quality monitoring station D8H003 is situated. Upstream Vioolsdrift Weir, water is also piped to the principal town of Springbok situated south of the river and then onto the coastal town of Kleinsee (Figure 2). A Chrome industry is situated in Springbok and 100km from Springbok is the Vaalputs nuclear waste repositary site, situated on the flat plains of the Bushmanland plateau. Springbok is also home to the Goegap Nature Reserve. The town of Kleinsee is home to the Kleinsee Nature Reserve as well as diamond mining activities (NCTA, 2007).

Downstream from Vioolsdrift Weir is the small farming town of Vioolsdrift situated on the South side of the river. Shortly after Vioolsdrift, a road bridge also serving as a border crossing, crosses the river into Noordoewer (Afrikaans for North Bank) on the Northern, Namibian side of the river. Thereafter, the river continues in a westerly direction before veering sharply towards the north, heading through the Richtersveld area. The Richtersveld is made up of many local Nama communities and marks the northern area of the Namaqualand. Approximately 160 000 hectares of the Richtersveld has been named a UNESCO World Heritage Site. This is due to migration patterns of the Nama people that have lasted for at least two millennia and their land management processes of communal grazing lands in an otherwise, dramatic, mountainous desert and botanical landscape.

Approximately 145 km after Vioolsdrift the Fish River meets the Orange River and is one of the major tributaries to the Lower Orange River. The river then veers in a westerly direction, before travelling in a southerly direction towards the next water quality monitoring point, D8H007 at Brand Karos, 120 km downstream of the confluence with the Fish River (Figures 6a and 6b). Only 25km downstream from this point, is the next and last water quality monitoring point, D8H012.

A further 10km downstream the river meets 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 (Figures 6c and 6d) 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 as a result of a severely degraded state of the salt marsh on the south bank (ARTP JMB, 2008).

Figure 6a: The Orange River at Brand Karos, in the near vicinity of water quality monitoring point D8H007

Figure 6b: Google Earth image showing the confluence of the Fish and Orange Rivers, upstream from D8H007 at Brand Karos.

Figure 6c: The Alexander Bay estuary, just upstream of the outflow of the Orange River into the Atlantic Ocean

Figure 6d: Google Earth image showing Alexander Bay estuary, downstream from D8H012 at the Openheimer Bridge.

Little water use and land use activity can be observed in the dry, arid and often rocky terrain between Pella and Vioolsdrift Weir. At the weir, water is transported via a canal on the south side of the river to downstream agricultural farms. Irrigated agriculture is concentrated along the river banks (Figure 6e) and produce is dominated by grape and wine production. Smaller scale agriculture include grapes, hoodia and tomatoes. Ostrich farming also occurs and subsistence stock farming is common amongst the local Nama communities who congregate in mission stations in the Richtersveld.

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 in the vicinity of Alexander Bay. Diamonds were first discovered on the West Coast in 1925. Mining and prospecting activities still continue today. Semi-precious gems and quartzite mining occur on a small scale. Historically, the Richtersveld, including Springbok, was extensively mined for copper ore and abandoned mines characterise certain parts of the landscape. Now, the |Ai|Ais/Richtersveld Transfrontier Park, is an important conservation area, initiated in 2003, after the signing of an international treaty by the presidents of Namibia and South Africa (NCTA, 2007).

Figure 6e: Irrigated agricultural activities downstream from Vioolsdrift Weir

The Orange River also plays a significant role in supporting eco-tourism as a whole 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.

In summary, the water users in Sub-Area 4 are variable and include mostly irrigators for agricultural activities, diamond mines, recreational and domestic users. Extensive abstractions for domestic, agricultural and mining use could exacerbate water quality problems by reducing flow. Agricultural return flows can contribute towards higher salinity, phosphate and nitrate levels. Such factors need to be incorporated into water quality management decision making.

8 SOCIO-ECONOMIC PROFILE AND DEMOGRAPHICS

The LOWMA, although the largest WMA, only contributes less than 1% of the Gross Domestic Product (GDP) of South Africa. The largest economic sectors as per 1997 figures for the Gross Geographic Product are (DWAF, 2004):

- Government 19.4%
- Mining 17.4%
- Agriculture 15.9%
- Trade 15.1%

There are no large government institutions in the LOWMA and the 19.4% government sector representation relates to services with respect to mining, agriculture and trade. Mining resources are comprised mostly of alluvial diamonds, copper, asbestos, semi-precious stones, alumni silicate, limestone and dolomite. Mining activities are described as relatively stable over the medium term (DWAF, 2004).

The Orange River can be described as the backbone to the agricultural sector as it supplies water for the growth of high value crops such as export dates and export table grapes. Other products include raisins, wine, flowers, vegetables, grain and fodder crops. The agricultural sector is vulnerable to changes and competition in the international market (DWAF, 2004).

Figures for 1994 place the LOWMA as having 32% unemployment, higher than the national average of 29%, with 30% of a 122 000 person workforce formally employed in the government sector, 30% in agriculture and 12% in trade. The LOWMA is largely contained within the Northern Cape Province which shows similar, but more recent economic figures (DED, 2007): 44.6 % poverty rate in 2001, a just over 2% contribution to the country's GDP. As the largest WMA, it is the second most scarcely populated with an estimated population of 382 200[1] (DWAF, 2004), with more than 70% living in urban areas (mostly mining towns). Rural population percentages increase to 40% in the areas concentrated along the Orange River. The general trend in this LOWMA is the migration of people from rural to urban areas in search of employment opportunities in mining towns.

The high unemployment rates, scarcely populated areas and minimal potable water available in the LOWMA, has resulted in a low human development index marked by limitations in water supply.

[1] The most scarcely populated WMA is the Olifants/Doring WMA, with a population of 104 000 – based on 1995 population figures (DWAF, 2002).

Statistics for the Northern Cape reveal the following (DED, 2007):

- 80,2% of households live in formal structures and 12,5% in informal structures
- The Human Development Index is 0.58 (below the country average of 0.72)
- 3.4 % of the population have no access to clean piped water
- 7.3% of households have access to piped water on a community stand more than 200m away
- 11,2% of all households in the province have no access to sanitation
- 11,8% of households in the province only has access to bucket latrine systems.

Sub-standard water quality may affect the economic viability of economic activities. Examples could include impaired animal health in the case of stock watering or reduced quality of expert fruit and even the forced withdrawal of such fruits form the export market. Sub-standard water quality may also affect human health, which in turn hampers the individual's ability to be productive or to fulfil social responsibilities.

If water quality resources in this catchment are effectively managed and planned for, then the availability of potable water can be increased and the issue of human development addressed – if and where necessary.

9 RELEVANT STAKEHOLDERS

A number of stakeholders and interest groups were identified (Table 2) that should be involved during the visioning process and who should also be invited when catchment forums are being established. Stakeholder participation is vital in effective catchment management as they provide inside, sight-specific information in terms of land and water use activities. They are also a vital source of any existing information relating to the catchment. However, the vastness of the WMA and large distances to be travelled to reach the next settlement, limits stakeholders to readily participate on a frequent basis.

Table 2: Interest groups and key stakeholders identified for the four sub-areas

Sub-Area 1	**Sub-Area 2**	**Sub-Area 3**	**Sub-Area 4**
Douglas to Boegoeberg	**Boegoeberg to Kanon Islands**	**Kanon Islands to Pella**	**Pella to Alexander Bay**
Upington and Kimberley regional offices, DWAF	Upington regional office, DWAF	Upington regional office, DWAF	Upington regional office, DWAF
District municipalities: • Pixley Ka Seme (Karoo) Local Municipalities: • Siancuma (Douglas) • Emthanjeni (De Aar) • SiyaThemba (Prieska)	District municipalities: • Siyanda (Upington) Local Municipalities: • !Kheis (Groblershoop) • Khara Hais (Upington)	District municipalities: • Siyanda (Upington) Local Municipalities: • Khai-Ma (Pofadder) • Kai Garib (Kakamas)	District municipalities: • Namakwa Local Municipalities: • Nama Khoi (Springbok) • Richtersveld
DME	DME	DME	DME
DTEC	DTEC	DTEC	DTEC, ARTP JMB
	Dept of Environmental Affairs	Department of Agriculture	Department of Agriculture
		N Cape Conservation	Department of Science & Technology
Orange/Vaal WUA / Irrigation Boards	Upington Irrigation Board, Upington Islands Irrigation Board (includes 7 at time of workshop)	Pella Water Board	Vioolsdrift Irrigation Board
Boegoeberg WUA	Boegoeberg WUA	Kakamas WUA	Namakwa Water Board
Farmers from Douglas and Prieska	Farmers	Farmers	Farmers and resource poor farmers (4 000ha for whole of N Cape)
Diamond diggers	Diamond prospectors	Prospectors, miners	Prospectors, miners
Nature conservation (fishing, etc.)	Nature enthusiasts (fishing, etc)	Nature enthusiasts (fishing, etc) and conservation	Namakwa Community
	Recreation and tourism	Recreation and tourism	Recreation and tourism, including African Paddler's Association
		NGOs: • Botsoc • Conservation International • SKEP • WESSA • Social NGOs	NGOs: • SKEP • Working for Water • Working for Wetlands SPP (Surplus People's Project)
			World Heritage Site CPA

10 RESERVE DETERMINATION STUDIES

One component of a Reserve determination study is to provide the ecological requirements of the water resources that will assist managers to protect the water resources for the aquatic ecosystem, while also allowing economic development. The results provide information on the quantity and quality requirement for habitat and biota. These studies can be undertaken at various levels of detail and confidence. These studies can be on a desktop, rapid, intermediate or comprehensive level.

Only desktop and rapid Reserve determination studies have been undertaken in the LOWMA. Table 3 below summarises for which quaternary catchments Reserves have been carried out, and whether they were Desktop or Catchment Reserves. A visual summary of completed Reserves is provided in Appendix A. No comprehensive Reserve has been completed for this WMA. A comprehensive Reserve determination for this WMA would greatly benefit any future Water Quality Planning initiatives as it would more accurately identify the water quality required to ensure a water quality use that was sustainable for aquatic fauna and flora, and that also provided for the Basic Human Needs in the catchment. It would also further quantify required instream flows, especially for the internationally important ecological system of the Alexander Bay estuary.

Table 3: Summary of completed Reserves for the LOWMA

Sub-Area No.	Quaternary Catchment	Rapid/Desktop
1	D71D	Desktop
1	D62J	Desktop
1	C92C*	Rapid
2	D73F	Rapid
2	D73B	Rapid
3	D57E	Desktop
3	D42E	Desktop
3	D81B	Desktop
4	D82A	Desktop
4	D82E	Desktop
4	F30D	Desktop
4	D82A	Desktop
4	D53J	Desktop
4	D82K	Rapid

*Also including Quaternaries C92A, C91E and C91D in WMA 10, Lower Vaal

11 AN INTERNATIONAL PERSPECTIVE

Due to the fact that the Lower Orange River is largely a shared watercourse with Botswana and Namibia, a consideration of the international obligations and bilateral agreements is imperative. These are outlined in the Overarching Catchment Context (Report No.1 of this series). Due to the logistical and political implications of international stakeholder engagement, and due to the foundational nature of this report series, a decision was taken to engage international stakeholders only as part of future work in the catchment, once a comprehensive terms of reference is established for a higher confidence study such as an Integrated Water Quality Management Strategy for the Orange River Basin. However, the Overarching Catchment Context (Report No.1) still serves as a useful tool in identifying the relevant stakeholders that would need to be part of such engagements.

12 CONCLUSION AND WAY FORWARD

The LOWMA is different to other WMAs, in that it has a particularly dry, arid climate, with tributaries to the Orange River that are typically non-perennial and have erratic flows. This requires a unique approach to water resource management such as the setting of only Level 1 Resource Water Quality Objectives. This WMA is also characterised by a series of unique systems of irrigation canals, and water transfer schemes, resulting in human settlement and associated activities being concentrated in areas along the immediate banks of the river or at destinations of pipelines.

This report serves as a desktop catchment assessment study and paves the way for a more comprehensive catchment assessment study to be conducted, particularly contributing towards an Integrated Water Quality Management Strategy for both the Lower and Upper WMAs, that especially involves international stakeholders.

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APPENDIX A: STATUS OF SURFACE WATER RESERVE DETERMINATIONS FOR THE LOWER ORANGE WATER MANAGEMENT AREA

Status of Surface Water Reserve Determinations
WMA 14
Lower Orange

Map Description:
This map depicts the current status of surface water Reserve determinations for the defined region (see version information below).
The map should be interpreted together with the associated tables.
Where Quaternary catchments are shaded it serves only as an indication that one or more Reserve has been approved within that catchment, and should not be interpreted as representative of the entire area.

LEGEND

- City / Town
- Dam
- River
- Provincial Boundary
- International Boundary
- WMA Boundary

Roads
- National Road
- Arterial Road
- Main Road

Drainage Regions
- Primary Drainage Region
- Secondary Drainage Region
- Tertiary Drainage Region
- Quaternary Drainage Region

Reserves
- Comprehensive
- Intermediate
- Rapid
- Desktop
- EWR Site on Comprehensive
- EWR Site on Intermediate
- EWR Site on Rapid Level
- EWR Site on Desktop Level
- Gauging Station

Aknowledgements:
Data on the coastline, international boundaries, cities, towns, roads, dams and rivers was obtained from the Chief Directorate: Surveys and Mapping, Department of Land Affairs.
Data on provincial boundaries was obtained from the Municipal Demarcation Board (Feb2006).
Data on Drainage Regions and Water Management Areas is available from the Department of Water Affairs and Forestry.
Data on reserve determinations was prepared by the Directorate Resource Directed Measures, Department of Water Affairs and Forestry.

Locality Map : WMA 14: Lower Orange

This map was designed for:
Resources Directed Measures (RDM)
by:
Spatial & Land Information Management (SLIM)
Geographic Information and Archiving
Cartographic Services

Surface Water Reserve Status Map:
Task : GM07_270
WMA: 14
Version: 2
RDM Audit Date : October 2007
Map Date: December 2007
Plotfile : RDM_WMA14_v2_2007.jpg