3 CATCHMENT ACTIVITIES AND INFRASTRUCTURE

This section describes the activities within a catchment that impact on both the water quantity and the water quality. Both the water resources developments and land-use activities will, therefore, influence water resource quality and the quality of the water supplied. This chapter highlights the activities (both point and non-point) which have an impact on the water resource quality in the Diep River catchment.

3.1 POPULATION

Development in the catchment has occurred mostly in the lower part of the catchment. The majority of the population, therefore, is found in the urban areas on the flood plain.

The present total population estimation in the catchment is approximately 93 500. Annual average population growth rate in the Western Cape is about 2.5 %, which makes the projected population in 2010 to be approximately 120 000 assuming that no migration towards urban areas takes place during the specified period. The projected figure does not account for the AIDS epidemic.

ISSUES:

- Lack of formal development controls in the vicinity of the river.
- Access to treated water in the Mosselbank and lower catchment for informal settlement and small rural areas is not adequate.

3.2 WATER RELATED INFRASTRUCTURE

3.2.1 Water Supply

The present supplier and infrastructure of the bulk water in the catchment is described in the Table 3 and Figure 5. The water is imported from the neighbouring Berg River catchment, and it is then supplied to various municipalities who supply to users.

Water supply is not complete in the informal urban settlement, formal urban townships, scattered rural areas, and small rural areas. One of the lowest percentages of water supply is found in the rural area within the Mosselbank sub-catchment area, with approximately 80 percent of the area not having water supply structures in place. The Informal Urban Settlements in the lower catchment has the lowest percent of water supplies.

The Paardeberg Dam is situated in the Siebritskloof, about 20 km south-east of Malmesbury (Figure 5). The dam was built in 1926 and it has a capacity of 233 Mm^3, (Midgley DC, WV Pitman, BJ Middleton, 1994).

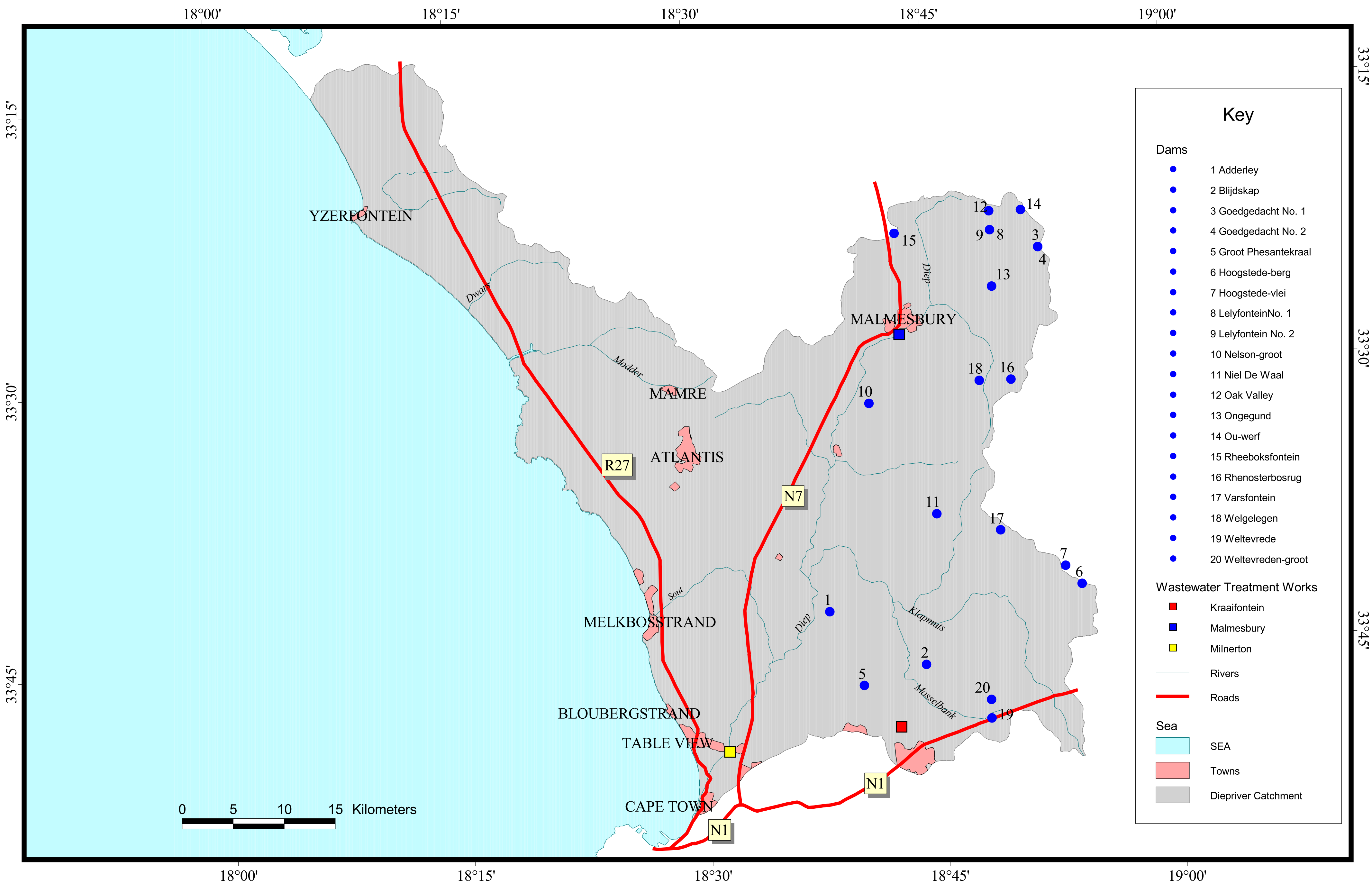

Fig5. Water Related Infrastructure

The Dam is concrete arch and it has water surface area at full supply level of 3 hectares. The quality of the water from the Paardeberg Dam is consistently of a good quality and the dam constantly delivers water to Malmesbury. During the winter months there is a decrease in the quality of water from Paardeberg Dam as a result of stormwater inflow to the pipelines with the result that changes the colour of water. From Malmesbury, water is further supplied by a pipeline to the Abbotsdale area to address the domestic needs of water supply to the people of the area. Water from the pipeline is fed into a system of tanks in the eastern half of the settlement, from which residents collect their water.

There is no upstream development planned in the future that could possibly threaten the source. There is also no factor that threatens the quality of the water. There is about 12 700 Kℓ/month of withdrawals from the dam. This dam is in the nature reserve, and no public is allowed to enter the premises.

Apart from Paardeberg dam there are other 20 dams in the Diep River Catchment. See Table 19 in Appendix B for the years in which the dams were built, and for their storage capacities. These dams are mainly used for irrigation. All of them are earthfill embankment construction, except for Groot Phesantekraal Dam, which is a rockfill/earthfill combination. These dams receive water from the rivers within the Diep River catchment, except for Rheeboksfontein and Hoogstede-berg Dams whose water sources are not accounted for.

Part of the catchment is situated on the sand aquifer, called the Cape Flats Aquifer Unit (CFAU). A number of home-owners on the CFAU have capitalised on this situation and successfully use well-points for garden irrigation and thus save on the use of potable water.

There are three boreholes that supply Riverlands and Chatsworth, found in Riverlands area. The recovery rate and water level of the boreholes are monitored regularly to determine if the abstraction rate is suitable for the recharge rate of the source. Each borehole has a meter to monitor the abstractions. The supplied standpipes and the reservoir have meters in order to monitor the losses. The boreholes are in a strategic position in Riverlands to keep sanitation pollution to the minimum. No further measures against pollution are known. The ground water is partially used in areas such Abbotsdale for domestic supply.

TABLE 3. BULK WATER SUPPLY FOR THE DIEP RIVER CATCHMENT

Water Source	River(s)	Treatment Works	Owner of Treatment Works	Area(s) supplied	Present Volume (Max. Capacity) Mℓ/d
Voëlvlei Dam	Klein Berg, Leeu and 24 Rivers	Swartland PW	West Coast RSC	Municipalities of Malmesbury, Korringberg, Darling, Gauda, Riebeek-wes, Riebeek-kasteel, Hernon and Yzerfontein	22.7
Voëlvlei Dam	Klein Berg, Leeu and 24 Rivers	Voëlvlei PW	CCT	CCT Reticulation system, Milnerton, Goodwood and Parow	273

Where: The maximum capacity is the maximum capacity of the treatment works in Mℓ/day
PW: Purification Works
CCT: City of Cape Town
RSC: Regional Services Council
SOURCE of Information, Bath AJ (1993)

ISSUES:

- The bulk of the water used for drinking purposes in the catchment is imported from other catchments.
- Stormwater threatens the quality of water in the pipelines from the Paardeberg Dam during the wet winter seasons.
- Groundwater abstraction in the lower catchment is mainly from the urban and industrial areas.
- Groundwater abstraction in the upper and in the middle of the catchment is mainly for the agricultural purposes and to a lesser extent domestic purposes.

3.2.2 Sanitation

Sanitation services within the catchment are described in Table 4. Tableview and Durbanville, have 100 % of the area served by flush sewage system. Kraaifontein has 95 % of the area served by a flush sewage system. Malmesbury (95 % of the area) is served by a flushing sewage system. Only limited sewage tanks are found in the town. Approximately 300 stands in Abbotsdale are supplied with flush sewage systems. The rest of the stands in Abbotsdale are equipped with septic tanks and soak-aways. Kalbaskraal is served partially by flush sewage systems and the remainder is served by septic tanks. Kalbaskraal has its own oxidation ponds. After completion of the recent housing project at Riverlands, 300 stands were supplied with full flush sewage system. The remaining communities, together with Chatsworth are supplied with septic tanks system. The two communities are served by a communal oxidation dam system.

ISSUES:

- Areas with low level of sanitation services have a high pollution potential.

TABLE 4. WATER SUPPLY AND SANITATION SERVICES IN THE DIEP RIVER CATCHMENT

Residential Areas	Water supply service	Sanitation service (Total served)	Pollution potential
Malmesbury	Voëlvlei	100% Waterborne sewage system, septic tanks	Low to Medium
Abbotsdale	Paardeberg dam	300 stands has flush sewage systems, and the rest are served by Septic tanks & Soak-aways	Medium to high
Kalbaskraal	Borehole	Partial flush sewage system, and Oxidation Ponds & Septic tanks	Medium to high
Riverlands & Chatsworth	Borehole – 3 Water schemes	(300 stands have waterborne sewage system), Oxidation Ponds	Medium to high
Philadelphia & Klipheuwel	3 Boreholes & Voëlvlei connection	Bucket System, Septic & Conservancy tanks	Medium to high
Vissershok		Septic tanks	Medium to high
Table view	City of Cape Town Reticulation System	100% Waterborne sewage system	Low
Durbanville	City of Cape Town Municipality System	100% Waterborne sewage system	Low
Kraaifontein	City of Cape Town Municipality System	95% Waterborne sewage system	Low to Medium

Types of Sewage System services found in Rural and Urban areas:

Urban Areas - 100 % Waterborne Sewage System

Rural Areas - Bucket System
- Septic and Conservancy tanks
- Soak-aways
- Oxidation ponds/dams

3.3 LAND USE ACTIVITIES

Information on the land use activities in the Diep River Catchment is obtained from the satellite imagery (Figure 6) and existing information.

A) POINT SOURCE POLLUTION

Significant water pollution is usually caused by point sources, the typical sources that contribute to this type of pollution are wastewater treatment works, industries, waste disposal sites, where the polluting wastewater is derived from one or more specific points. The point-source pollution around the world will probably account for more than 90 % of the pollution (Danissøe J, 2000). However, the types of pollution from these points are often easy to investigate and thus easy to monitor manage.

In most industrialised countries, the point sources of pollution are being mitigated by cleaner technology and treatment facilities, although this may not be sufficient to eliminate the impact from such sources.

3.3.1 Wastewater Treatment Works (WWTW)

There are three wastewater treatment works in the catchment (Figure 5), the Malmesbury Wastewater Treatment Works (WWTW), Kraaifontein WWTW, and Milnerton WWTW. Riverlands and Kalbaskraal areas have oxidation pond systems.

3.3.2 Industries

The water use and wastewater discharges for both the major and minor industries within the catchment, which are point sources of pollution, are given in Table 5.

Industries dispose their wastewater in different ways, for an example disposal by flush sewage system to WWTW, or by evaporation ponds, or pipelines to the sea, or by irrigation. In South Africa, wastewater that is difficult to treat is usually disposed into evaporation ponds or irrigated.

ISSUES:

- The industrial area and the WWTW in the lower catchment have the greatest potential to influence water quality in the catchment.

TABLE 5. INDUSTRIAL WATER USE AND WASTEWATER DISPOSAL

No.	Industry	Water-use Permit	Quantity-Source	Effluent Exemption	Industry Type	Disposal Manner	Permitted Quantity	Permitted Quality
1	Bruining Compost-Vissershok				Composting Site			
2	Dorstberg Quarry	Proposed Quarry			Quarry			
3	Strategic Fuel-Fund, Milnerton	EIA	CCT Supply					
4	Vasco cheese-Philadelphia		3.75l/s Boreholes		Cheese factory	Irrigation	184 m^3/month 9.2 m^3/d	GA
5	Durbanville-Hills Winery		150 m^3/d CMC		Winery	Irrigation 4 ha field	4 800 m^3/a 51.2 m^3/d	GA
6	Mijnburg Winery, Klapmuts		Borehole		Winery	Irrigation 3 ha Kikuyu	1 440 m^3/a 6.05 m^3/d	GA
7	Caltex-oil Milnerton	545N	• 2 372 500 m^3/a • 6 500 m^3/d	1575B	Oil Refinery	To the Sea - Marine pipeline	1 934 500 m^3/a 5 300 m^3/d	GS
8	Kynoch fertiliser, Milnerton			1393B	Nitrogen products	To the Sea - Marine pipeline	438 000 m^3/a 1 600 m^3/d	Plant downsized
9	Swartlandse-koop Winery, Malmesbury	1193N		625B	Winery	Irrigation		
10	Anglo Alpha stone, Penn. Quarry	757N		1036B	Quarry	Settling dams		
11	Hoechst SA, Milnerton		CCT Supply	789B	Polyester fibre	Milnerton WWTW		Permit cancelled
12	County Fair Foods, Fisantekraal	1107N	338 000 m^3/a, Paarl, Oostenberg	816B	Poultry/ Chicken	Irrigation 60 ha Kikuyu	1 530 m^3/d	
13	Simonsberg Pigery, Klapmuts			1411B	Pigs	Irrigation 27 ha Kikuyu	15 330 m^3/a 42 m^3/d	

Table 5 cont.

No.	Industry	Water-use Permit	Quantity-Source	Effluent Exemption	Industry Type	Disposal Manner	Permitted Quantity	Permitted Quality
14	Malmesbury WWTW			1509B	Wastewater Treatment	Dispose to Diep river	1 140 000 m^3/a 3 120 m^3/d	GS
15	Riverlands Oxidation Pond				Wastewater Treatment	Irrigation 4 ha	3 540 m^3/month 118 m^3/d	GA
16	Kraaifontein WWTW				Wastewater Treatment	Irrigation 2.9 ha	4 710 m^3/month	GA
17	Sappi Cape Kraft, Milnerton	602N	• 1 048 000 m^3/a, Milnerton Municipality.		Paper	Dispose to Milnerton WWTW	575 m^3/d	
18	Tydstroom Plumveeplaas, Durbanville	1496N	560 m^3/d, Mun.	1736B	Poultry	Irrigation, 20 ha	131 040 m^3/a 504 m^3/d	Applied to dispose to Mosselbank, 450 m^3/d
19	Cramix Quarry, Brackenfell	1376N	• 92 000 m^3/a • 55 000 m^3/a borehole, • 37 000 m^3/a Brackenfell Municipality	1499B	Bricks/Pottery	Domestic Eff.-Eva.ponds	10 000 m^3/a	
20	County Fair Farm, Kraaifontein			1364B	Poultry			
21	Corobrick Phesantekraal, Durbanville	1319N	• 95 000 m^3/a • 45 600 m^3/a supplied by Durbanville Municipality • 49 400 m^3/a abstracted from boreholes and clay quarries on the Permit Holder's property		Bricks	No Indu.effl. Domestic only-Cons tank		
22	CPC Tongaat Foods, Durbanville	1507N		1766B				
23	Golden Groove, Fisantekraal	1486N	Boreholes	1662B	Poultry	Irrigation	137 500 m^3/a 544 m^3/d	
24	Milnerton WWTW				Wastewater Treatment			

GA - General Authorisations (National Water Act, 1998, Act 36 of 1998);
WWTW – Wastewater Treatment Works;

GS - General Standard (Water Act, 1956, Act 54 of 1956)
Information obtained from Permits and Licences

3.3.3 Solid Waste

Table 6 describes the type of waste sites in the catchment.

TABLE 6. SOLID WASTE SITES

No.	Solid Waste Site	Owner	Areas/Class[1]
A	Vissershok	City of Cape Town	H:H, H:h, G:L;B*
B	Highlands	Malmesbury Municipality	2

[1]different areas are explained below

Waste disposed at both the Visserhok and Highlands waste sites must be compacted and covered on a daily basis with a minimum of 150 millimetres of soil or any other material. Unauthorised entry to the waste sites is prohibited to public. The sites are fenced to a minimum of 1.8 metres, with gates of the same height at all entrances, to reasonably prevent unauthorised entry and curtail the spreading of wind-blown paper and plastic materials.

Visserhok waste site has three different disposal areas, H:H area, H:h area and the G:L:B* area for permissible waste disposal, which differs from Highlands waste site.

H:H and H:h areas of the site may be used for disposal of all waste types except, waste types over which specific control has been established in terms of the Nuclear Energy Act, 1993 (Act 131 of 1993).

G:L:B* area of the site may be used for the disposal of the sanitary waste which has been treated according to the technology described.

All the areas of disposal have potential of polluting the groundwater through leachate, thus monitoring of groundwater at these sites is important.

ISSUES:

- The landfill sites have high risk of groundwater pollution from leachate.
- Between 1 and 2% of domestic waste is hazardous and is incorrectly disposed of at general waste sites.

B) NON-POINT SOURCE POLLUTION

This type of pollution is mainly connected to the pollution of organic waste, siltation, nutrients, and pesticides. Non-point source is an activity that takes place over a broad area and results in the release of pollutants from many different locations. Agriculture, forestry, residential and urban development are examples of non-point sources of pollutants. The pollution from nutrients through non-point discharges may in some countries be the biggest source, due to excessive use of artificial fertilisers and manure. Also the pollution from pesticides may be derived from the non-point sources (Danissøe J, 2000).

The typical areas that contribute to non-point source pollution are the agricultural and forestry areas including settlements, villages, and husbandry areas.

3.3.4 Residential Areas

Urbanised areas and satellite settlements in the catchment are a potential source of nutrients, pathogens and litter that wash off these areas during rain events and impact on the quality of both ground and surface waters. The extent of this is dependent mainly on the sanitation services, Table 4 indicates available services to the communities.

Future residential growth in the area, especially low income housing, could have a major negative effect on the quantity and quality of stormwater entering the Rietvlei/Diep River system.

The storm water canals or drains from informal settlements are of concern as they often carry raw sewage, high in pathogens and nutrients, from those areas where no formal sewage system exists or where problems with the sewage system are often experienced.

ISSUES:

- Poor sanitation services have a high pollution potential.
- Urbanisation and urban growth gives rise to an increase in volumes of all types of waste.
- Informal settlement areas have a high risk from faecal pollution, because there is no proper structure of water supply to the area.
- Many informal settlements possess inadequate refuse removal and reticulation services

3.3.5 Mining and Quarries

Mining activities (sand, gravel and stone) occur in the Diep River catchment and lead to the complete alteration of the land surface in those areas in most cases. If rehabilitation and environmental management plans are not implemented, mining activities will lead to the loss of soils and the consequent loss of agricultural land, habitat for conservation, and siltation of streams and wetlands.

Mining activities and unused mineral rights exist in some areas of the catchment. These include mining of Malmesbury hornfels and other building materials in the Tygerberg Hills.

There are three major quarries in and around the surrounding areas of the catchment (Figure 6), which need to be closely monitored to avoid alteration of the land surface.

ISSUES:

- Poor control of mining activities and excessive impacts of mining activities due to lack of co-ordination.

3.3.6 Agriculture

Virtually the entire catchment is under cultivation with only a few patches of natural vegetation remaining (Figure 6). Small proportions of the cultivated land consist of vineyards and orchards. Grain farming has dominated agriculture and 90% of soil losses in the region could be attributed to this activity during this century. This was due to bad land management (Grindley JR and S Dudley, 1988). Predominant land-use in the Diep River catchment area remains wheat-farming. The relative proportions of agricultural activities are shown in Figures 7 and 8.

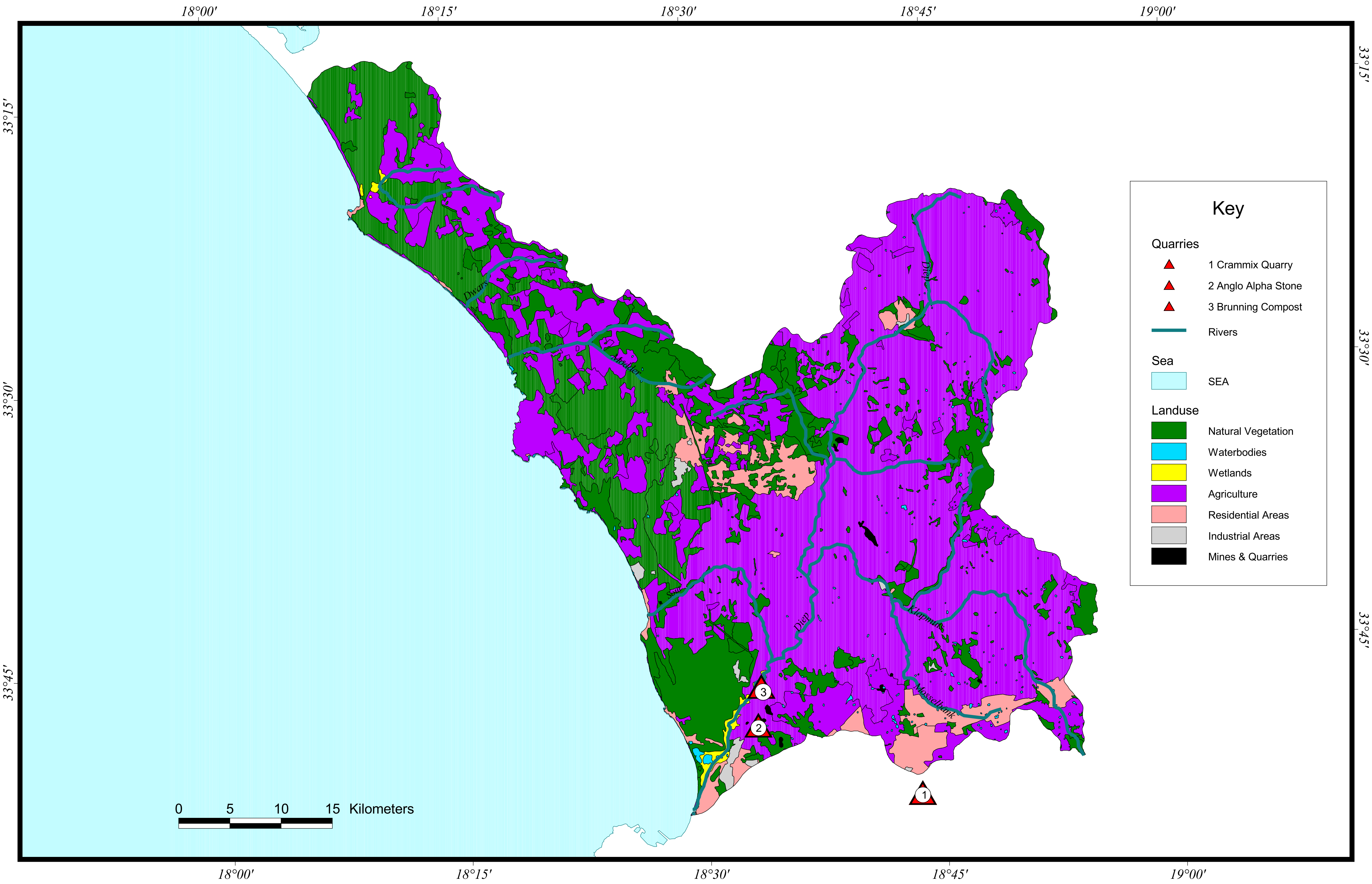

Fig6. Landuse

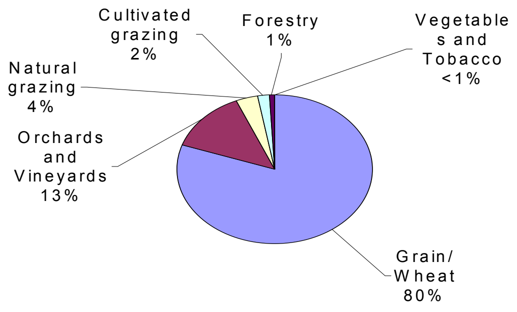

Figure 7. Areas (km^2) under crops within the Diep River Catchment

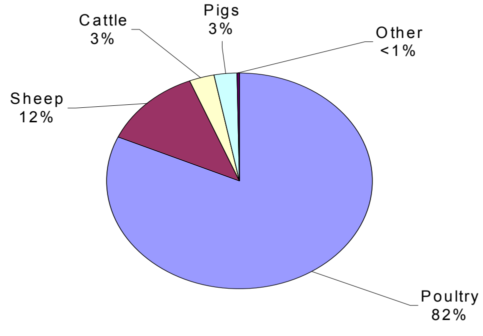

Figure 8. Livestock types within the Diep River Catchment

Vines make up most of the irrigated land surface area (70%) and are found in the upper catchment area of the Diep River and its tributaries. Fruit (10%) and vegetables (20%) comprise the rest of the irrigation demand and are found in the middle and lower catchment areas of the Diep River, where wheat is also grown. The cultivation of wheat utilises dryland-farming techniques and does not require irrigation.

Livestock farming is practised most in the upper catchment area of the Diep River. Livestock farmed are mostly cattle, chicken, and sheep. Runoff from the farmlands in the catchment contains fertilisers and pesticides. These add to the nutrient levels in the river, for example, adding dissolved nitrate, ammonia, and reactive phosphate. Runoff from activities especially dairy farming along the Diep River also adds nutrients to the system.

ISSUES:

- Irrigation return flows can also lead to an increase in salts in the surface and groundwater, and runoff can increase the turbidity in the surface water.
- Stormwater from agricultural areas, especially irrigated areas, is a potential source of nutrients from fertiliser use and this may enrich the surface and groundwater.
- The runoff from the feedlots in the catchments is also a potential source of microbiological pollution and nutrients.
- Extensive livestock farming can physically alter runoff patterns and hence increase rates of soil erosion.

3.3.7 Forestry and Nature Reserve

There is little or no afforestation in the catchment and the natural vegetation is fynbos. Fynbos growth varies from dense concentrations in the gulleys to sparse coverings on rocky mountain slopes, (Figure 3 & 6).

3.4 WATER USERS

The term water quality is used to describe the physical, chemical, biological and aesthetic properties of water that will determine its fitness for use and its ability to maintain the integrity, or health, of the aquatic ecosystem. These properties are determined from the constituents that are dissolved or suspended in water and which make up the water chemistry. In order to determine the suitability of water quality of the catchment for use, the first step will be to determine the use of water in the Diep River catchment. The aquatic ecosystem is recognised as part of the water resource and not as a water user.

3.4.1 Domestic

Most of the potable water is imported into the catchment from the Voëlvlei Dam that is outside the catchment area. The surface water quality of the Diep River is saline, and it is considered of an unacceptable quality for domestic and agricultural use.

The ground water is partially used for domestic supply in areas such as Riverlands, Chatsworth, and Abbotsdale. Purified water from the Paardeberg Dam is also supplied to the Malmesbury and Abbotsdale areas to address water supply for domestic needs.

3.4.2 Recreation

Formal recreational activities are well established within the Table View Sports Centre, Milnerton Aquatic Club, and the Theo Marais Sports Ground.

The Rietvlei area of the Diep River has become an important recreational area that is under the control of Milnerton Aquatic Club. The Management Committee of the Milnerton Aquatic Club fosters a range of aquatic activities but with a strong conservation emphasis. The activities include a variety of water sports in the dredged north-western part of the vlei (Flamingo Vlei), as well as model aircraft flying and trail bike riding on land in the vicinity. Other activities include bird watching, walking and fishing. The Milnerton Canoe Club and fishermen mostly use the estuary.

3.4.3 Industrial

There is no apparent or clear use by industries of surface water from the Diep River. Permits have been issued under the Water Act (Act 56 of 1954) by the DWAF, for some of the industries to abstract water from boreholes on their respective premises. A great number of industries within the catchment get their supply from the Municipalities (Potable water) and/or Wastewater Treatment Works (Table 5).

3.4.4 Agricultural Use - Irrigation

In the upper catchment, cultivated areas along the Skurweberg and Riebeek Kasteel Mountains are assumed to be supplied from farm dams. Cultivated low-lying areas are supplied by borehole water. Very little is abstracted from the river due to its the poor water quality (Richards C and P Dunn, 1994). The cultivation of wheat utilises dryland-farming techniques and does not require irrigation.

3.4.5 Agricultural Use - Livestock Watering

Cattle, sheep, and poultry are farmed and they are predominantly found in the upper catchment of the Diep River. Intensive water abstraction from the Diep river system for livestock watering occurs primarily in the upper and middle catchment.

ISSUES:

- The majority of potable water supplied for domestic needs is imported into the catchment from other catchments.
- Only groundwater is used for irrigation, domestic and industrial purposes and monitoring is necessary to check the rate of water recharge.
- Extensive irrigation from boreholes takes place in the catchment.

3.5 FUTURE DEVELOPMENT

Future development of the catchment can be expected, especially in the lower part of the catchment where it is comprised mainly of urbanised and industrialised areas. The most significant driver of this development is population growth. Increases in population and urban developments close to the estuary and the entire catchment will place a growing demand on the water supply, sanitation services and on the Diep River, (see Table 7 for the percentage of major urbanised areas in the Diep River Catchment).

There is a housing and bulk services supply project that is currently underway at Fisantekraal (North of Durbanville). The housing project is meant to accommodate about 1300 families. The most viable sewage disposal option was to pump the sewage to the Kraaifontein Wastewater Treatment Works. Untreated human waste, industrial discharges and agricultural run-off into rivers and water bodies increases loads of faecal pathogens, toxic chemicals, pesticides and fertilisers and heightens the health risk to water users.

The tourism industry is a major growth sector with respect to investment, employment, and the diversification of services.

TABLE 7. MAJOR URBANISED AREAS IN THE DIEP RIVER CATCHMENT

Quaternary	Catchment area (km^2)	Urban area (km^2)	Percent of catchment urbanised	Percent of catchment assumed to be impervious*
G21C[a]				
G21D[a]				
G21E	531	9	1.8	0.2
G21F	242	14	5.6	0.7

a – G21C and G21D form part of the Diep River Catchment but they are not mentioned by the source under major urbanised areas

* In the PWV/ Gauteng area it was assumed that one eighth of the urbanised area was impervious. This ratio has been used in the above Table. However, this may not be applicable in less densely populated areas.

Source: Adopted from Midgley DC, WV Pitman, BJ Middleton

ISSUES:

- Increased wastewater disposed of to the Kraaifontein Wastewater Treatment Works will put pressure on the treatment works.
- People living in un-serviced housing are most at risk of contracting communicable diseases given that they lack access to clean water, sanitation and/or a safe energy source.

3.6 ISSUES

Key issues raised out of this chapter are summarised in the table below:

TABLE 8. SUMMARY OF LAND AND WATER USE RELATED ISSUES

Issue	Description
Alteration of flow/habitat	Irrigation return flows increase salts in the surface and groundwater, and runoff can increase the turbidity in the surface water.
	Stormwater from agricultural areas, especially irrigated, is a potential source of nutrients from fertiliser use and this may enrich the surface and groundwater.
	The runoff from the feedlots in the catchment is also a potential source of microbiological pollution and nutrients.
	Extensive livestock farming can physically alter runoff patterns and increase soil erosion.
Water Quality	The majority of potable water supplied for domestic needs is imported into the catchment from other catchments.
	Stormwater threatens the quality of water in the pipelines from the Paardeberg Dam during the wet winter seasons.
	Groundwater abstraction in the catchment is mainly from the urban and agricultural areas
	Problems of pollution to the water resource by effluent from sewage systems.
	The effluent from industries is discharged into the sea.
	Evaporation ponds are susceptible to leakage.
	The landfill sites have high risk of groundwater pollution from leachate.
Development	Access to ready treated water and poor sanitation services in informal urban settlement, small rural areas is a major problem.
	Lack of formal development controls around the river.
	Urbanisation and urban growth gives rise to an increased need of water supply, sanitation and also increase in volumes of all types of waste.
	The industrial area, downstream of the catchment, has the greatest potential to influence water quality in the catchment to a worse state.

4 WATER QUALITY CHARACTERISATION

This chapter provides a general overview of the water chemistry of the surface, ground, and coastal water within the catchment.

4.1 MONITORING ACTIVITIES IN THE CATCHMENT

The regional office of DWAF, the City of Cape Town, and Local Authorities are currently in charge of the monitoring activities within the catchment. Some of the data used in this assessment are available from DWAF and from other authorities responsible for the data collection. A description of the monitoring points is given in Table 21, Appendix B. The surface water monitoring points are indicated in Figure 9, and Groundwater monitoring points are indicated in Figure 10.

4.2 SURFACE WATER CHEMISTRY

A general description of the surface water chemistry is given below. This section contains a summary of the water quality constituents that were monitored in the river, viz.: pH, electrical conductivity, suspended solids, Kjeldahl nitrogen, ammonia, nitrate, phosphate, chemical oxygen demand, and *E. coli*.

The information described herein this report is based on the data obtained from January 1998 to May 2000. The data used for the Maucha diagrams was obtained from once off sampling conducted on the 21st September 2000. The diagram indicates dissolved ions that were analysed, Appendix E, Table 31-26 shows the relevant data used for surface water. The diameter of the circle indicates relative total concentrations of dissolved ions, i.e. the larger the circle the higher the TDS concentration is the particular indicated monitored station, Figure 9.

4.2.1 Total dissolved salts

Maucha diagrams on Figure 9 have been used to “fingerprint” the water chemistry in the Diep River Catchment. The surface water chemistry of the catchment is dominated by high sodium and chloride concentrations. This is to be attributed to the geology in the catchment.

4.2.2 Nutrients

High levels of nutrients are caused by activities such as effluent discharges by wastewater treatment works, agricultural use of fertilisers, industries, and urban runoff. An increased growth and thus production of algae can be expected that will lead to diurnal oscillations in the oxygen level with super-saturated conditions during the daytime because of the oxygen production from photosynthesis and critically low oxygen levels during the night because of the respiration.

Relatively higher inputs of ammonium occur at the monitored Wastewater Treatment Works (WWTW) discharge points.

Kraaifontein WWTW, Table 31-22, has the mean of 11.9 mg N/ℓ for ammonium concentration (To ensure a more reliable assessment of the situation, more data for each of the WWTW are required to do trend and seasonal analyses). The load of ammonium seems to be decreasing towards the end of the data. Milnerton WWTW, Table 31-24, has gaps and more frequent data for WWTW are required to do trends and seasonal analyses.

Background concentration of ammonia in the catchment is below 10 mg N/ℓ.

The target water quality range for instream ammonium concentration that is stated in the South African Water Quality Guidelines for Aquatic Ecosystems is much lower (i.e. less of than or equal to 0.007 mg N/ℓ). For the user of the guidelines it is recommended that an expert advice be obtained as certain areas may require modification of criteria provided in the guidelines (DWAF, 1996).

4.2.3 Bacteriology

Escherichia coli is a specific indicator of faecal pollution from human or warm-blooded animals.

Stormwater and urban runoff, as well as the discharge of treated sewage effluent appear to be the major sources of faecal contamination of the rivers. The type of sanitation services and their maintenance have a major impact on the quality of the runoff. Samples were taken once for analysis at the selected monitoring points.

ISSUES:

- Naturally high salt concentrations are the determining factors for the use of surface or groundwater in the Diep River Catchment.
- Pathogen pollution (bacteria, viruses and protozoa's and other parasites) is mainly caused by the discharge of untreated wastewater to the surface water.
- The pollution might impact on human health, but also on the health of animals.
- Increased nutrient concentrations may move the ecological balance towards the stage of eutrophication.
- Nutrient concentrations are high as a result of sewage effluent discharges, stormwater, urban runoff, and agricultural runoff.

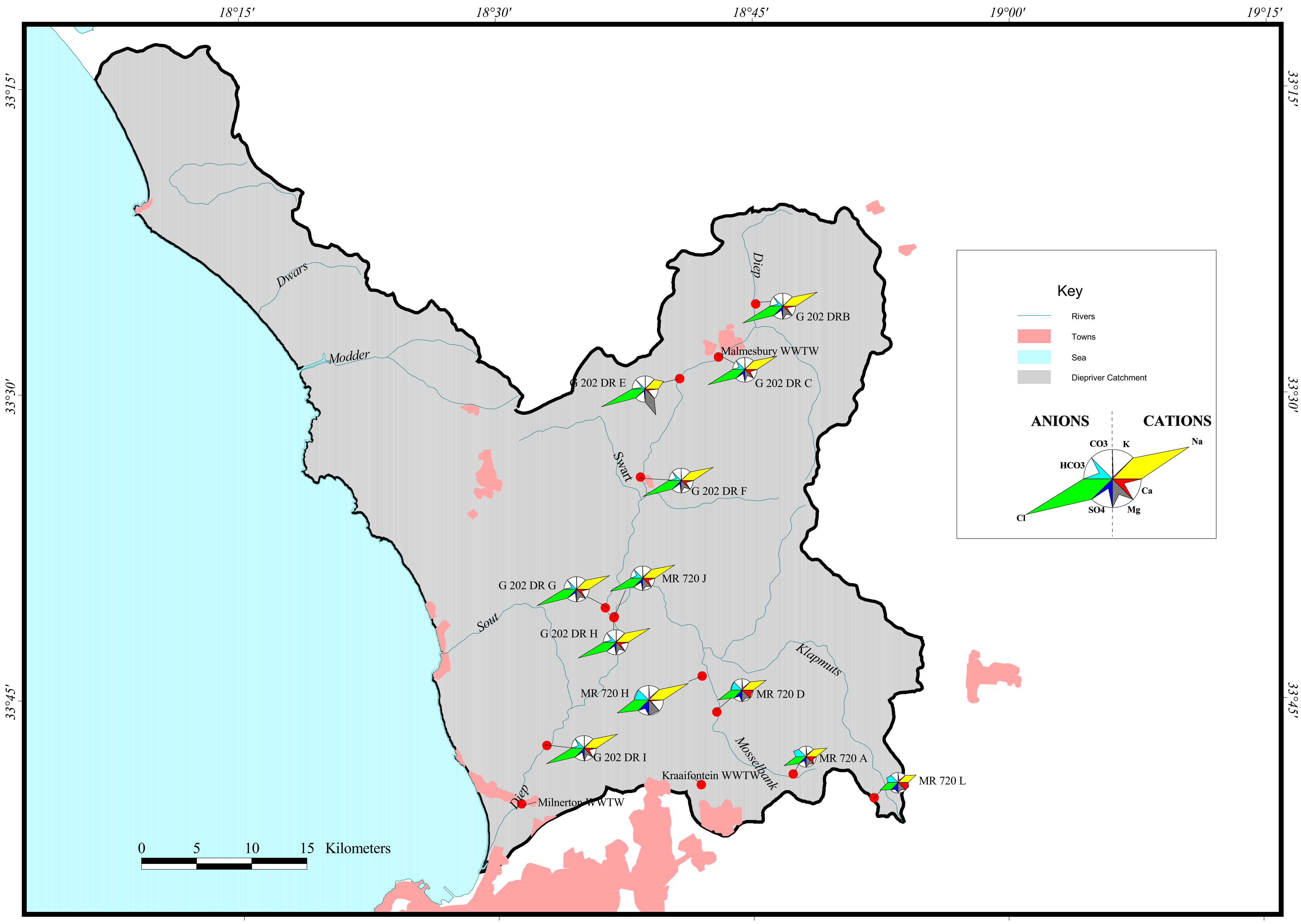

Fig9. Surface Water Chemistry

4.3 GROUND WATER CHEMISTRY

This section contains a summary of the water quality constituents that were monitored in the groundwater from previous studies of groundwater quality by DWAF, and data from April 1998 to February 2000 analysed for trace metals and inorganic salt analyses, and physical parameters analysed, Appendix F, Tables 32-1/2.

4.3.1 Total dissolved salts

Maucha diagrams were used to "fingerprint" the groundwater chemistry and are shown on Figure 10. **Naturally high salt concentrations dominate throughout catchment**, and this is attributed to the geology of the region. In particular, this water has high concentrations of sodium and chloride ions. The electrical conductivity is high especially in the boreholes in the lower catchment.

4.3.2 Nutrients

Agricultural application of fertilisers and manure is a major contributor of nitrate/nitrite to the ground water. Both phosphates and ammonia resulting from agricultural runoff are adsorbed onto sediments and will only be released under anoxic conditions or high flows. Ammonia is very soluble and will be oxidised to nitrate fairly rapidly under normal conditions. There are no significant levels of nutrient pollution (ammonia, nitrate & nitrite) in the groundwater, Table 32-2. Data for 1999 November in the following boreholes Olyphants fontyn, Rozenburg, Spes bona/Kalbaskraal, Vryheid, Mosselbank 906, Groen River outspan, and Swellengift all have their pH's less than 2, and very high nitrate + nitrite concentrations and thus treated as outliers. Thus more data will have to be collected so that the trends can be measured more accurately in these boreholes.

The water in the pits and wells in the Abbotsdale area are not protected and could contain high bacterial counts as they are situated down drainage of septic tanks in the region, local cemetery and Malmesbury's waste disposal site (Sephton JR, 1995). The water quality of the secondary aquifer is acceptable. The boreholes in the Riverlands/Chatsworth areas are of relative good quality (Rosewarne PN et al, 1996).

ISSUES:

- Upstream where most activities are agriculture related, the pollution of groundwater by pesticides (or due to the use of pesticides) was not analysed, since agrochemicals analyses are too costly.
- Nutrients may be adsorbed onto the sediments, as their concentrations are very low in the water from the boreholes.
- For data where pH is less than 2 and nitrates levels are high, an investigation should be made and more data needs to be collected.
- The water quality within the primary aquifer, at Abbotsdale, is of poor quality (Sephton JR, 1995).

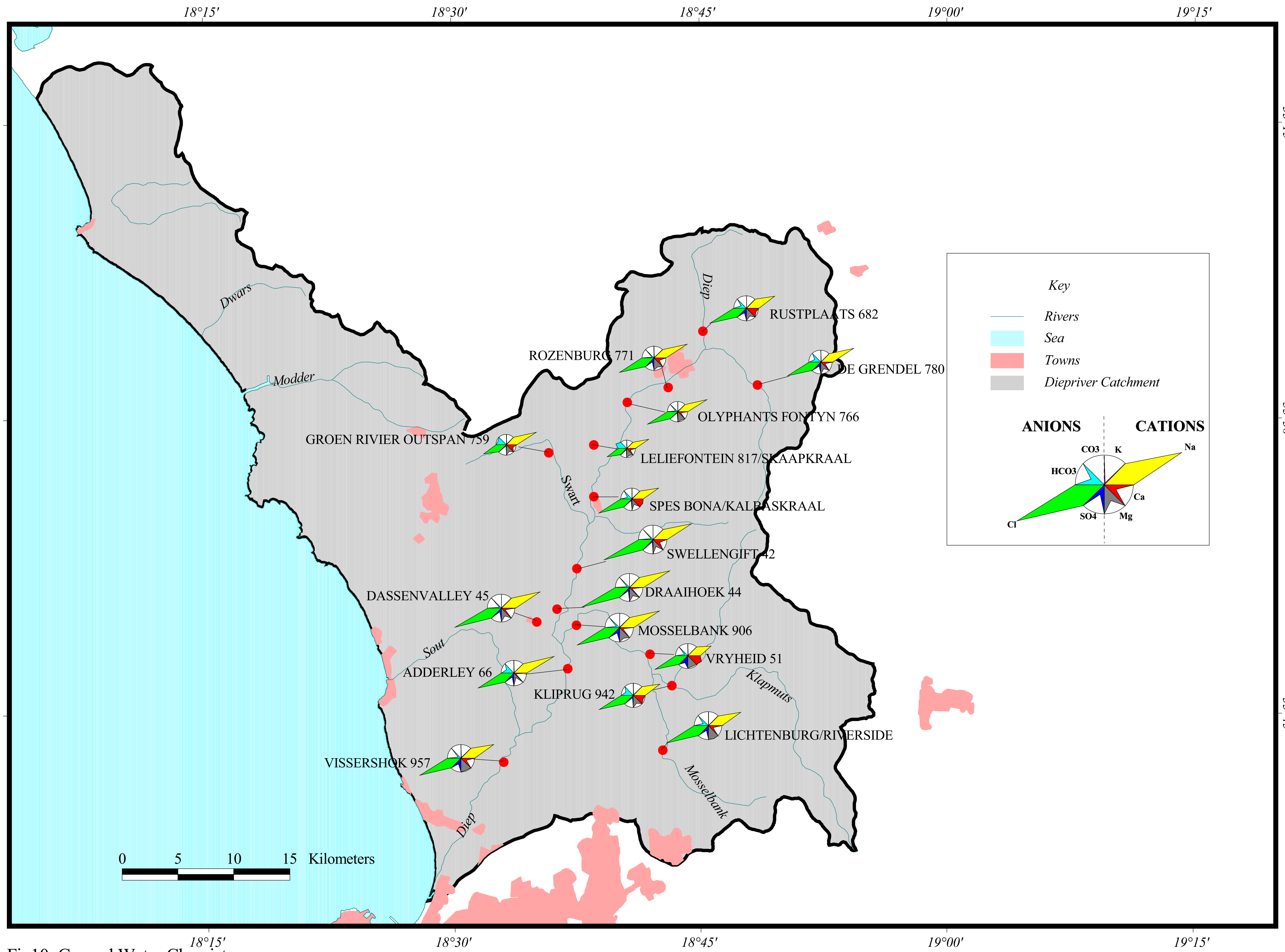

Fig10. Ground Water Chemistry

4.4 COASTAL WATER CHEMISTRY

Monitoring of the coastal waters, where the Diep River and industries discharge into the coastal area, is undertaken by the City of Cape town at the monitoring points indicated in Figures 11. This section contains a summary of the bacteriology constituent (*E. coli*) that was monitored in the coastal area, for the period, 1995 to 2000, data in Appendix G Table 33. Analysis of data as against Water Quality Guidelines show concern is human health risk if water is swallowed during recreational use.

The ocean has a large capacity to assimilate waste, where its ability is limited by the rate at which the natural processes of mixing, degeneration, and dispersion can occur. Coastal waters are especially at risk, where pollutants from land remain trapped in the surfzone. Monitoring of faecal pollution within the surfzone is of greatest importance, because of the risk to recreational users (e.g. swimmers). City of Cape Town undertakes microbial monitoring.

ISSUES:

- Need to change the perception that the ocean has large capacity to assimilate waste.
- The water might pose health risk to recreational users if swallowed due to faecal pollution.

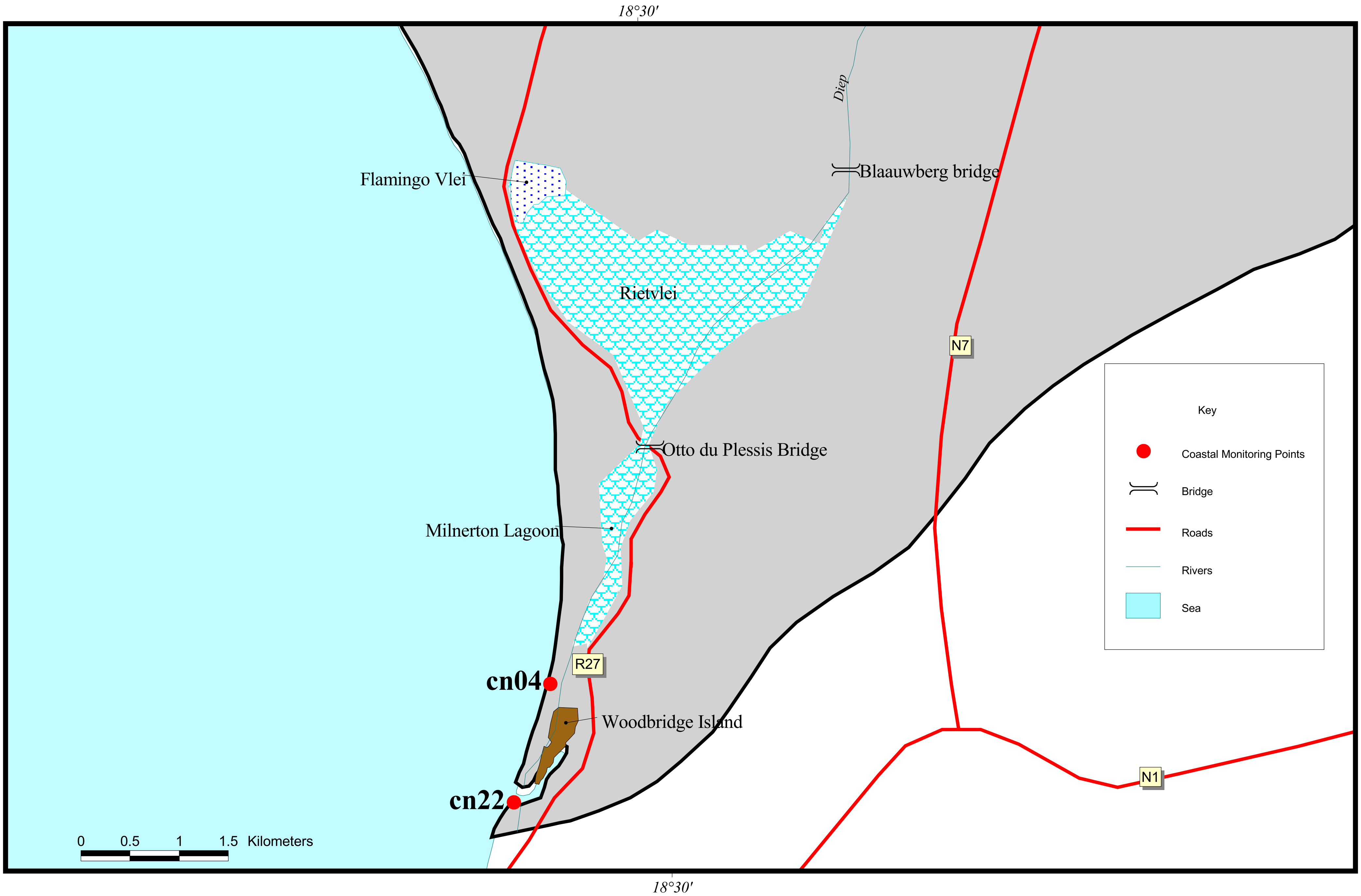

Fig11. Coastal Water & Suitability for Recreational Use

4.5 ISSUES

The key issues raised in this chapter, in terms of relevant river sections, are summarised below:

TABLE 9. SUMMARY OF WATER QUALITY CHARACTERISATION ISSUES

Issue	Description
Water Quality	Natural high salt concentrations in surface or groundwater in the Diep River catchment.
	Increased nutrients may move the ecological balance towards the stage of eutrophication.
	Development in catchment (especially lower catchment) impact on water quality, i.e. sewage effluent discharges, stormwater, urban runoff and agricultural runoff.
Development	Faecal Pollution in the river and the coastal areas might hamper human health, as well as the health of animals.