9. THE BREEDE WMA

9.1 GENERAL DESCRIPTION

9.1.1 Topography, Rainfall and Landuse

The topography of the Breede WMA varies considerably from east to west, with consequential impact on the climate of the region. Rainfall is highest in the mountainous regions in the southwest where the mean annual precipitation is as high as 3 000 mm per annum, whilst the central and north-eastern areas receive as little as 250 mm per annum. There is intensive irrigation in the Breede and Riviersonderend River valleys (Breede component of the WMA) as well as in the extreme west of the Western Overberg, notably in the Palmiet River catchment. ***Figure 9.1.1*** shows the Breede WMA.

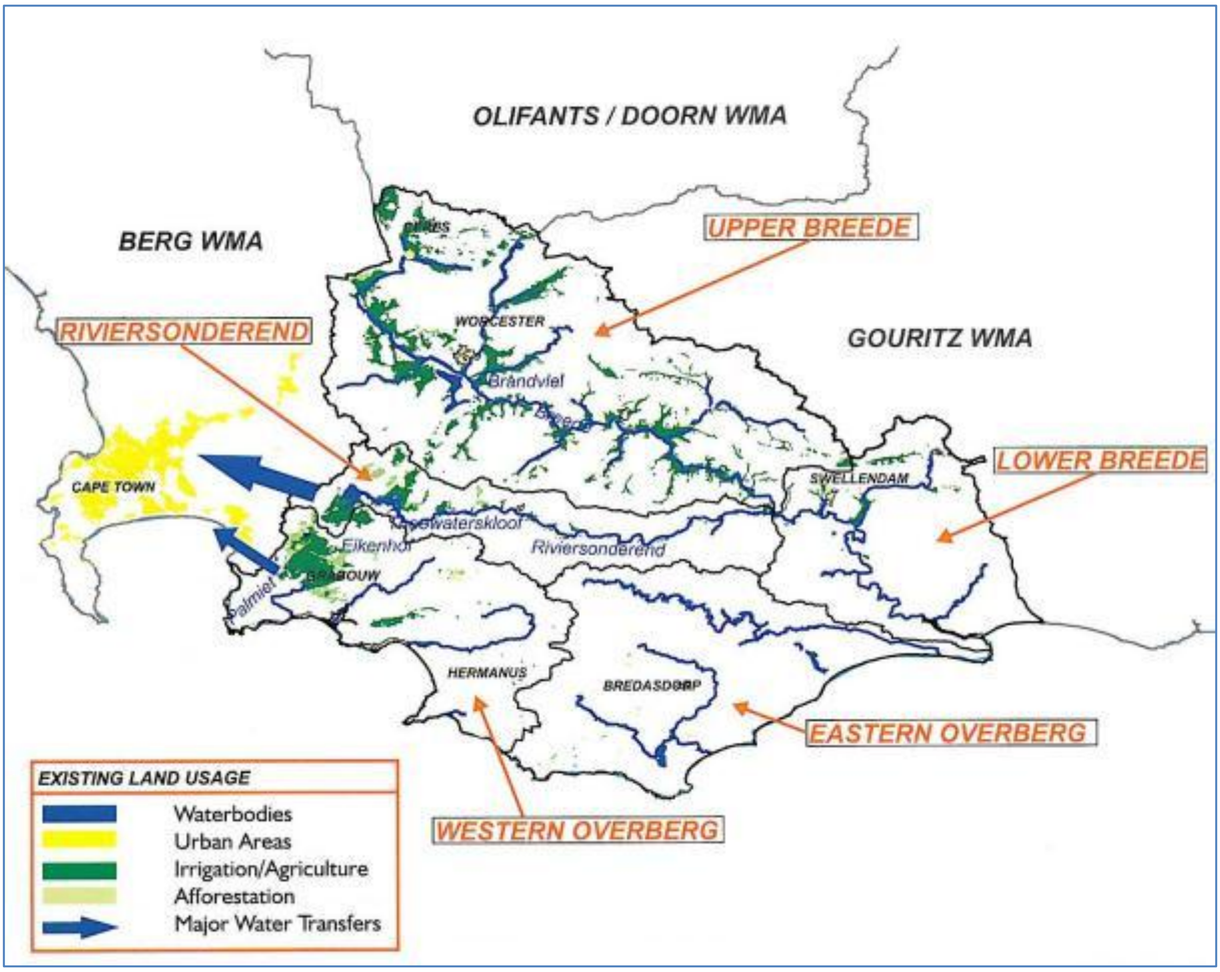

Figure 9.1.1 The Breede WMA

9.1.2 Geological Setting

The following sections have been taken mainly from the GEOSS (2011a) report. The oldest rocks in the area are the meta-sediments of the Malmesbury Group which are exposed mainly by fault controlled valleys. Exposure is most conspicuous along the Breede River valley itself. Granite plutons of the Cape Granite Suite have intruded into the Malmesbury Group and small outcrops are evident throughout the WMA. The Cape Supergroup occupies most of the map area and was deposited in a trough depositional setting (Tankard et al, 1982). The Supergroup constitutes the largely arenaceous Table Mountain Group which unconformably overlies the Malmesbury and Cape Granite rocks, and underlies the Bokkeveld Group (composed predominantly of argillaceous beds) and the uppermost

Witteberg Group (consisting of alternating shales and sandstones). To the north of the Breede WMA the basal units of the Karoo Supergroup outcrop and are represented by the basal Dwyka Group (glacial diamictite), the mostly argillaceous Ecca Group and the shales and subordinate sandstones of the Beaufort group. In the Worcester region the conglomerate with interbedded sandstone of the Conglomerate Formation outcrops, occurring primarily along the Worcester fault. There are a number of Tertiary and Quaternary deposits within the Breede WMA and they consist mostly of unconsolidated to semi-consolidated shelly, calcareous sands of the Bredasdorp Formation. There is also a considerable deposit of alluvium consisting of clay, sand, pebbles and boulders which occurs in the valley of the Breede River and its tributaries. There are also limited occurrences of coastal sands deposited mainly between Agulhas and the Breede River Mouth. Apart from the intrusions of the Cape Granite Suite into the Malmesbury Group, a number of mafic dykes have intruded into the Malmesbury Group and Cape Granite Suite-notably in the Cape Peninsula, Worcester, Tulbagh and Wellington areas (Meyer, 2001). The dykes commonly occur with a north-westerly to north-easterly strike direction and in swarms (Gresse and Theron, 1992). ***Figure 9.1.2*** shows the geology of the Breede WMA.

9.1.3 Structural Geology

The Cape Fold Belt (CFB) is the dominant structural feature in the Breede WMA and the greater Southern and Western Cape area. In Breede WMA the CFB occurs as a largely east-west striking feature and is composed of sedimentary and metamorphic rocks. Two major Orogenic events have determined the structure of the area, namely the Saldanian and Cape Orogenies. The Saldanian Orogeny refers to the deformation of the pre-Cape Malmesbury strata which resulted in folding, shearing and faulting. There were a number of deformational phases but folding occurred mainly along a north-west trending axis.

Rocks of the Cape and Karoo Supergroups were deformed by what is termed the Cape Orogeny which is the dominant cause of the outcrop pattern of the geology, characterized by mega-anticlinal mountain ranges separated by synclinal intermontane valleys. Three tectonic domains exist as a result of the Cape Orogeny, namely the Southern Cape Branch to the east, the Cedarberg Branch to the west and the Syntaxis Domain where they meet. The Breede WMA is located predominantly on the Southern Cape Branch and the Syntaxis domain. The Southern Cape Branch comprises north verging eastward trending folds as well as thrusts and normal faults. The Syntaxis Domain consists of varied northeast striking faults and is defined as the area where the Cedarberg Branch and Southern Cape Branches merge (Gresse and Theron, 1992).

Due to the brittle and competent nature of the arenaceous TMG, fracturing is prevalent within this Group. This to a lesser degree in the Bokkeveld and Witteberg Groups. Numerous minor fold structures abound in the incompetent strata of the Bokkeveld, Witteberg, Ecca and Beaufort Groups (Meyer, 2001).

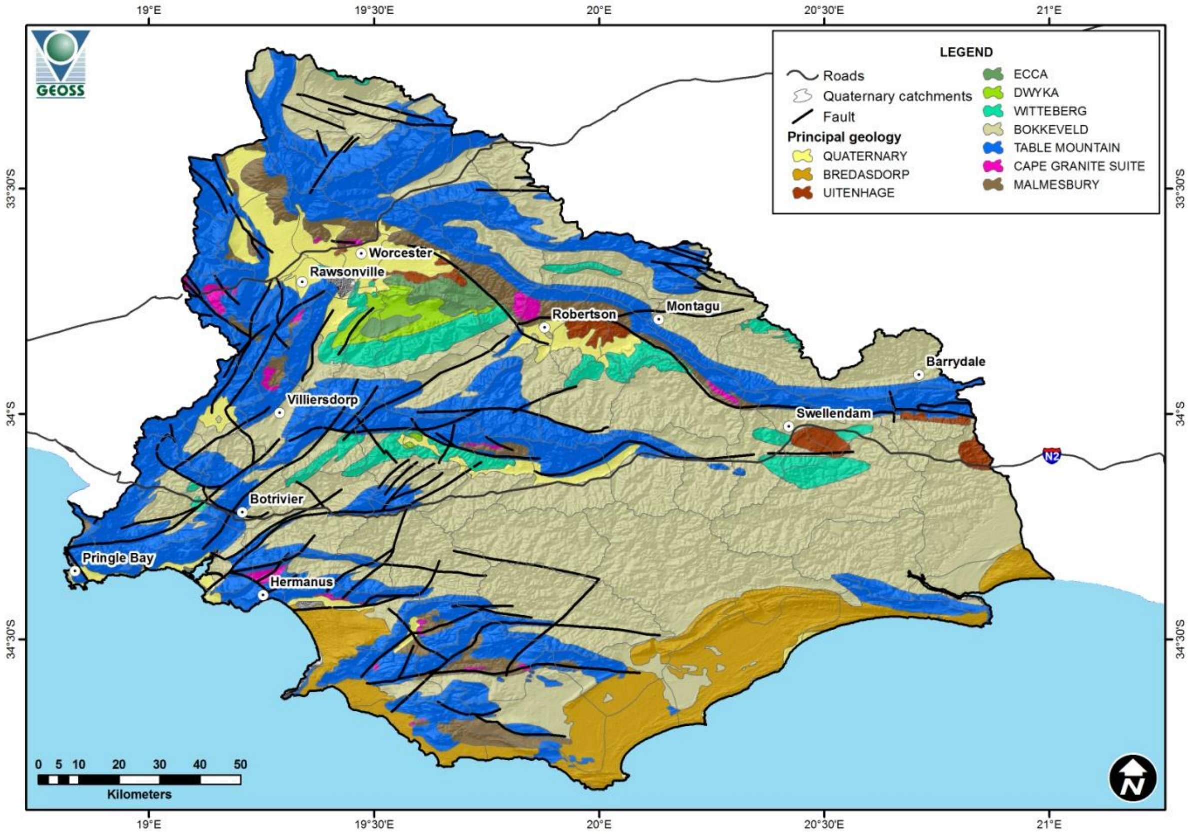

Figure 9.1.2 Geological setting of the Breede WMA

9.2 WATER QUALITY

The natural geology (shales) and agricultural practices contribute to the salinity problem in the Breede River, which impacts on water quality for irrigation. Salinity levels are currently managed as far downstream as the Zanddrift weir, through freshening releases of about 22 million m^3/a out of Brandvlei Dam. With the exception of the Palmiet River and the headwaters of certain rivers of the Overberg West, naturally occurring salinity is prevalent throughout the Overberg as well. Of significant concern is the contamination of water resources by municipal waste water and urban runoff, contributing high pathogen and nutrient loads to the system. The impact on fruit and vegetable irrigation and on recreational contact with rivers and estuaries is significant.

9.2.1 Water Quality Monitoring

The water quality monitoring points within the Breede WMA and the various institutions responsible for undertaking that monitoring are shown in **Figure 9.2.1**. The River Health monitoring points that are located in this WMA are shown in **Figure 9.2.2**.

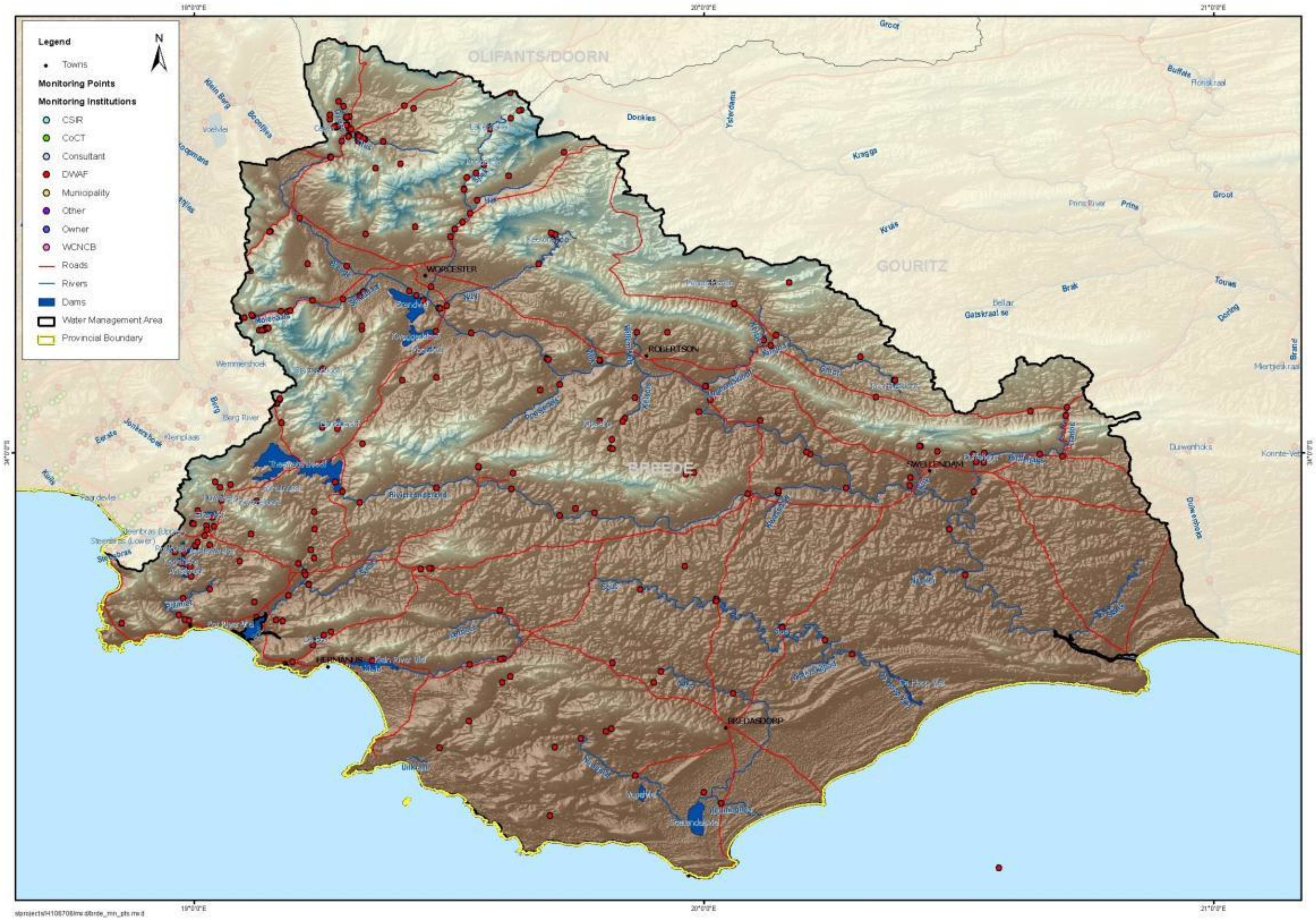

Figure 9.2.1 Water quality monitoring points in the Breede-Overberg WMA.

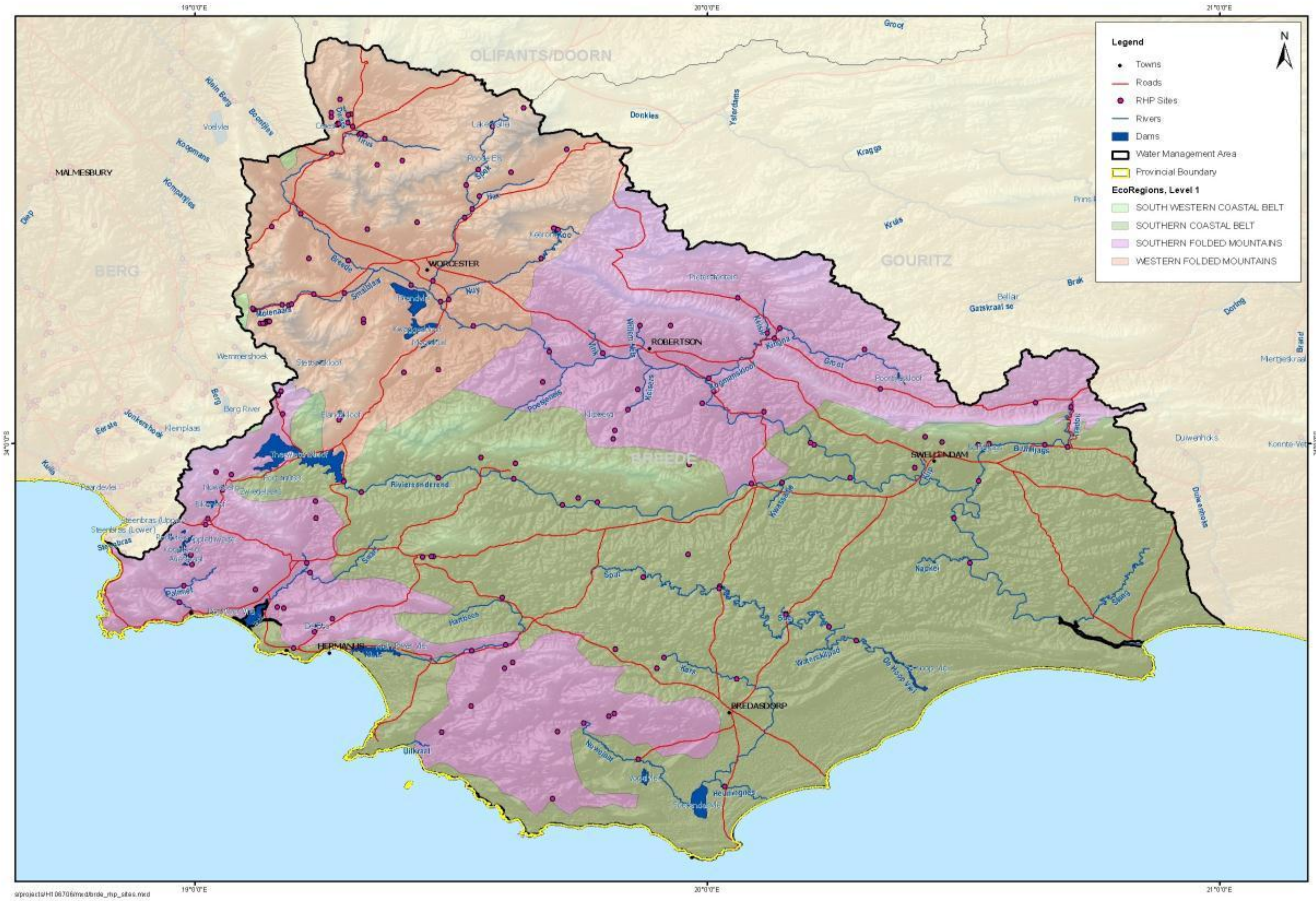

Figure 9.2.2 River Health Programme monitoring points in the Breede-Overberg WMA.

9.2.2 Surface Water Quality Status in the Breede WMA

Water quality in the headwaters of the Breede and many of its tributaries are ideal but it becomes progressively poorer in terms of salinity in a downstream direction. The biggest increase occurs in the middle Breede River due to intensive farming activities and geological influences, which results in poor quality return flows, and the natural geology (bokkeveld shales). The assessment of ecosystem health is included in **Annexure D**.

A graphical interpretation of the water quality status in the Breede WMA is presented in ***Figure 9.2.4*** which shows a summary at the selected monitoring point of the compliance of the water quality variable at that point along the river, in comparison with a generic set of Resource Water Quality Objectives (RWQO) that are applicable to all the rivers across the entire country. The figure shows that the general trend is one of decreasing water quality in a downstream direction, with fairly good water quality in the headwaters of most of the rivers. The reasons for this observation are briefly explained below. **Annexure F** provides the detailed records in the Breede River of the observed water quality profile on which the hexagon “fit for use” summaries at each monitoring point are based.

9.2.3 Water Quality Concerns in the Breede WMA

From the numerous studies, investigations and monitoring information that is available on the subject, the following water quality issues are summarised for the Breede WMA:

- ***Salinity in the Breede River***

Salinization of the middle and lower Breede River and its tributaries are the result of the irrigation return flows discharged to the rivers, the geology of the area, and agricultural practices. Of particular concern is the intentional leaching of natural salts where new lands are cleared and soils purposefully leached to prepare those lands for irrigation. Acceptable salinity levels in the Breede River are maintained as far downstream as the Cogmanskloof tributary, by freshening releases out of the Greater Brandvlei Dam.

- ***Nutrient enrichment in the Breede River***

At certain locations within the Middle Breede River, the occurrence of algal blooms and excessive filamentous algal growth under low flow conditions, clogging of canals by filamentous algae, and aquatic weed infestations (Water hyacinth) have been recorded. These are all symptoms of nutrient enrichment and can be controlled by ensuring WWTW meet the effluent discharge standards and by controlling fertilizer runoff from diffuse sources. Algal blooms resulting have also been noted in Theewaterskloof Dam. The locations of the WWTWs in the Breede WMA are shown in ***Figure 9.2.3****.*

- ***Microbiological quality***

The sources of microbial contamination include the discharge of inadequately treated wastewater effluent from WWTWs, and irrigation with untreated winery and other industrial effluent. While most municipal WWTWs and larger industries are attempting to meet discharge standards, as specified in their individual Water Use Authorisations, the cumulative effect of many smaller operators irrigating with effluent which does not meet the discharge standards, remains a source of contamination. Diffuse pollution from poorly serviced informal settlements and the use of soak ways on the banks of the Lower Breede River are also of a source of microbiological pollution. Storm water runoff from informal settlements and poorly serviced urban areas has increased microbial counts in receiving rivers. Microbial impacts tended to be localised due to the die-off of pathogens in the water.

- ***Agrochemicals in irrigation return flows***

Studies in the Hex River valley have detected pesticide residues in irrigation return flows. It is probably reasonable to assume that the same patterns of pesticide contamination would occur in the rest of the Breede River Basin where intensive irrigation agriculture and spraying of orchards and vineyards is practiced.

- ***Dissolved oxygen and dairy industry***

Concerns have been expressed about the impacts of intensive dairy farming and dairy industries on the organic loads to rivers. In rivers the breakdown of organic compounds reduces dissolved oxygen concentrations which have a negative impact on aquatic organisms. Similar concerns have been raised about local authorities and wineries that irrigate with high COD effluents. Although most individual winery irrigators may be operating within the conditions of their permits, the combined effect of many of them is a concern. These effluents can be washed into rivers during high rainfall events increasing the organic loads to the receiving rivers. The impacts of piggeries in the Bonnievale area on organic loads have also been a concern to water quality managers. Runoff and effluent discharges high in COD has negatively affected estuaries in or near coastal towns in the eastern Overberg area resulting in calls for their protection and rehabilitation.

- ***Turbidity and impacts of sand mining***

Sand mining activities in the Barrydale, Ashton and Suurbraak areas result in increased turbidity and suspended sediment concentrations in rivers. This leads to siltation problems and smothering of aquatic habitats. Bulldozing of streams and tributary rivers in the Breede valley has similar impacts on sediment loads (DWA, 2010).

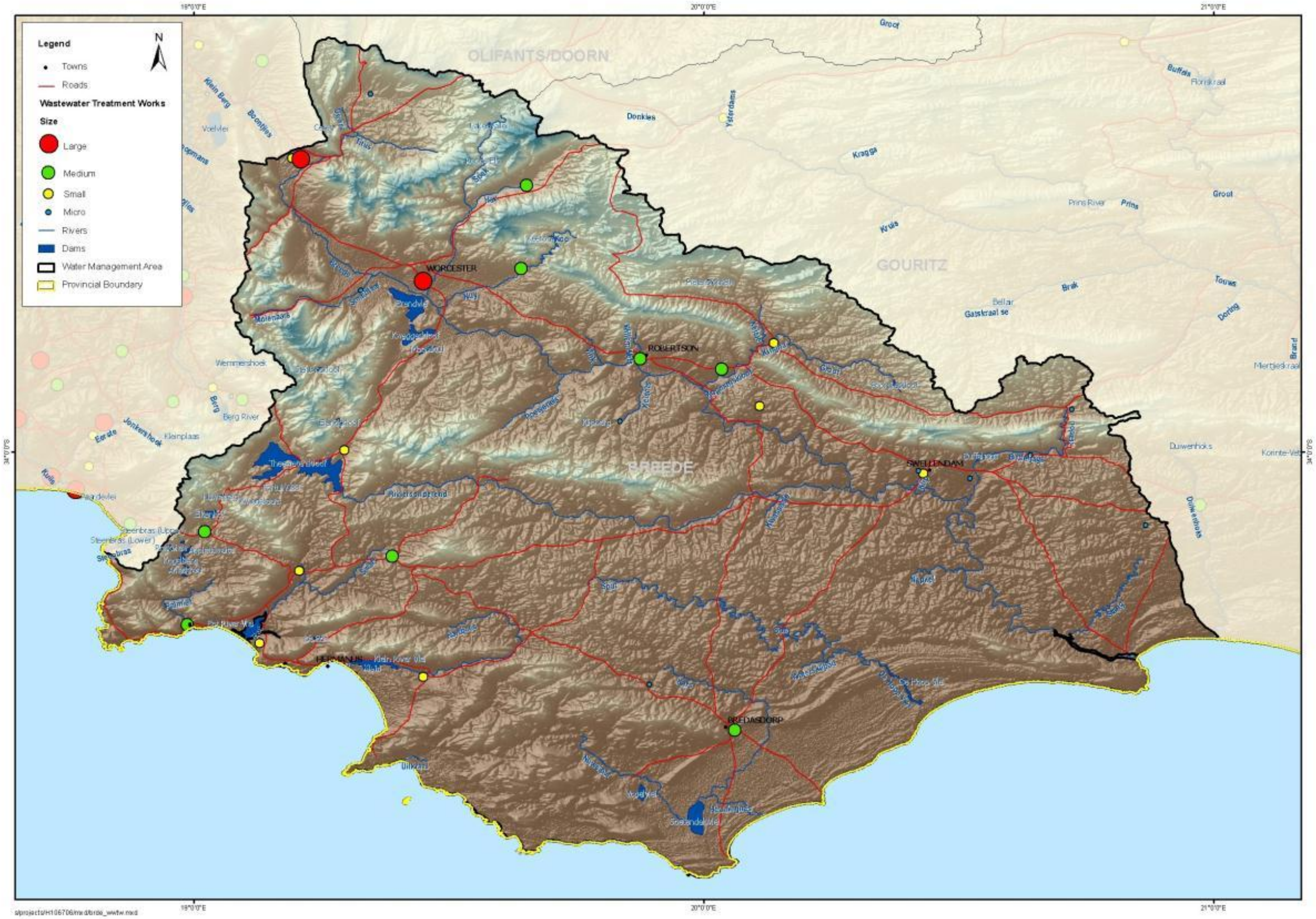

Figure 9.2.3 Location of WWTWs in the Breede-Overberg WMA.

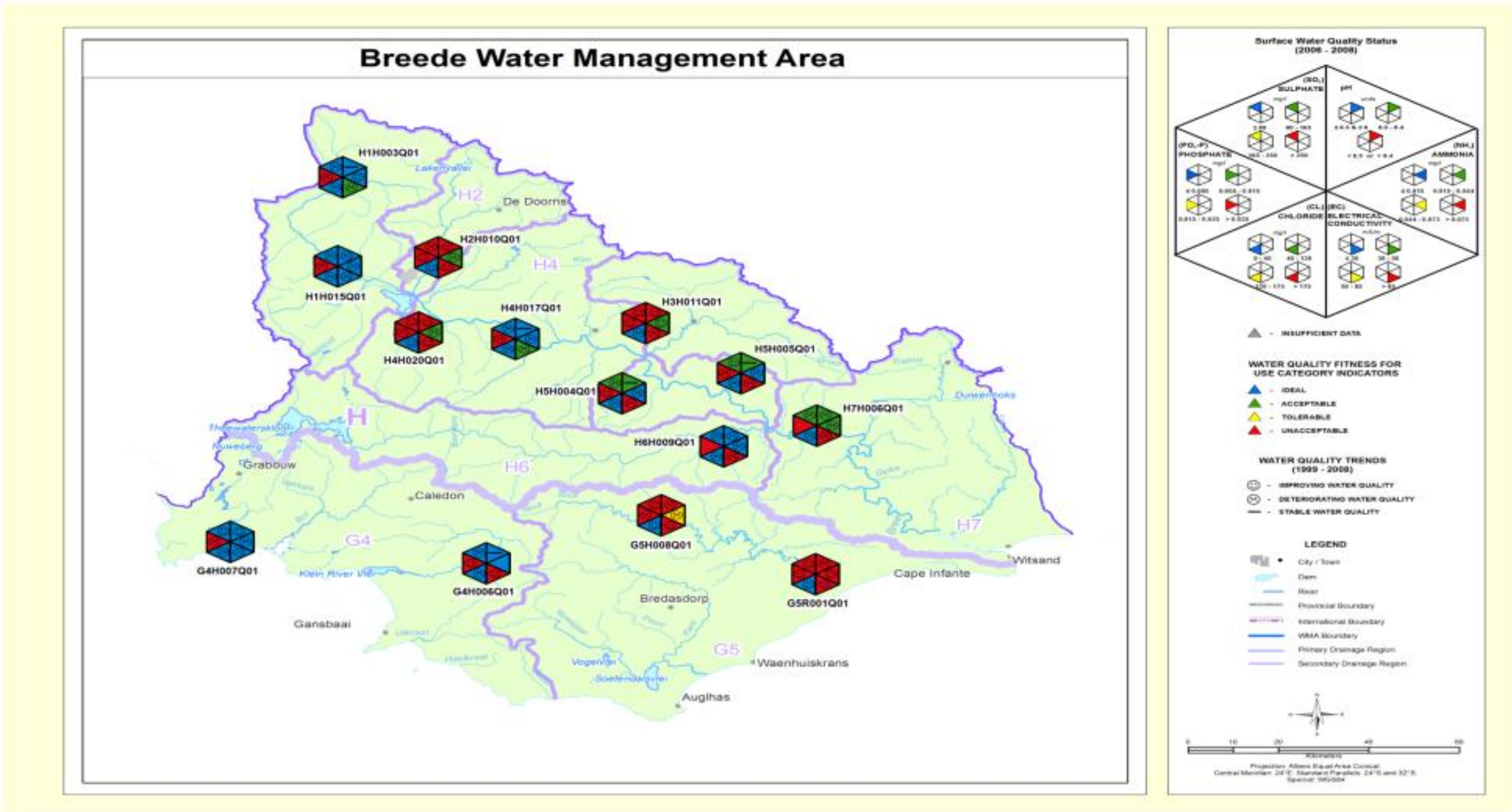

Figure 9.2.4 Water quality status "Fit for use" for the Breede WMA. (Source: DWA, 2010)

9.3 GROUNDWATER

Groundwater use in the Breede WMA is estimated to be 107 million m^3/a of which 103 million m^3/a takes place in the Breede River catchments, most of which supplies irrigation from farmers' boreholes. About 4 million m^3/a is used in the Overberg catchments for domestic and stock-watering purposes. The CCT is investigating sites in the catchment of Theewaterskloof Dam (Riviersonderend) for possible augmentation of the City's water supply. The TMG Aquifer in the Riviersonderend area holds significant potential for development.

9.3.1 Aquifer types

The aquifer types and yields for the Breede WMA are summarized and depicted in ***Figure 9.3.1*** as taken from the DWAF hydrogeological series (1:500 000).

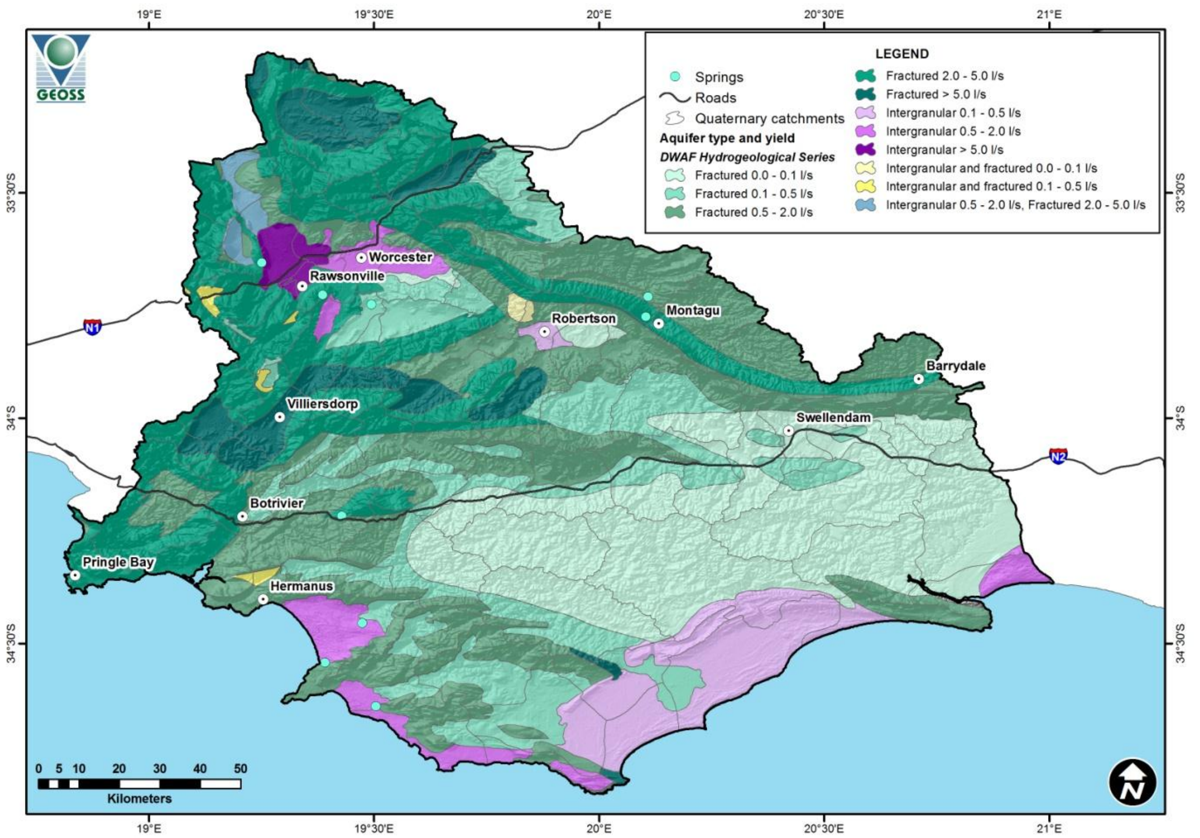

Figure 9.3.1 Aquifer types and springs of the Breede WMA.

The above figure indicates that fractured aquifers dominate the area with increased yields to the northeast being related to the geology, specifically the TMG. Higher yielding zones also show a definite correspondence with faults, as expected. Alluvial aquifers exist along the rivers and where the Bredasdorp Group is concerned. ***Table 9.3.1*** provides a summary of the extent of the aquifer types.

Table 9.3.1 Extent of aquifer types within the Breede WMA

Aquifer Type	Percentage coverage of the Breede WMA
Fractured	88 %
Intergranular	10 %
Intergranular and fractured	2 %
Karst	0 %

Table 9.3.2 lists the spatial extent of the different aquifer types per average borehole yield. The most extensively occurring aquifer type is Fractured 0.5-2.0 ℓ/s.

Table 9.3.2 Aquifer types, sub-classes and coverage for the Breede WMA

WMA	Aquifer type and yield	Area (km^2)	% Area in Western Cape
BREEDE	Fractured 0.0 - 0.1 l/s	4303	22
BREEDE	Fractured 0.1 - 0.5 l/s	2841	14
BREEDE	Fractured 0.5 - 2.0 l/s	5066	26
BREEDE	Fractured 2.0 - 5.0 l/s	4114	21
BREEDE	Fractured > 5.0 l/s	1028	5
BREEDE	Intergranular 0.1 - 0.5 l/s	1158	6
BREEDE	Intergranular 0.5 - 2.0 l/s	700	4
BREEDE	Intergranular > 5.0 l/s	179	1
BREEDE	Intergranular and fractured 0.0 - 0.1 l/s	31	0.2
BREEDE	Intergranular and fractured 0.1 - 0.5 l/s	60	0.3
BREEDE	Intergranular 0.5 - 2.0 l/s, Fractured 2.0 - 5.0 l/s	129	0.7

9.3.1.1 Fractured Aquifers

These are by far the most important within the Breede WMA and cover in excess of 88 % of the area. Of the fractured aquifers, the TMG aquifer is the most important, while rocks of the Malmesbury, Witteberg and Karoo Supergroup can yield water under fractured conditions. Most boreholes in the area are drilled into the TMG or the Bokkeveld Group rocks. From the TMG and Bokkeveld Group aquifers in the Hex River Valley, Rosewane (1981) determined a transmissivity in the order of 23 to 110 m^2/day and a storage coefficient between 3.5 x 10-5 and 1 x 10-3 (0.1 – 0.004%) which is representative of semi-confined to confined aquifer conditions. In the Rawsonville – Goudini area the TMG aquifer is unconfined to semi-confined with leakage in areas overlain by saturated alluvium (DWAF, 2003b).

Fractured aquifers are less prominent towards the south east relating to the change in predominant geology from the TMG to the Bokkeveld and younger groups. As previously mentioned, the TMG has a brittle arenaceous nature and therefore faulting and fracturing is prevalent. The Bokkeveld and younger groups are generally more argillaceous and therefore less susceptible to brittle deformation.

9.3.1.2 Intergranular Aquifers

These aquifers consist of unconsolidated to semi-consolidated coastal and alluvial deposits in which the granular interstices and pore spaces contain groundwater. These aquifers cover large areas but have variable thickness and are often largely unsaturated where they are poorly developed (<10 m) (DWAF, 2003b). The Intergranular Aquifers cover 10% of the Breede WMA.

Bredasdorp Group calc-arenites and unconsolidated sands form an extensive coastal aquifer. The aquifer stretches along the majority of the southeast coast of the Breede WMA between Hermanus and Port Beaufort. The aquifer also extends inland up to more than 20 km in a number of cases. Higher yields are associated with the Bredasdorp Group to the west of Agulhas than to the east thereof related to rainfall distribution, recharge and fractured rock aquifers and faulting.

Intergranular aquifers composed of alluvium consisting of clay, sand, pebbles and boulders of smaller aeriel extent are present inland and occur predominantly in the valleys of the Breede River and its tributaries. This is prevalent within the synclinal and fault controlled valleys in the northwest of the Breede WMA in the Worcester region. A significant intergranular aquifer is found at, and to the north of Rawsonville. Generally the alluvial sands, gravels and boulder beds in the Breede do not attain a thickness of more than 20 to 30 m (Whittingham, 1975) but there are a few which are significant and there are areas in the Hex River valley where they are believed to be in excess of 50 m. Utilization of alluvial groundwater in this region, as well as at Rawsonville, is the most significant with regard to the river related alluvial aquifers. The Hex River alluvial system (Rosewane, 1981) has a transmissivity between 20 – 280 m2/day and a storage coefficient of 1 x 10-1 to 1x10-3 (10% - 0.1 %) (DWAF, 2003b). The alluvial aquifer in the Rawsonville and Goudini area is semi-confined to confined due to clay layers. The aquifer reportedly has a specific yield of 1- 5 % and an average transmissivity of 285 m2/day (DWAF, 2003b).

9.3.1.3 Fractured and Intergranular Aquifers

Fractured and intergranular aquifers are commonly related to weathered coarse-medium grained granites of the Cape Granite Suite where the groundwater is contained in the intergranular interstices in the saturated zone or in the jointed and occasionally fractured bedrock (DWAF, 2003b).

Fractured and intergranular aquifers are limited in extent (only 2% of the Breede WMA). They are present to the northwest in the TMG structurally controlled valleys where alluvium along the rivers overlies the fractured and high yielding TMG. A significant high yielding aquifer of this type is found in the Upper Breede portion of the WMA.

9.3.1.4 Fault Zones and Contact Zones

There are a number of large scale faults within this WMA which relate to the large folding within the TMG. It has been suggested that the north-south trending faults in the area are more closed (compressional), while the east-west trending faults are open (tensional faults) (DWAF, 2003b). One of the most extensive faults is the Worcester fault which strikes east west across the entire water management area. The fault is covered by alluvium in a number of places, but where it outcrops or has been intersected by boreholes drilled in the TMG side (north), high groundwater yields have been obtained (Van Zijl, 1979). It is possible that the fault does not conduct water along its entire length as Smart (1998) speculated that faulting in incompetent sedimentary rocks (shales) results in the formation of a low permeability rock flour which decreases permeability or results in a closed fault.

9.3.2 Groundwater Recharge

For groundwater use to be sustainable it is important that there is adequate recharge. Recharge varies according to the geology and the type of aquifer (alluvial or fractured rock). Recharge to an alluvial aquifer takes place through direct infiltration of water through the ground surface, influent seepage from rivers and streams as well as from interflow from the bedrock. Recharge to fractured rock aquifers takes place via the infiltration of rainfall into the bedrock in the higher mountainous areas (particularly the fractured arenaceous TMG sandstone), interflow from overlying alluvial aquifer and subsurface flow of groundwater due to pressure gradients and gravity.

South Africa as a whole has low recharge volumes, commonly less than 10% of precipitation. Within the TMG in the Western Cape considerably higher values have been obtained. Weaver et al (1998) reported recharge of 50 % by comparing Cl and ^{18}O of groundwater with that of rainfall. A large percentage of this rainfall does not, however, reach the lower lying aquifers in the valleys as it daylights as springs and streams (baseflow) (DWAF, 2003b).

In the Breede WMA, the GRDM data (derived from WR90 data) of recharge per quaternary catchment was used for Reserve calculations. This data is displayed in ***Figure 9.3.2***. Based on this data a total recharge of 573 Mm^3/a takes place in the area of which only about 170 Mm^3/a is abstracted (according to WARMS database). A large volume of this is recharge is expected to contribute to baseflow and springs. The most significant recharge areas occur along the western borders of the Upper Breede, Riviersonderend and Overberg West Management Zones and in the north of the Lower Breede Management Zone. In most cases the highest recharge corresponds with the geology of the TMG and mountainous areas. Recharge towards the southeast of the Breede WMA is low and in the range of 0 – 77 mm/a. Recharge in the TMG mountainous regions can be more than 500 mm/a in places.

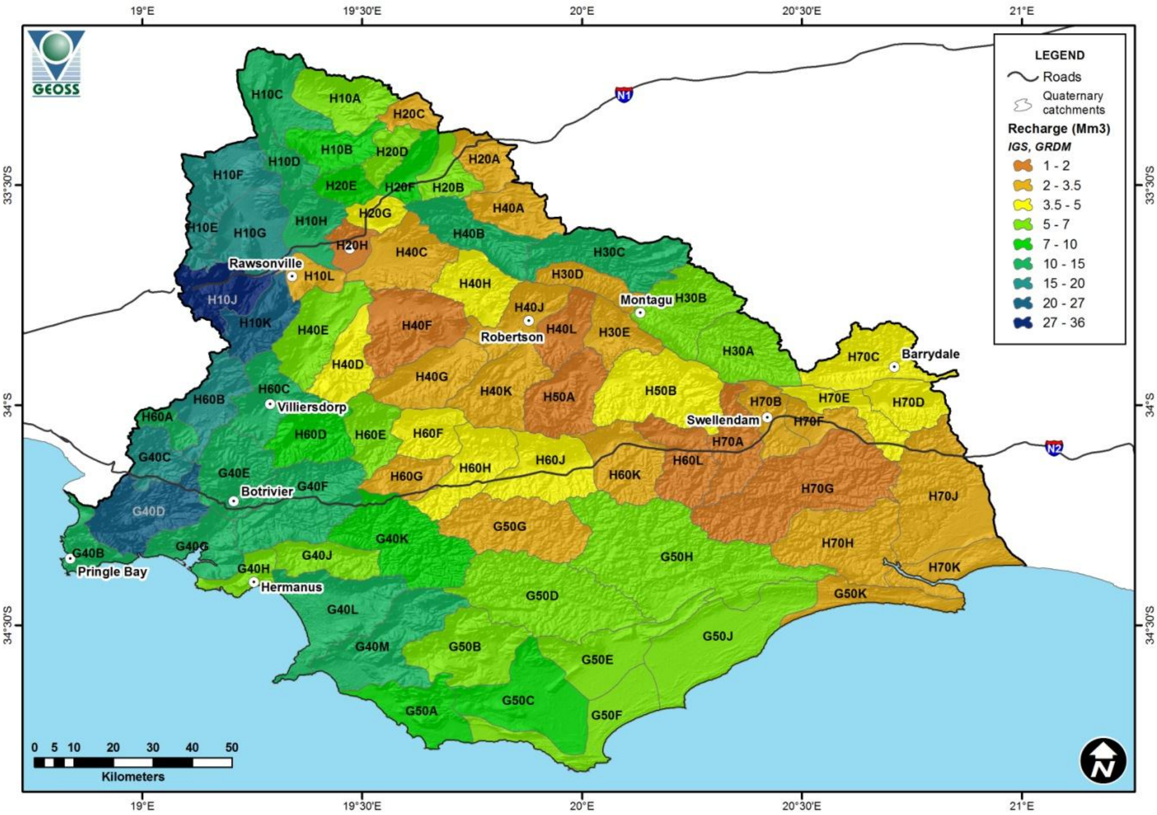

Figure 9.3.2 Groundwater recharge within the Breede WMA.

9.3.3 Groundwater Quality

The western portion of the Breede WMA has excellent quality groundwater associated with the Table Mountain Group geology. Even the southern coastal areas have surprisingly good groundwater quality. The area with the most saline groundwater is located in the central portion of the WMA, south of the national road (N2). This is attributable to the low recharge rates and argillaceous (shale-rich) structure of the host rock (Bokkeveld Group) and mineralized. This area of high salinity is essentially a vast agricultural landscape where dryland practises occur (wheat farming). All the main towns are located close to the good quality groundwater resources. The spatial variability in electrical conductivity (salinity) is shown in ***Figure 9.3.3***.

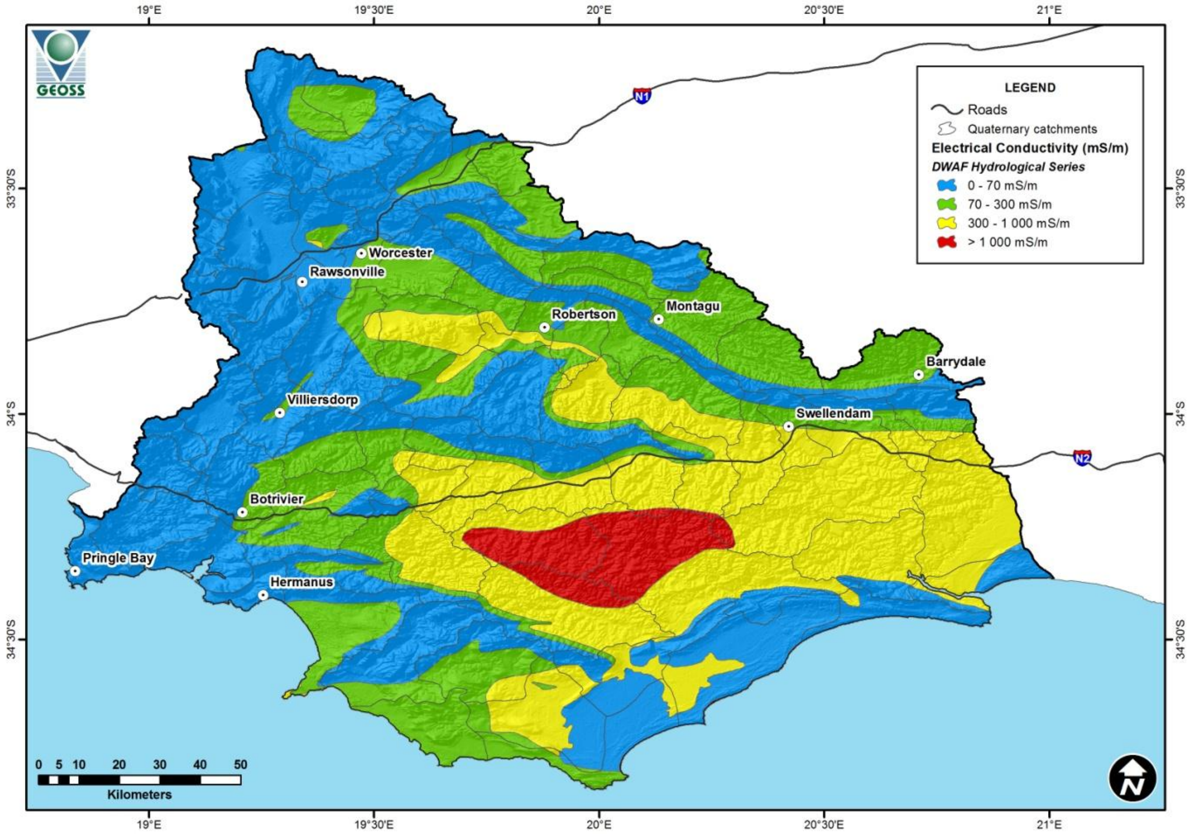

Figure 9.3.3 Groundwater quality (EC) of the Breede WMA.

9.3.4 Groundwater Abstraction

Groundwater abstraction volumes from DWAF (2005) are displayed in ***Figure 9.3.4*** where the values are plotted per quaternary catchment within the Breede WMA. Groundwater use is varied, but the highest abstraction relates to the TMG, Bokkeveld Group and alluvial aquifers. Low abstraction areas relate to inaccessible locations within the TMG mountains and the low permeability units of the argillaceous younger geological groups. Regions of high abstraction from intergranular aquifers occur along the southern coast relating primarily to the Bredasdorp Group intergranular aquifer.

Within the Breede WMA the primary land-use activity is for agricultural purposes and there is intensive irrigation in the Breede and Riviersonderend River valleys and the western parts of the Overberg region. Abstraction decreases towards the east related to poor water quality and low yields from the Bokkeveld Group and Karoo Supergroup.

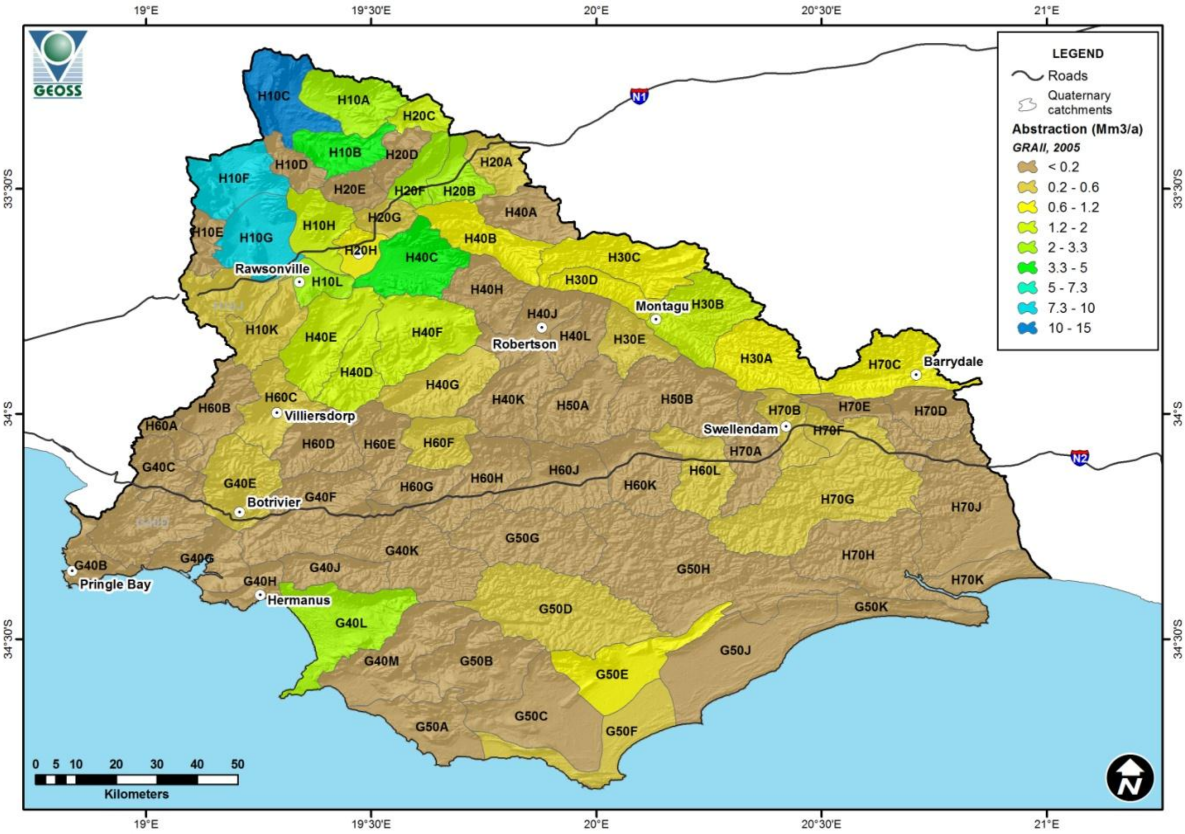

Figure 9.3.4 Groundwater abstraction of the Breede WMA.

9.3.5 Groundwater Stress Index

This is calculated for all 79 Quaternary catchments in the Breede WMA and displayed in ***Figure 9.3.5***. Decision making with regards to future groundwater development must consider the stress indices of the relative Quaternary catchments and should target those with minimal current stress. Attention needs to be given to management and monitoring of the moderately to critically stressed catchments to ensure that the resource utilization is sustainable.

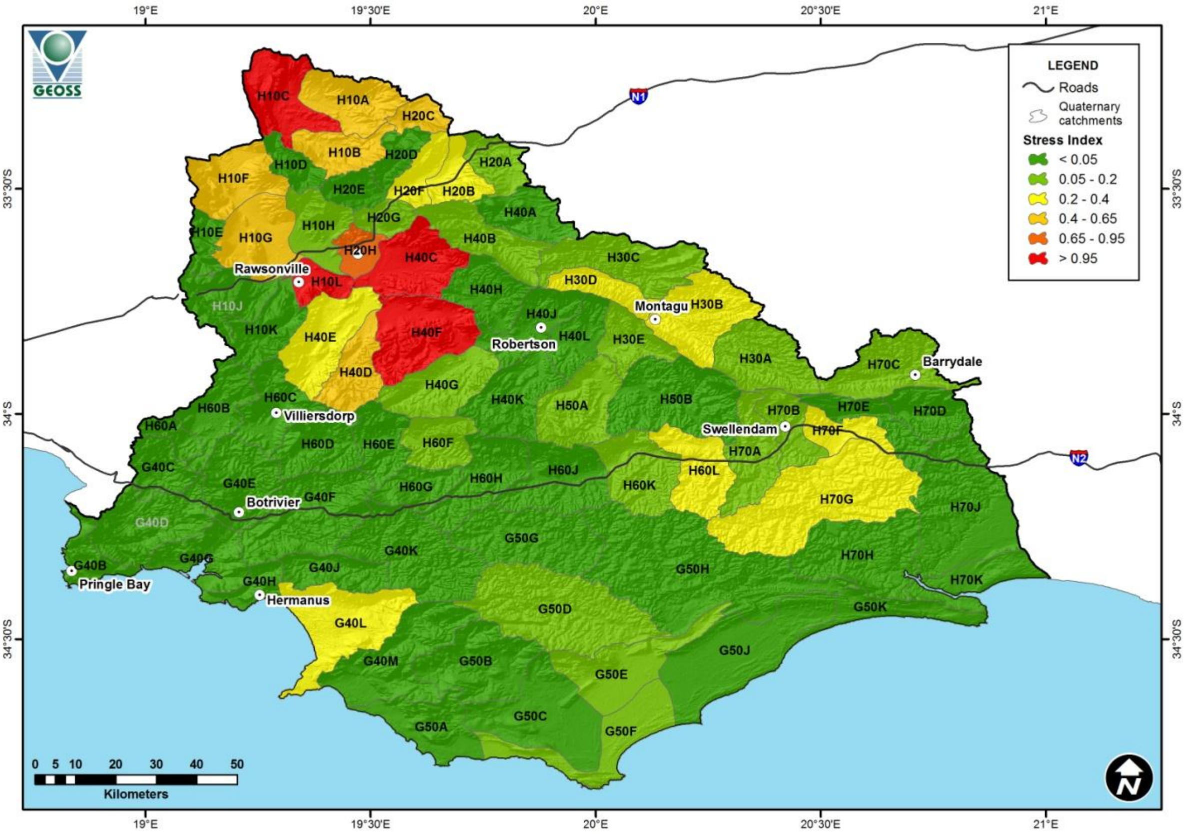

Figure 9.3.5 Groundwater Stress Index of the Breede WMA.

9.3.6 Groundwater contribution to river base flow

According to DWAF (2003b) two routes for groundwater flow from recharge to discharge areas are considered to operate in the Breede catchment. The first component is described as interflow, and comprises 75 – 90 % of infiltrating precipitation. This groundwater rapidly becomes surface water in the mountainous catchments that form the Breede River tributaries. The remaining 10-25 % of infiltrating precipitation in recharge areas is believed to infiltrate fracture systems that transport it down to the deeper underlying regional water table.

An investigation by Parsons (2003) found that not all baseflow is derived from groundwater and that inconsistent use of terminology contributed to a poor understanding of the interaction. Baseflow is a non-process related term for low amplitude, high frequency flow in a surface water body during dry or fair weather periods (Parsons and Wentzel, 2006). It is not a measure of groundwater discharged into a river or wetland, but it is recognised that both groundwater and interflow contribute to baseflow. For the purposes of this study baseflow is considered to represent groundwater contribution to stream flow and the flow of water through the unsaturated zone is ignored.

The baseflow for the Breede WMA is displayed in ***Figure 9.3.6*** where values for the different quaternary catchments are taken from GRDM programme (derived from WR90 data). The data indicates that higher baseflow volumes relate to the TMG geology, areas of high recharge and the mountainous regions.

An abundance of springs, and a corresponding high groundwater contribution to baseflow, is a characteristic of the TMG. These are related to major fault structures, lithological contacts as well as the numerous joints and fractures.

Small streams are often related to local flow systems of limited extent with a seasonal nature. It is therefore possible for the smaller tributaries of the Breede to have both gaining and losing reaches that change seasonally. Often streams flow out of mountainous terrain across alluvial fans at the edges of valleys and most streams in this setting get a "losing nature" as they traverse highly permeable alluvial fans (DWAF, 2003b). Generally the upper reaches of the rivers and tributaries are fed by groundwater and interflow. When there is a lateral change in flow path to lower permeability formations (from quartzite to shale) the groundwater may rise to the surface as springs. This may be case for the Koo River which flows from the TMG over the Bokkeveld Group. Due to the source location of the Breede River tributaries up in the mountainous regions it is anticipated that they are mostly groundwater fed. It is anticipated that they may become losing streams when they flow out over alluvium in the valleys (recharge the alluvium).

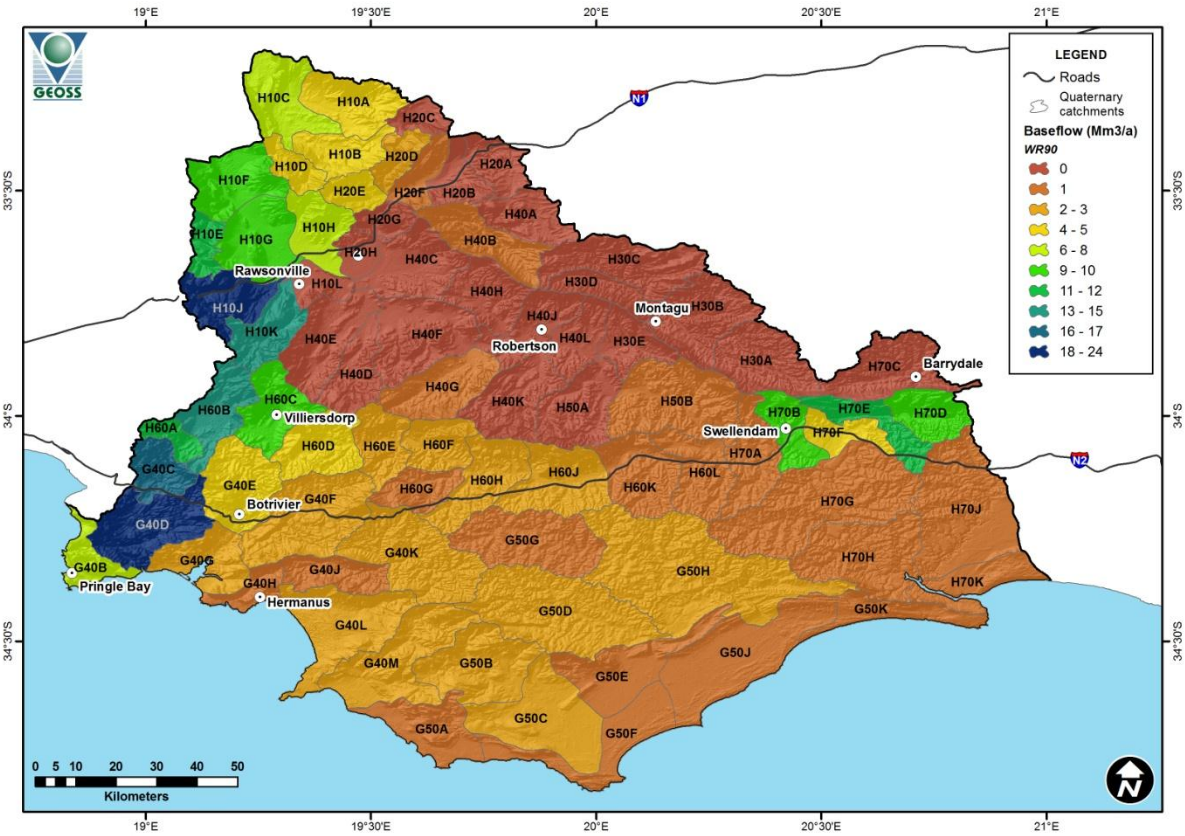

Figure 9.3.6 Groundwater contribution to river base flow within the Breede WMA.

9.3.7 Groundwater – general comments

Table 9.3.3 lists the quaternary catchments where the groundwater abstraction exceeds the groundwater recharge and the volume of groundwater required to meet the groundwater Reserve allocation. Intervention measures are required to ensure sustainable use of groundwater occurs in these over-abstracted Quaternary Catchments.

Table 9.3.3 Quaternary catchments where groundwater abstraction exceeds recharge and the Reserve - Breede WMA

WMA	Quaternary Catchment	Allocable Volume (Mm^3/a)	% Area of Quat included
BREEDE	G40C	-0.85	100
BREEDE	H10A	-1.18	100

BREEDE	H10B	-0.02	100
BREEDE	H10C	-9.23	100
BREEDE	H10F	-2.63	100
BREEDE	H10G	-0.46	100
BREEDE	H10L	-0.35	100
BREEDE	H40C	-0.86	100
BREEDE	H40F	-0.61	100
BREEDE	H60L	-0.04	100
BREEDE	H70B	-7.04	100
BREEDE	H70D	-4.58	100
BREEDE	H70E	-8.41	100
BREEDE	H70F	-3.49	100
BREEDE	H70G	-0.19	100

9.4 WATER RESOURCE INFRASTRUCTURE

A major inter-basin transfer takes place between the Breede and Berg WMAs via the Riviersonderend-Berg-Eerste River Government Water Scheme (Theewaterskloof Dam), which also supplies water for irrigators in the Riviersonderend sub-area and to the Overberg Water Board schemes in the Overberg. Of the total scheme yield of 234 million m^3/a, an average annual net transfer of 161 million m^3/a takes place into the Berg WMA, within which the largest beneficiary in the Berg WMA is the City of Cape Town (CCT). Irrigators in the Berg and Eerste River catchments also have an allocation out of this scheme. Four other small transfer schemes totalling approximately 12 million m^3/a also transfer water out of the Breede River.

An inter-basin transfer also takes place out of the Palmiet River (Overberg West) into the Upper Steenbras Dam (Berg WMA), via the Palmiet Pumped Storage Scheme. The average annual volume transferred is 22,5 million m^3/a and this is utilised by the CCT. The Overberg Water Board operates the Ruensveld West and Ruensveld East Schemes, which abstract water from the Riviersonderend River. The water is treated and distributed to rural users and for stock watering. Collectively, the transfers from the two Ruensveld Schemes total about 4 million m^3/a.

Stettynskloof Dam (Worcester) and De Bos Dam near Hermanus are the only dams of significant size that are owned by local authorities, and for which the primary purpose is urban water supply. The remaining larger dams supply water primarily for irrigation. Farm dams collectively provide about 83 million m^3 of storage.

9.5 STRATEGIC PERSPECTIVES FOR THE BREEDE WMA

The Breede WMA ISP (completed in 2004) served to guide the strategic management of water resources in this WMA until such time as the BOCMA had been established. The CMA is in now place and is in the process of developing its Draft Catchment Management Strategy. ***Figure 9.5.1*** summarises the strategic areas addressed within the strategy.

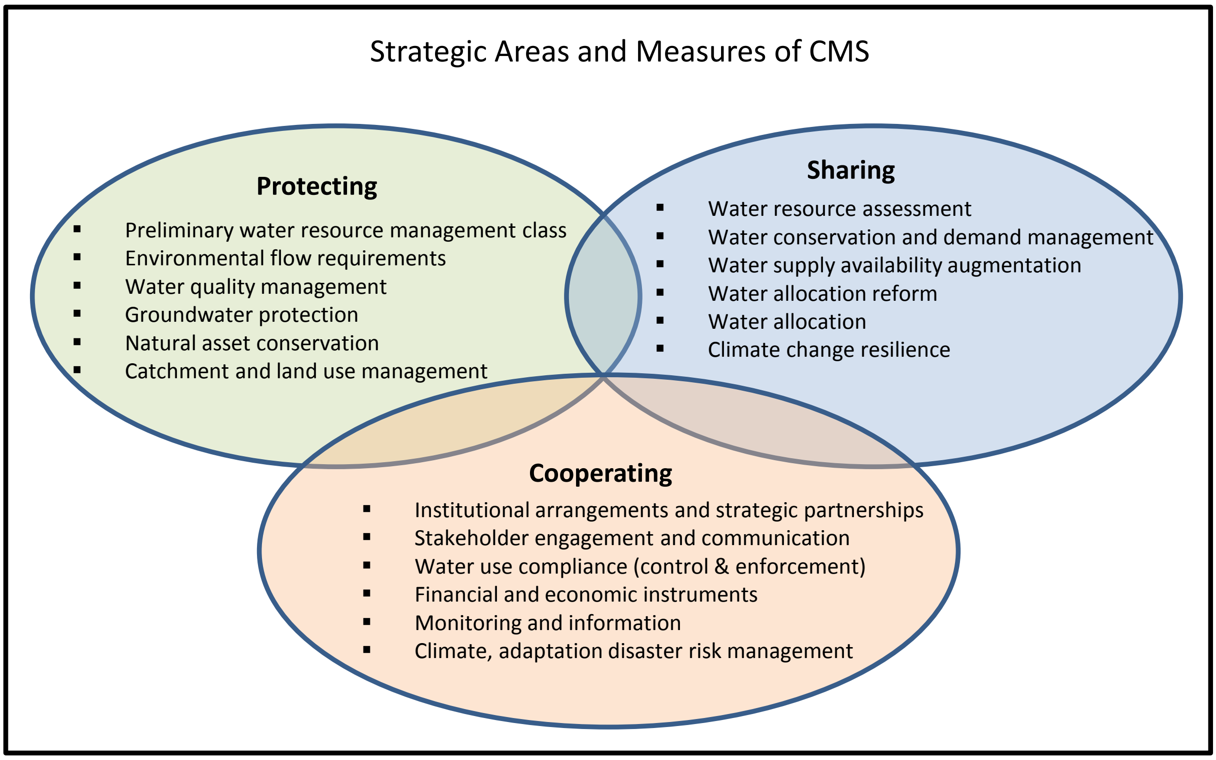

Figure 9.5.1 Strategic Areas and Measures of the BOCMA CMS

From a regional perspective, one of the key aspects recognized is that water will shape the growth and development of the Breede Valley and Overberg region, and that the future of the region is linked to that of Cape Town, the Western Cape and the country as a whole. Of particular relevance is the potential for the provision of additional water (via increased inter-basin transfer) to the Berg WMA, which will have to be very cautiously considered. This is due to various factors including the possible potential for further irrigation development within the Breede region, the outdated hydrology of the Breede system, the desired ecological status of the rivers and Breede Estuary, as well as the fact that other options for augmentation to the Berg WMA, other than increased transfers from the Breede also exist. The need for a cautionary approach to water allocation is further explained hereafter.

9.6 BREEDE WMA WATER AVAILABILITY AND UTILIZATION

In 2005 (based on the Breede WMA ISP), the water availability and utilisation for the Breede WMA is as shown in ***Figure 9.6.1***.

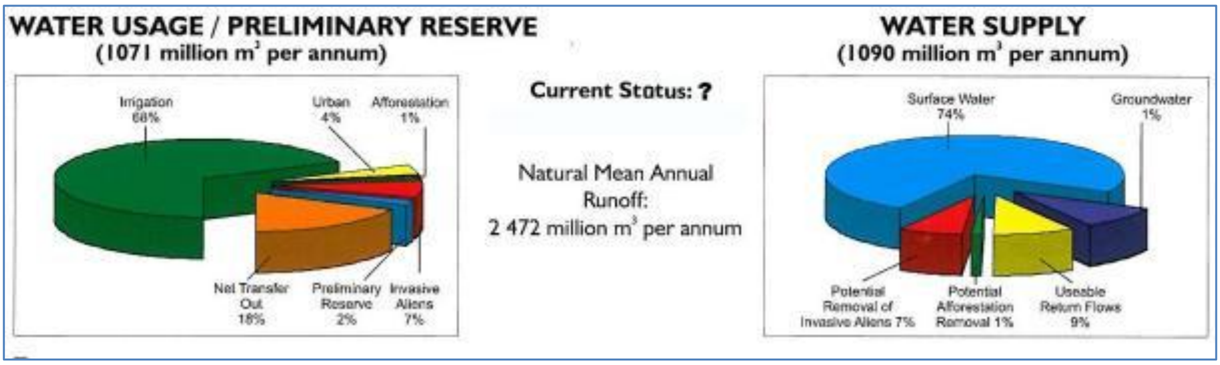

Figure 9.6.1 Breede WMA water availability and utilisation (2005).

It should be noted that:

- Irrigation comprises 68% of total consumptive use and water exports 18%.
- Many coastal towns are located in water scarce areas with particular problems in meeting peak holiday season demands, particularly during drought periods..
- These estimates of water availability are heavily impacted by decisions around the implementation of the Reserve, particularly in the Riviersonderend catchment (Theewaterskloof Dam). Physical interventions that could minimise this impact might include the targettted clearing of Invasive Alien Plants for example. Management inteventions such as possible reduced ecological class requirements could also be a possibility for consideration in the BOCMA CMS.
- The hydrology is out-dated and the BOCMA CMS makes recommendations on addressing this problem and adopting a cautionary approach in the interim, in terms of water allocation. The extent of any surplus availability (if any) is uncertain at this stage.

9.6.1 A Cautionary Approach to Water Allocation

The Breede-Overberg Catchment Management Agency (BOCMA) is the first CMA to be established in the Western Cape, and in terms of terms of the National Water Act (36 of 1998), is the lead agent for water resource management within the Breede-Overberg WMA.

From a water availability and utilization perspective, the BOCMA Catchment Management Strategy (CMS) emphasises that the water resources of the Breede and Overberg system are heavily utilised. It does recognise that there may be some opportunities to further develop the resources in some areas. However, the modelled hydrological information on the Breede River is based on the Breede River Basin Study, which used data prior to 1990, except for the catchment upstream of Brandvlei which used data until 2000.

Apart from the Palmiet, the information in the Overberg catchments is even more uncertain, being based primarily on WR90 estimates. Similarly, no water use information is available for the past decade, which poses a challenge with the alleged expansion of water use in parts of the WMA. Making any material water resources decisions in catchments under possible stress with limited updated or reliable information poses a serious management challenge.

The CMS recommends that the water resources information must be improved in the Breede Overberg CMA through a comprehensive assessment study, with a focus on the following areas:

- Hydrological variability, considering land use changes, recent extreme events, possible shifts related to climate variability (temperature and rainfall) and the interplay between ground and surface water.
- Irrigation water use, noting variations between different locations and seasons, as well as the legality of this water use. Irrigation water supplied from outside of controlled irrigation areas (government schemes and WUAs) is estimated to be about 25% of the total irrigation from the Breede catchment. There is some uncertainty regarding the legality and magnitude of this water use from run of river, farm dams and boreholes, but this must be clarified.
- Yield of the system in supplying water (reconciliation of hydrology and demands), considering existing and potential infrastructure developments and the environmental flow requirements.

The objective of the water use, hydrological and systems assessment will be to gain a comprehensive understanding of current water use, estimate surface and ground water availability, and to consider uncertainties such as climate change and changes in land use. This assessment will provide the basis for water allocation and water resources development decisions to be made.

From a groundwater perspective, come specific concerns requiring particular attention include:

- over utilisation in the Ceres area (up to 28 million m^3/a of over-utilisation in just one quaternary catchment, H10C;

- impacts of irrigation return flows on water quality;
- the impact of untreated agricultural effluent (discharged or used for irrigation) on the alluvial aquifers and on the rivers.
- possible saline intrusion of primary coastal aquifers due to poor management/over-abstraction;
- monitoring and management, including adequate provision human resource allocation (including the consideration of artificial groundwater recharge) are key considerations;
- allocations in “stressed” catchments requires urgent attention;
- existing lawful use and the extent of new borehole licence applications must be addressed;
- validation and verification of groundwater use is crucial, and it is essential that the WARMS database be kept up to date for these stressed catchments.

9.7 TOP PRIORITY AREAS AS PER BITT REPORT

The BITT report has prioritized the infrastructure development needs in the Cape Winelands and Overberg DM’s, as well as the need for skilled resources to operate and maintain the various WWTWs. Some of the towns mentioned below lie within the Berg WMA but are included here for completeness so as to retain the prioritzation per DM.

Table 9.7.1 10 Most Urgent Technical Interventions Required in the Cape Winelands DM

Ranking (1 = Highest Priority)	Description
1	Ashton WWTW - Bulk Sewer Pump
2	Witzenberg WWTW - Upgrade outfall sewer
3	Witzenberg WWTW - Upgrade outfall sewer
4	Paarl WWTW - Bulk sewer to Paarl South
5	Paarl WWTW - Carolina Bulk Sewer
6	Bonnievale WWTW - New 5 Ml reservoir
7	De Doorns WWTW - Irrigation system for effluent
8	Cloetesville WWTW - supply upgrading
9	Worcester WWTW - Bulk water supply
10	Klapmuts WWTW- 4 Ml reservoir

Table 9.7.2 10 Most Urgent Skills Requirements for WWTWs in the Cape Winelands DM

Ranking (1 = Highest Priority)	Town/Suburb
1	Wellington
2	Gouda
3	Paarl
4	La Motte
5	Pniel
6	Saron
7	Wemmershoek
8	Hermon
9	Montagu

Ranking (1 = Highest Priority)	Town/Suburb
10	Stellenbosch

It is relevant to note that in the Cape Winelands DM the Paarl WWTW features both in terms of Top 10 infrastructure needs and Top 10 staffing requirements and as such can be considered to be in urgent need of attention.

Table 9.7.3 10 Most Urgent Technical Interventions Required in the Overberg DM

Ranking (1 = Highest Priority)	Description
1	Theewaterskloof-Municipality-wide: Water demand management interventions
2	Overstrand-Municipal wide - Water Demand Management
3	Overstrand-Municipal wide - Stormwater Ingress Reduction
4	Swellendam-Municipality-wide: Water demand management interventions
5	Overstrand-Upgrade Hermanus WWTW
6	Overstrand- Municipal wide - Water Resource Management
7	Overstrand-Greater Hermanus - New 4 Ml reservoir for Sandbaai and supply pipe
8	Theewaterskloof- Villiersdorp: 2Ml reservoir at Ham St
9	Overstrand- Greater Hermanus - Upgrade of Preekstoel WTW
10	Overstrand- Greater Hermanus - New 1.5 Ml reservoir for Onrus and supply pipe

Table 9.7.4 10 Most Urgent Skills Requirements for WWTWs in the Overberg DM

Ranking (1 = Highest Priority)	Town/Suburb
1	Greyton
2	Koomland
3	Genadendal
4	Riviersonderend
5	Botrivier
6	Villiersdorp
7	Buffeljags
8	Suurbraak
9	Hawston
10	Caledon

It is relevant to note that in the Overberg DM many of the interventions are related to WCDM implementation, which highlights the opportunities for more efficient water use in that DM. Villiersdorp features in both the top 10 technical needs and in the need for skills to operate and maintain its WWTWs and as such can be considered to be in urgent need of attention.

9.8 PROBLEM SYNTHESIS

The problems and gaps identified in this Chapter that are broadly summarised as follows:

- Water Quality impacts from natural geology and from intensive irrigation practices in the Breede WMA has been addressed previously under the water quality theme.
- Also of significance is the problem of irrigation with high COD concentrations (such as winery effluent) which is having a collective impact on water quality. This requires management attention as most of the individual winery irrigators operate within the conditions of their permits but the combined effect on the receiving rivers is a concern. DWA are in the process of updating their water quality guidelines.
- Groundwater use in the Breede WMA is significant (estimated to be 107 million m^3/a) of which 103 million m^3/a takes place in the Breede River catchments. A cautious approach needs to be adopted in terms of applications for further abstraction in the Ceres and Hex River valley areas, where the resource is being over-utlized.
- The CCT and Eerste River irrigators depend on large scale water transfers from the Breede WMA. These transfers are primarily from the Theewaterskloof Dam (Riviersonderend River) and from the Palmiet River (Overberg). There has been a perception that there may be some surplus water available from the Breede, either for in-basin development or possible further transfer to the Berg WMA. This cannot however be confirmed until the Reserve for the Breede system (including its Estuary) has been determined, which in turn requires the out-dated hydrological information (20 years old) to be updated. A cautionary approach to further allocation of water from the Breede River must be adopted. DWA are planning to conduct an updated hydrology and landuse study for the Breede to support decision making based on latest available data.