



DEPARTMENT: WATER AFFAIRS AND FORESTRY

North West Groundwater Master Plan

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1. INTRODUCTION

This document will serve as a Master Plan to be used by Northwest Regional Management to structure the tasks of the groundwater staff component related to the water functions as set out by the National Water Act of 1998.

A comprehensive discussion of the water functions, as defined in the NWA (1998), in relation to groundwater is found in Appendix A. The different geohydrological regions (Vegter-regions) will be discussed and where possible, any potential groundwater activities identified and actions needed to execute the functions, proposed.

None of the functions and/or management actions however, can be executed effectively without the necessary data and information. See Appendix B for a discussion on sound data/information management principles. Additional to these principles, one chapter in this document will deal exclusively with data and information management relating to the Northwest Region.

Without the necessary staff and the appropriate structures none of the above will be possible - thus a staff structure necessary to execute these groundwater functions will also be proposed.

Typical information products and reports in relation to the strategic and operational decisions that the department has to make regarding groundwater will also be addressed.

1.1 Purpose

The purpose of this document is to assist the management cadre in the Northwest Region to effectively execute the required groundwater functions.

At the same time this document can serve as a communication tool between adjacent Regions with overlapping aquifers and the relevant Head Office components as well as neighbouring countries where applicable.

This document can also serve as an input to the Regional Director's and Chief Director's work plans/performance agreements.

1.2 Scope

The Groundwater Master Plan aims to address all water functions as defined by National Water Act (1998) for the Northwest Region.

Other related activities and projects that have relevance also need to be recognised and as the document progresses, these will be added. The relevance and potential impacts these projects might have on the improvement of the execution of the functions must be addressed as well.

1.3 Audience

Before the audience of the document is stated, the term 'Northwest Region' needs to be defined. The term 'Northwest Region' will in the context of this report, mean the areas of jurisdiction for water resources management that is the Water Management Areas of Crocodile (West)-Marico (No. 6).

The audience is: -

- Management of the Northwest Region;
- Sub-directorate: Groundwater Information in the Directorate: Hydrological Services at National Office;
- Sub-directorate: Groundwater Monitoring and Assessment in the Directorate: Hydrological Services at National Office;
- Adjacent Regional Offices in terms of overlaps in groundwater management units and cross-cutting issues;
- Water services - It is recognised that the areas of jurisdiction relating to water services, differ from the above. In the overall scheme of things it is envisaged that these different areas of jurisdiction will cause either duplications or gaps to appear and needs to be addressed.

1.4 Revision

Version 1 (this document) is only a draft, to kick start the required groundwater functions and it is strongly recommended that it be revised and adapted once a year in close conjunction with the Northwest Region's management structure.

As more detail becomes available and good quality data and information is gathered both the structure and content of this document must be adapted.

1.5 Applicable Documents

1. ISP documents for the 1) Crocodile (West) and Marico Water Management Area.
2. National Water Resources Strategy.
3. National Groundwater Strategy (in preparation).

1.6 Acronyms and Abbreviations

Acronym/Abbreviation	Definition
ISP	Internal Strategic Perspective
WMA	Water Management Area
Open-NGDB	National Groundwater Database running on an open server
KNP	Kruger National Park
WMS	Water Management System (chemical database)
SGD	Standard Geosite Descriptors
NGA	National Groundwater Archive (used to capture all groundwater-related data) which will be replacing the Open-NGDB soon.
D:WQM	Directorate: Water Quality Management
WSA	Water Services Authority – usually the District Municipality

1.7 Introduction

The water functions as identified in the NWA (1998) are the following: - i) development, ii) utilisation, iii) protection, iv) conservation, v) management and vi) control. In order to create a common understanding of these terms, a comprehensive

discussion about them and the tasks related to these water functions, is attached in Appendix A.

From the outset of the drawing up of this document, some shortcomings in terms of the data and information for the Northwest Region, were already evident and will be discussed together with solutions that must be instated with immediate effect. These shortcomings will be discussed under the heading of 'Current Situation'.

1.8 Current situation

1.8.1 Monitoring

When talking of groundwater monitoring the reader of this document should understand that it entails the monitoring of groundwater abstractions, water level fluctuations and chemical quality. For a comprehensive discussion on monitoring refer to Appendix C of this document and to Van Wyk (2003).

About 35 points are currently being monitored actively for water level fluctuations. The spatial distribution of these points is very uneven and mostly covers the northern and southern most portions of the Northwest Region (See figure 1). No knowledge about the reasons for the placement of these points is available due to a high staff turnover. A project to try and establish the value and reasons for these monitoring points has to be launched immediately.

There are 7 points where chemical monitoring is being done on a six-monthly basis. In terms of the envisaged plan (Simonic, circa 2000, per. comm.) there should be between three and five monitoring points per hydrogeological region. Thus there should be between 15 and 30 points.

No abstraction monitoring is taking place at all within the Northwest Region and a first priority would be to identify areas where this type of monitoring should start. However, to extend the monitoring network one must ask the questions 'what am I monitoring for?' and 'why am I monitoring certain points/areas?' Thus a systematic approach is needed.

1.8.2 Data management

Very little data management relating to groundwater data is happening in the Northwest Region.

To address this problem the following short-term actions can be taken: -

- Appoint and train two specialised auxiliary officers in groundwater data capturing;
- Identify all consultants operational in the Region, who was in any way involved in any groundwater development projects in the past;
- Obtain from each of them, a list of available reports. Based on this data, decide whether it is necessary to launch a full-scale Groundwater Resources Information Project (GRIP);
- Engage these consultants to ensure that any future projects are duly registered and borehole numbers acquired to ensure that all groundwater-related data reaches the relevant offices.

In the long-term the framework 'Groundwater Data Acquisition and Capturing Strategy' should be adapted to suit the needs of this Region.

1.9 Conclusion

It is clear that some short-term actions, identified through the previous paragraphs, must be taken to put the data management on a sustainable path. Refer to Table 1 to see the actions needed and the priorities allocated to these.

Table 1: List of immediate actions

Action	Tasks	Priority
Determine the reasons for the current monitoring points	Visit each one of the current monitoring points and visually evaluate its worth and classification. This should include monitoring points that is currently not being measured but might be important to start again	1
Extend current monitoring network	Drill previously selected monitoring boreholes and re-drill strategically placed	2
Improve the current level of data management	1. Appoint two data capturing staff members, train them and	2

To place the extension of the monitoring network on a systematic path and to ensure that the correct priorities are allocated, a description of the geohydrological regions will follow. The economic activities which pose potential risks to the groundwater sources will be discussed together with the aquifer properties and potential monitoring actions which could be implemented very soon.

2. GEOHYDROLOGICAL REGIONS

2.1 Introduction

Vegter (1990) divided the RSA into 64 homogeneous hydrogeological regions based on lithology and climatology. At least five of these regions falls either wholly or largely within the Northwest Region and another three falls partially in this Region. Colloquially these hydrogeological regions are referred to as the Vegter-regions. Refer to Table 1 for the list of Vegter regions that falls within the Northwest region.

Table 1: Vegter-regions that fall largely or wholly within the North West Region

Number	Name of Hydrogeological Region	Link
Wholly or largely		
1	Eastern Kalahari	#2.3
2	Western Highveld	#2.4
3	Karst Belt	#2.5
4	Western Bankeveld and Marico	#2.6
5	Western Bushveld Complex	#2.7
Partially		
6	Central Highveld	#2.8
7	Ghaap Plateau	#2.9

For a comprehensive delineation and discussion on each of the Vegter-regions, refer to Vegter (1990). Cognisance must be taken of the subsequent name and rank changes; i.e. sub-region is now a full region, which is treated in detail in Vegter (October 2001). Each Vegter-region will be discussed individually in terms of known groundwater activities and functions to be executed in relation to these activities. As the level of detail regarding these activities are either scares or non-existent, this document will be in a narrative format which inevitably contains very little detail and data and/or information. However, each revision should contain more comprehensive data sets and information products.

2.2 Hydrogeological Map Series

The following three 1:500 000 scale hydrogeological maps cover the Northwest Region, i.e. Vryburg, Kimberley, Johannesburg and Polokwane.

These maps depict the groundwater occurrences in terms of four aquifer types, i.e. 1) fractured, 2) intergranular, 3) karst and 4) intergranular & fractured. Five borehole yield classes were used, i.e. 0-0,1l/s, 0,1-0,5l/s, 0,5-2,0l/s, 2,0-5,0l/s and >5,0l/s – eighty percent of the borehole yields fall into these stated ranges, which means that 10% could fall above the highest value stated in each range.

When classifying the different regions in terms of ‘development potential’ the terms extremely low, very low, low, medium and high will be used respectively for the aforementioned yield classes. This provisional classification as set out below: -

Extremely low: - virtually no groundwater can be found in these aquifers and should any water be found, only a wind- or hand pump could be installed. At best this would be adequate for individual household supplies.

Very low development potential - one can generally expect enough water for either hand- and/or wind pumps, i.e. small supplies for small communities and/or stock

watering or single households. Little additional groundwater could be available for community gardening or other poverty alleviation actions. Many boreholes will have to be drilled to obtain a yield at the high-end of the range.

Low development potential - enough water for either hand- and/or wind pumps, i.e. small supplies for small communities and/or stock watering or single households can easily be achieved. Additional groundwater for community gardening or other poverty alleviation actions will be available. At the high-end of the yield range larger communities from single boreholes and wellfields supplying large communities would be possible. However, due to large variability in borehole yields, an appreciable amount of boreholes will have to be drilled to obtain a yield at the high-end of the range. Pumping at 2l/s for 8hours per day, 2000 persons, @25l/day can be supplied comfortably.

Medium development potential – domestic water supplies for large villages, towns and small-scale irrigation from several boreholes, would be achievable in aquifers with medium development potential. The amount of boreholes to be drilled before high-end yields that can be expected depends on the variability of borehole yields. Wellfields and the concomitant benefit for the management of aquifer(s) make the development of groundwater within medium potential aquifers very attractive. Pumping at 5l/s for 8hours per day 5000 persons, @25l/day, can be supplied comfortably.

High development potential – Large-scale irrigation and/or large village and even large town supplies can be obtained from these aquifers.

2.3 Eastern Kalahari Hydrogeological Region

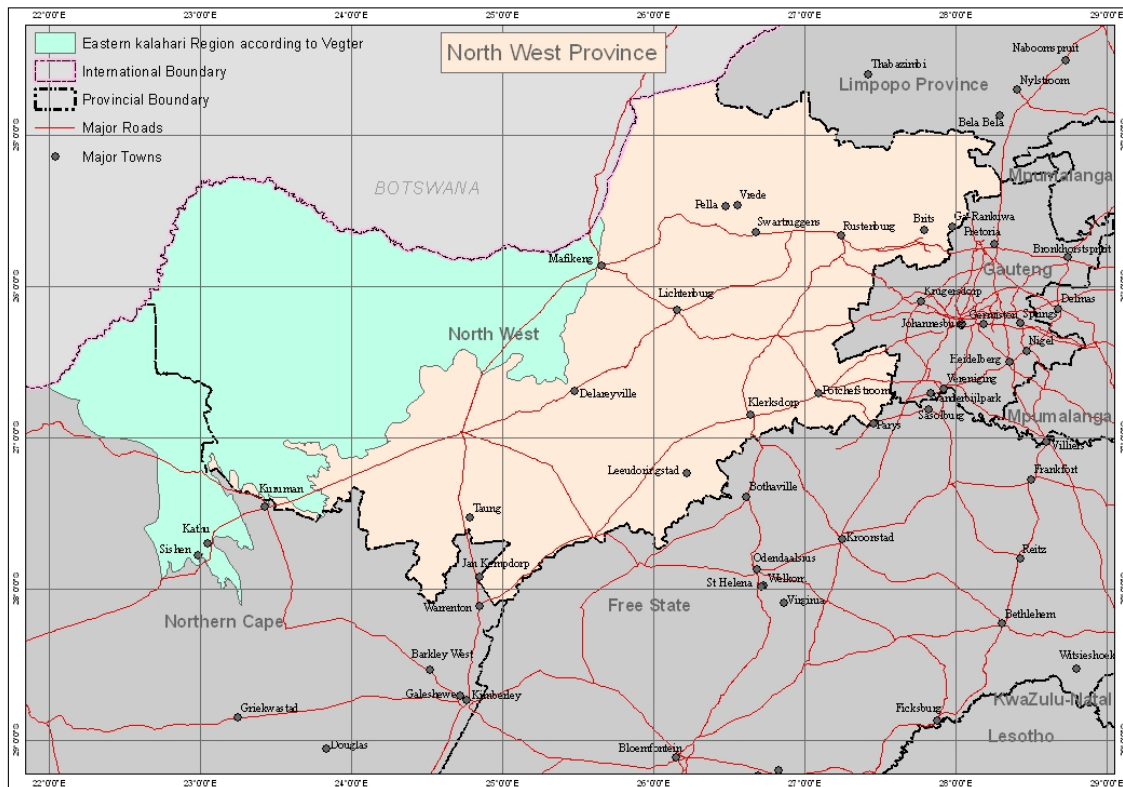


Figure 2: The distribution of the Eastern Kalahari Hydrogeological Region

2.3.1 Economic activities

Some mining activities may occur in this region.

Many rural villages which are wholly or largely dependent on groundwater occur in this region. However, the level of groundwater use is completely unknown.

Cattle and sheep farming form the mainstay of economic activity in this region as well as large-scale irrigation from dolomitic rock formations is taking place in and around Pomfret-Tosca-Vergeleë area (Tosca-area). Subsistence farming would in all probability be another economic activity in this region.

2.3.2 Aquifer properties

The largest portion this region is covered by recent sand deposits of the Kalahari Group. Some outcrops of sedimentary rocks of different Groups and Supergroups also occur. For a more complete description refer to Vegter (2001, Table 16, p68).

This region is mapped as intergranular and fracture aquifer with a very low to extremely low development potential. The aquifers formed by the Ghaap Group are mapped as having a very low up to medium development potential. The Vryburg(2522) Hydrogeological map also shows large-scale irrigation in the Tosca-area which refutes the mapped groundwater potential.

Dolomitic outcrops shown on the Geological Map of South Africa (1984) indicate that dolomite could occur underneath the Kalahari sands. In the light of the high water yielding capacity of the dolomite it would be worthwhile to drilling deep exploration boreholes to determine the real water bearing capacity of the sand-covered dolomite.

Development:

The potential for further groundwater development in this Region can only be determined once the current level of groundwater use has been established. Many investigations have been executed in the Tosca-area and some monitoring is already taking place. Further developments, which will require groundwater, will be driven by economic factors like access to markets and the need for particular products.

Utilisation:

The rural communities within this Region are dependant for their sustainable livelihoods on groundwater. The prevalent perception that a borehole can yield only enough water for a hand pump must be broken and where higher yields do occur any boreholes should be equipped with higher yielding pumps and the additional water should be made available for community gardening purposes.

The current irrigation in the Tosca-area must be managed and a water user association must be formed. The DWA cannot continue to monitor the abstractions and water levels in the area forever as their role is one of a regulator and not implementer. The measuring of water levels by an external organisation creates the impression that that organisation is also responsible for the management of that particular source.

The rural settlements will in all probability depend wholly or largely on groundwater and this need to be established.

Protection:

From first principles it can be assumed that the intergranular and fractured aquifers are vulnerable to pollution and needs a fairly high level of protection measures (Braune & Bredenham, 1995). However, nothing is known about the potential sources of pollution and these needs to be determined.

Management:

With a fairly high level of confidence one can surmise that very little is done in terms of management of groundwater resources by the communities utilising this source – this is a historic fact and no reflection on Northwest Region specifically. The level of groundwater use can be used to prioritise the area where the most effort to establish groundwater management, should be placed.

Data/information management:

Monitoring of the irrigation in the Tosca area is being done. Whether any of this data is on the DWAF's databases need to be determined. However, the fact that there are so many unknowns as set out above reflect on the poor data management of the Region.

2.3.3 Summary of known problems and risks for the Eastern Kalahari Hydrogeological Region

- The abstraction of groundwater for irrigation in the Tosca area must be managed through a WUA;
- The level of groundwater use in all the rural settlements needs to be determined before any groundwater management actions can be initiated;
- The possible pollution of groundwater through uncontrolled and/or poorly sanitation must be investigated.

Actions: -

- Survey of the level of dependence on groundwater in all the rural settlements;
- Determine the extent of the pollution if any and its causes before any further actions can be defined;
- Establish a Water user Association in the Tosca-area.

2.4 Western Highveld Hydrogeological Region

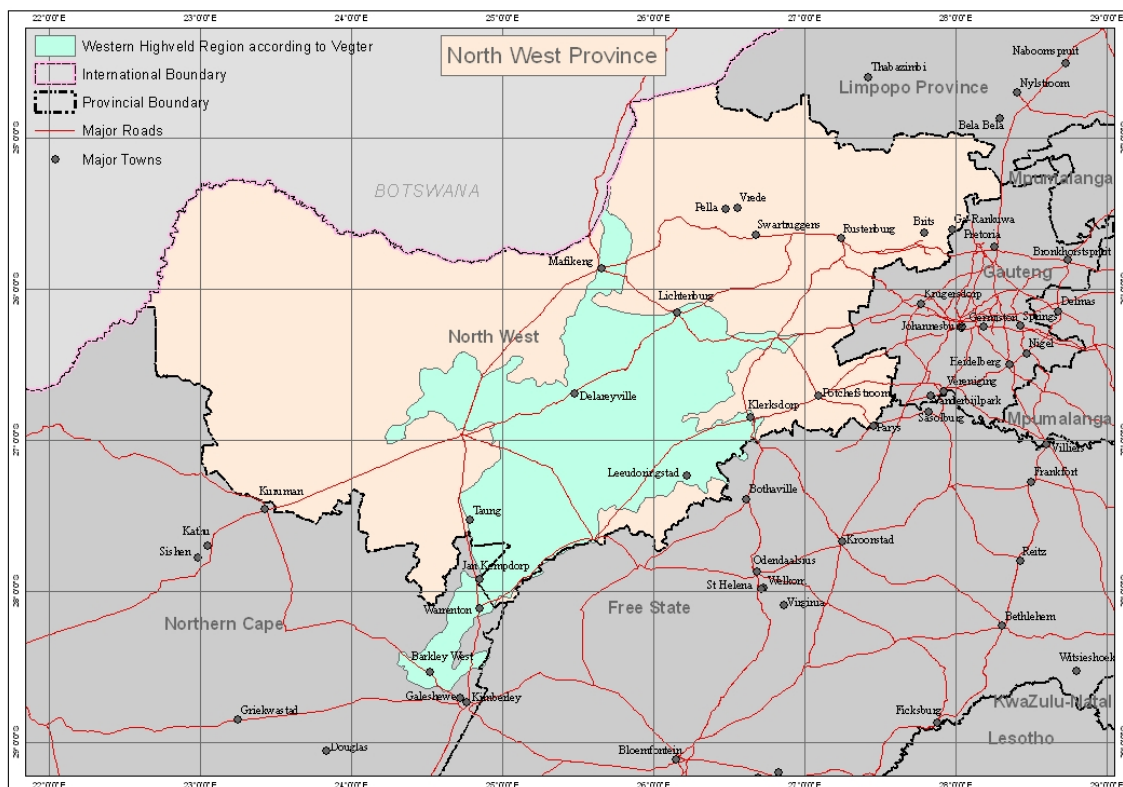


Figure 3: The distribution of the Western Highveld Hydrogeological Region

2.4.1 Economic activities

Dry land maize farming is the mainstay of economic activity in the northern parts of this region and stock farming is prevalent.

Many rural settlements occur in the Taung-ward of the former homeland of Bophuthatswana. It is not known where their water comes from (groundwater or surface water).

Some small-scale mining especially alluvial diamond diggings, is taking place in this region.

Many of the towns in the Western Highveld Hydrogeological Region are probably dependant on groundwater supplies and from experience it can be said with fair amount of confidence that no groundwater management is taking place at this point in time.

2.4.2 Aquifer properties

The region is underlain by mostly by volcanic rocks of the Ventersdorp Supergroup. For a more complete description of the rocks that occur in this region refer to Vegter (2001, Table 9, p64). The Vryburg (2522) and Johannesburg (2526) Hydrogeological map indicate the aquifer types as fractured with an extremely low to medium development potential. Some small areas, i.e. in and around Coligny, are mapped as intergranular and fractured with a high development potential.

Development:

Without any knowledge about the current level of groundwater use by any of the economic sectors mentioned above, nothing can be said about excess groundwater available for augmentation and/or further development. The high development potential in and around Coligny need to be investigated as it might be possible to utilise groundwater in this area for irrigation.

Utilisation:

The towns of Sannieshof, Delareyville and Coligny are all dependant on groundwater for domestic supplies. Some known monitoring is taking place in Delareyville but nothing is known about the other towns.

Protection:

No protection actions can be defined unless the level of use and potential threads to groundwater has been determined.

Management:

Unless the level of groundwater use has been determined, no groundwater/aquifer management actions can be defined. The management of the groundwater resources of the mentioned towns should be established.

Data/information management:

Yet again with no data is available to support any of the above actions.

2.4.3 Summary of known problems and risks in the Western Highveld Hydrogeological Region

- Nothing can be said about any risks and or any action suggested except that the collection of all relevant groundwater data is of the utmost importance;

Actions: -

- Collect all available groundwater-related data;
- Initiate a programme to teach/educate the local municipalities to manage their groundwater sources.

2.5 Karst Belt Hydrogeological Region

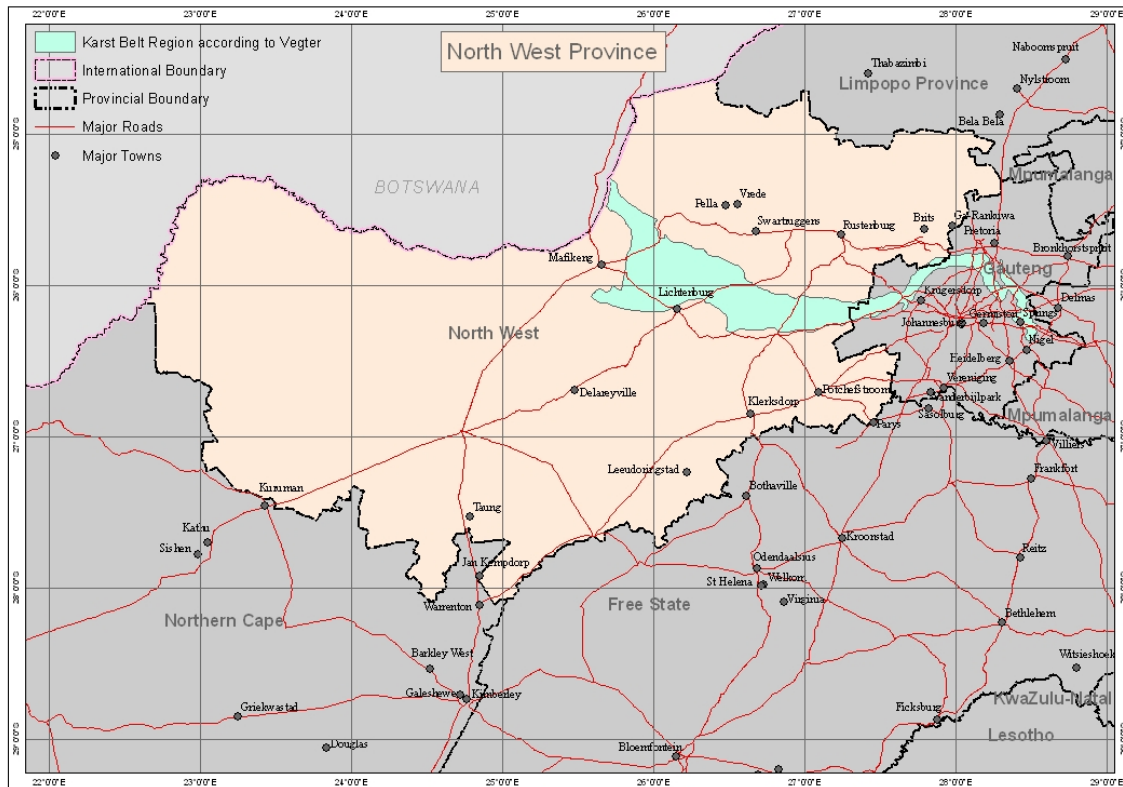


Figure 4: The distribution of the Karst Belt Hydrogeological Region

2.5.1 Economic activities

Gold mining forms the mainstay of the economic activities in this region which poses a high risk in terms of decanting acid mine water. In the Lichtenburg area cement factories also use groundwater.

Irrigation from groundwater sources in the Bo-Molopo area is taking place. Several studies for inter alia the Grootfontein Compartment has been done during the nineteen eighties and an effort to establish a subterranean water control area failed. Mafikeng also receives its domestic water supplies from this compartment.

Some rural settlements in the Dinokana area use groundwater for domestic supplies as well as the towns of Zeerust, Lichtenburg and Mafikeng.

2.5.2 Aquifer properties

The rocks found here belong to the Chuniespoort Group and the hydrogeological maps of Johannesburg and Vryburg shows this area as karst aquifer with a medium to high development potential.

Many springs emanate from the dolomites, some of which might be monitored, but no comprehensive list of springs currently exists.

The dolomitic rocks in the RSA forms high potential karst aquifers but at the same time are highly vulnerable to pollution. The pollution risk (risk = potential of a pollution event happening X impacts) this region is high due to the many springs feeding rivers.

Development

The level of groundwater utilisation need to be established before any comments may be made regarding any further action can be taken regarding any future groundwater development in this region.

Utilisation

The abstraction of groundwater for irrigation in the Grootfontein Compartment has been studied extensively. The data and information need to be collated and made readily accessible. The current situation regarding volumes being abstracted is unknown. The DWA is abstracting water from the same compartment for the town of Mafikeng but it is not known where the abstraction records are being kept. At one point in time efforts was made to establish a subterranean water control area – nothing is known about the current situation.

The town of Lichtenburg also utilise groundwater from the karst aquifer. The volumes and whether there are monitoring and/or manage the abstractions is unknown. If the data is available anywhere it need to be obtained and captured.

The town of Zeerust also utilise groundwater from the karst aquifer. The volumes and whether there are monitoring and/or manage the abstractions is unknown. If the data is available anywhere it need to be obtained and captured.

Several cement factories operate in the vicinity of Lichtenburg (Alglo Alpha, Slurry and La Frage) and they do use groundwater from the karst aquifer. The volumes and whether there are monitoring and/or manage the abstractions is unknown. If the data is available anywhere it need to be obtained and captured.

The rural communities in and around Dinokana is dependant on groundwater. Recent problems with water supplies in this area indicate a total lack of groundwater management.

The communities across the border in Botswana also tap the same aquifer but the effect of neither their abstraction, nor the abstraction on the RSA side has been quantified at all.

Dolomitic springs feeding rivers can be affected when over-abstraction takes place. The Marico River is potentially at risk from abstractions from the Groot Marico Compartment (**mmmm**). A valuable biodiversity area within the upper reaches of the Marico River has been identified and an effort to calculate a natural resource economic value to this biodiversity spot has partially failed (**NNNN**) due to many groundwater unknowns, i.e. water level fluctuations and abstraction of groundwater and its uses in this compartment.

The WRC project to describe the geohydrology of this Vegter-region (Region 10) has been initiated. However, based of the results of the (**mmmm**) study, the format will have to be changed. A strong recommendation that this project should be redirected to collect all groundwater use data (volumes abstracted and usage) together with other data needed for a natural environmental economic value calculation is made.

Protection

As explained in the paragraph on aquifer properties, karst aquifers are vulnerable to pollution. The risk however, depends on the potential impact as well and according to Braune and Bredenham (1995) the protection measure should be commensurate with the risk.

The re-watering of worked-out gold mines poses a high risk in terms of acid mine drainage which not only affects the groundwater resources but impacts heavily on surface water sources as well.

The 'All Town Study' currently running should assist with determining the level of groundwater use in towns. A dedicated person should be identified to keep track of progress and update the necessary table in this document regularly.

Management

The lack of reliable data and information needs to be addressed before any more comments can be made regarding actions that can and should be taken to create WUA and/or groundwater management structures. The mentioned 'All Town Study' will help determine the level of groundwater use which in turn can be used to prioritise towns for groundwater management interventions.

Data/information management

It is clear that data management needs urgent attention.

2.5.3 Summary of known problems and risks Karst Belt Hydrogeological Region

- Some sources of data do exist for this region - the collation of this data is seen as one of the most urgent priorities for this particular region;
- Over-abstraction and possible pollution of the karst aquifers are a hazard with the level of groundwater use in this region unknown but with the lack of data prevents one from creating management structures;

Actions: -

- Collect, collate and capture all available groundwater-related data;
- Create WUAs or develop management structures to manage these aquifers as a high priority – especially the Grootfontein Compartment which have a long history of groundwater utilisation;
- Interact with WRC to redirect their project for Region 10.

2.6 Western Bankeveld & Marico Bushveld Hydrogeological Region

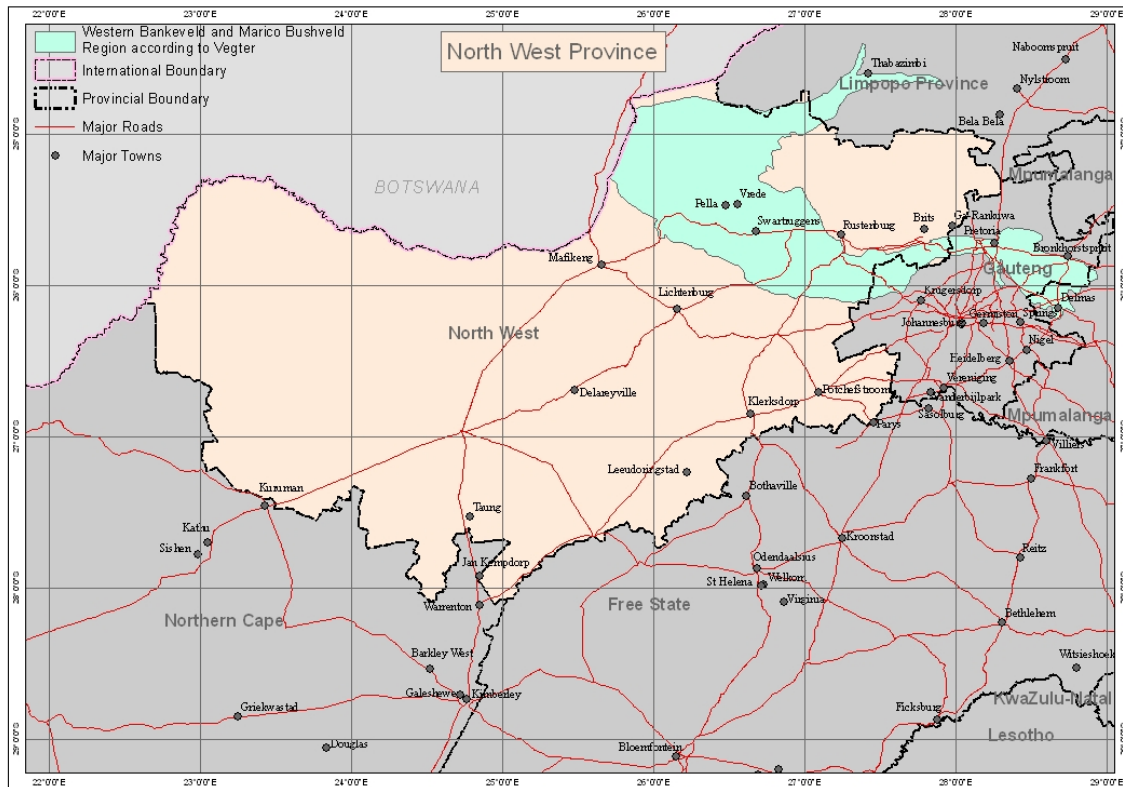


Figure 5: The distribution of the Western Bankeveld & Marico Bushveld Hydrogeological Region

2.6.1 Economic Activities-1-

Many rural settlements occur within the boundaries of this region but their level of dependence on groundwater for domestic water supplies is at best only a conjecture.

Some formal towns, i.e. Swartruggens, etc. lying within this hydrogeological region might also be dependant on groundwater.

Stock farming probably forms the mainstay of the economic activities in this region.

2.6.2 Aquifer properties

The rocks underlying this region are predominantly sedimentary of nature and mostly belong to the Pretoria Group. For a more complete description of the geological formations refer to Vegter (2001, Table 10, p65).

The aquifer types are mapped (Johannesburg and Polokwane Hydrogeological maps) as intergranular and fractured with a low to medium development potential.

Development

The development potential of this region seems uniformly low, thus able to supply basic water to small rural settlements with at least some capacity for community gardens and thus can contribute towards sustainable livelihoods.

Utilisation

Nothing is known about the level of groundwater use in this region. In all probability all the rural settlements is totally or largely dependant on groundwater. The poor are usually the most vulnerable to any negative impacts like droughts and it is imperative to determine the level of groundwater use and start with some groundwater level monitoring.

Protection

With nothing known about the use of groundwater in the region, no comments can be made regarding the protection of the groundwater resources although the pollution through on-site sanitation and refuse dumping poses a real hazard.

Overgrazing poses a thread to not only the groundwater resources but to the environment in general. The results of overgrazing are the removal of the vegetation with the associated enhanced run-off and thus diminished infiltration and the removal of the soils which alters the plant species and further degradation. Thus should overgrazing occur, it needs to be managed as part of integrated water resources management.

Management

With nothing known about the use of groundwater in the region, no comments can be made regarding the management of the groundwater resources.

Data/information management

The lack of data is hampering any systematic decisions regarding the protection and/or management of groundwater to be taken and the collection of all available data is of the utmost importance.

2.6.3 Summary of known problems and risks in the Western Bankeveld & Marico Bushveld Hydrogeological Region

- Lack of data about groundwater use (domestic and agricultural), which is hampering any systematic decisions regarding protection and management to be taken. A data collection, collation and capturing project;
- Massive sanitation projects are being launched all over the Northwest Province. Great concern has been expressed that although the Groundwater Protocol has been applied, the recommendations are ignored;
- The efficacy of the Groundwater Protocol has never been tested and the vulnerability of the rural communities to lack of potable water is unacceptable.

Actions: -

- Collect, collate and capture all available groundwater-related data, similar to the Limpopo Province's GRIP is strongly recommended;
- Improve the cooperation between the groundwater staff and staff members of both directorates 'Water Services' and 'Protection and Waste' to ensure that guidelines and protocols are properly implemented and data generated through their actions reaches the relevant groundwater databases;
- Launch a project to test the efficacy of the Groundwater Protocol.

2.7 Western Bushveld Complex Hydrogeological Region

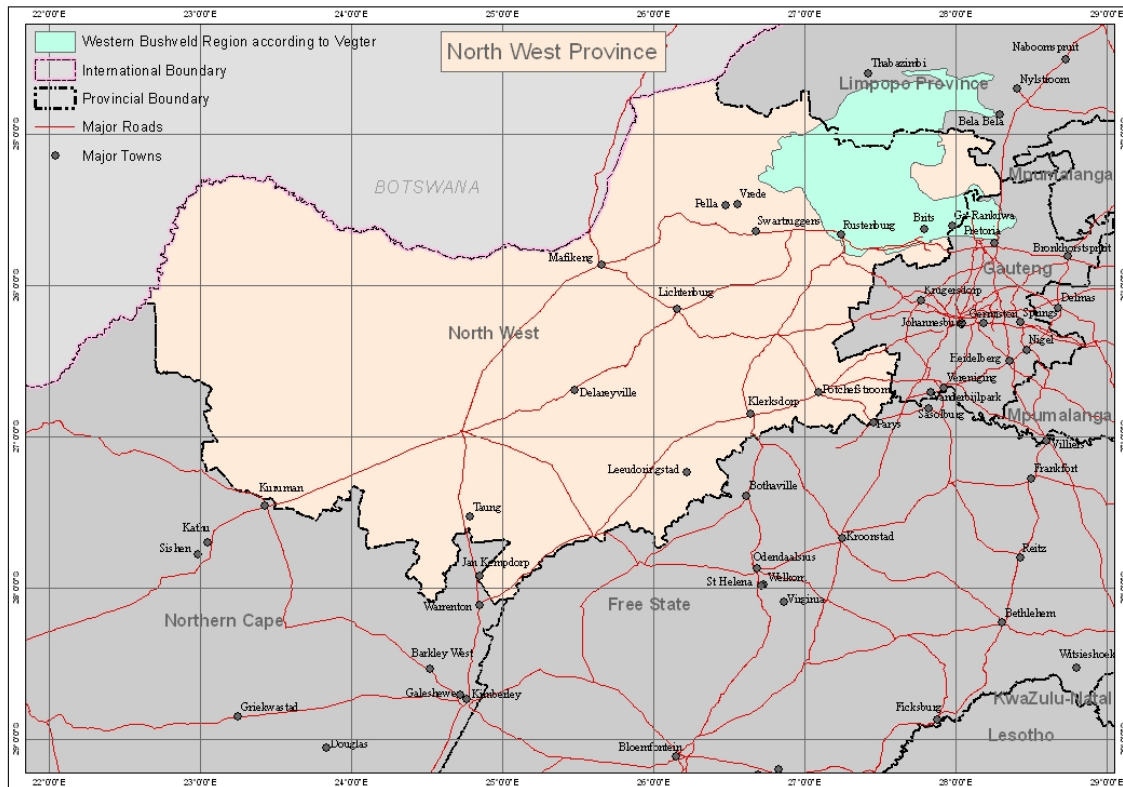


Figure 7: The distribution of the Western Bushveld Complex Hydrogeological Region

2.7.1 Economic Activities

Mining of Chrome and the Platinum-group metals forms the mainstay of economic activities in this region.

Many rural settlements also occur in this region and are not only dependent for their domestic supplies from groundwater but also for their sustainable livelihood. Aspects like private and/or community gardens and livestock watering need to be addressed where excess capacity exists.

Crops under irrigation from surface water sources are taking place and it is known that some groundwater is utilised.

2.7.2 Aquifer properties

The aquifers are mapped as both fractured and intergranular and fractured and are formed by igneous rocks of the Bushveld Complex with a low to medium potential. For a more complete description of the geological formations refer to Vegter (2001, Table 8, p64).

Utilisation:

Based on experience one can safely assume that some groundwater is used together with surface water for irrigation purposes but volumes abstracted are currently unknown.

In the NWA's definition of water use the mining industry will be a large user of groundwater in the sense that they are impacting on the quantity and quality of the groundwater. A project to load all water chemistry analyses data from the mines onto WMS in preparation for the pilot implementation of Waste Discharge Charge System has been completed. However, no effort was made to trace the analyses results back to groundwater monitoring points and to try and capture the available data onto the National Groundwater Archive.

Most of the rural villages in this Region are probably dependent on groundwater but the amounts being abstracted are unknown. It is important to determine the current level of groundwater use so that monitoring can be started in those villages that are the most vulnerable to both quality and quantity.

Protection:

The mining industry has the largest capacity for polluting the groundwater sources and much work need to be done to collect and collate all available data from EIA-and/or EMP-reports in order to identify existing pollution and initiate actions to prevent future pollution. According to Braune and Bredenhan (1995) the level of protection should be commensurate with the value of the source. It is thus important to launch a project to determine the value of the groundwater sources in and around the mining activities. The methods developed by the Natural Resources Accounting practitioners are ideal for this activity.

The efficacy of the Groundwater Protocol has never been established and a project to determine the potential level of nitrate pollution must be initiated.

Management:

Once the level of groundwater usage has been determined, one can decide what groundwater management actions need to be initiated. The easiest would be to target those towns that are wholly or largely dependent on groundwater. A groundwater assessment and management project like the one launched in the Free State can serve as a good example.

Data/information management:

Level of data management is extremely poor.

2.7.3 Summary of known problems and/or risks in the Western Bushveld Complex Hydrogeological Region

- Determine the level of pollution of the groundwater round the current mining activities;
- Determine the value of the groundwater sources in and around the mining activities;
- Determine the level of groundwater use in areas where irrigation is taking place;

Actions: -

- The level of dependence on groundwater in the rural village needs to be established;
- The pollution hazard by the mining industry need to be defined;
- Data management must be improved.

2.8 Central Highveld Hydrogeological Region

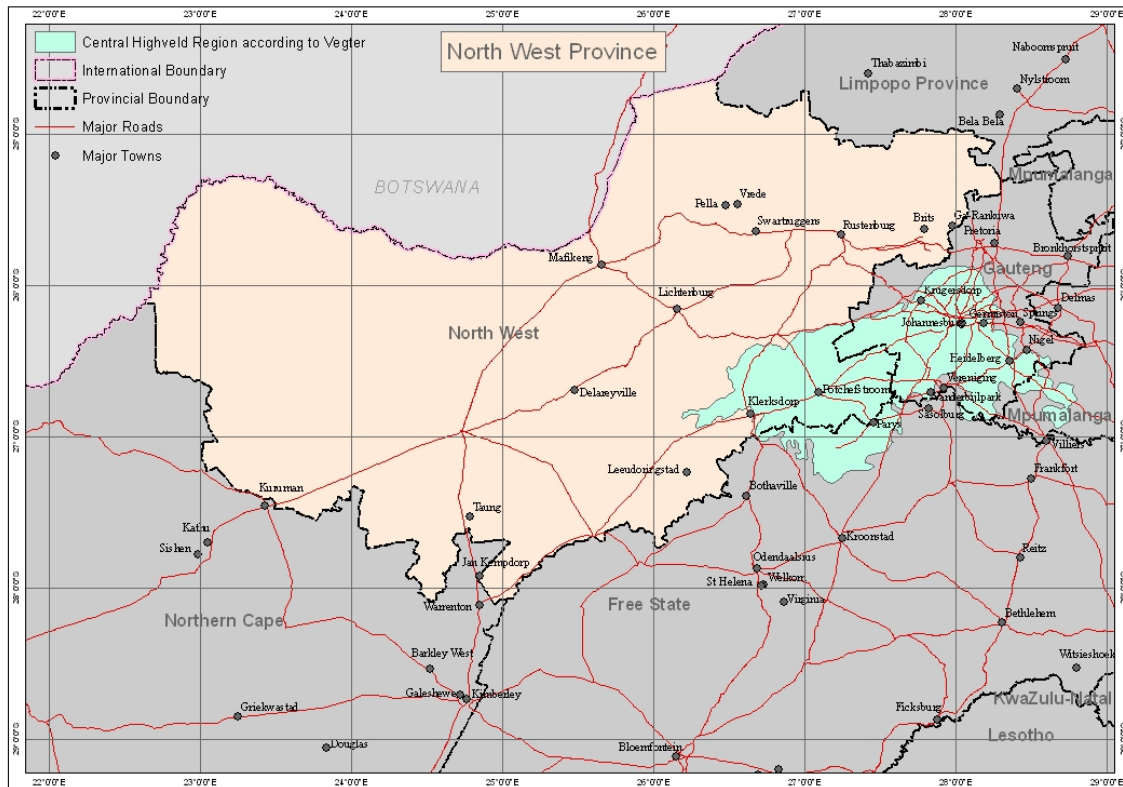


Figure 8: The distribution of the Central Highveld Hydrogeological Region

2.8.1 Economic Activities

Gold mining is the mainstay of economic activities this Region.

Stock farming and dry-land maize are other economic activities.

2.8.2 Aquifer properties and protection measures

The geological formations underlying this Region consist of mostly of sediments of the Witwatersrand Supergroup. For a more complete description refer to Vegter (2001, Table 16, p 68).

The aquifers are mapped as fractured and intergranular and fractured aquifers with a very low to low development potential.

Development:

Nothing is known about any further development potential of the region and thus no comments can be made regarding possible augmentation.

Utilisation:

In the NWA's definition of water use the mining industry will be a large user of groundwater in the sense that they are impacting on the quality of the groundwater resources.

Management:

The re-watering of worked-out gold mines need to manage their water as acid mine drainage impacts both on the groundwater resources and the surface water sources.

Data/information management:

Level of data management is extremely poor.

2.8.3 Summary of known problems and risks in the Central Highveld Hydrogeological Region

- Groundwater is widely being used for domestic water supplies but unfortunately nothing is known about the extent of this water use sector;
- Re-watering of the gold mines is posing a big hazard for pollution of both groundwater and surface water;
- The value of groundwater is unknown thus no relevant protection measure can be devised and implemented.

Actions:-

- Collect all available groundwater-related data;
- Determine the value of the groundwater in this Region.

2.9 Ghaap Plateau Hydrogeological Region

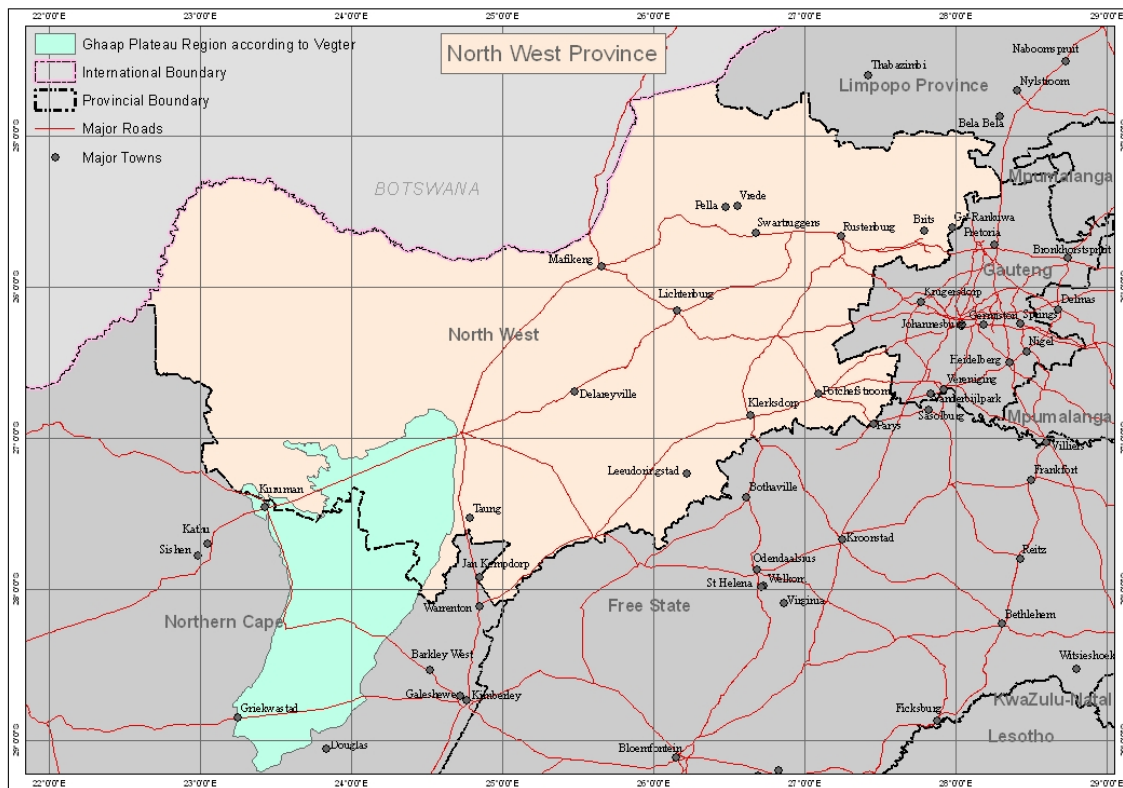


Figure 8: The distribution of the Ghaap Plateau Hydrogeological Region

2.9.1 Economic Activities

Quite a lot of agricultural activities are taking place in region with stock- and wild life farming and probably some irrigation from groundwater.

Many rural settlements occur within the boundaries of this region. It seems that in general groundwater is accepted as a reliable source but still no groundwater management is executed.

2.9.2 Aquifer properties and protection measures

The dolomites in general provide groundwater of good quality and high yields. It thus seems rather puzzling why groundwater is not utilised on a larger scale in this region.

Development:

Nothing is known about any further development potential of the region and thus no comments can be made regarding possible augmentation.

Utilisation:

Nothing is known about the sources of water for the rural settlements in this region i.e. surface- and/or ground water.

Protection:

Once the above mentioned hydrocensus has been more comprehensive data sets will be available and the level of protection needed could be determined.

Management:

No known management of groundwater is taking place.

Data/information management:

Level of data management is extremely poor.

2.9.3 Summary of known problems and risks in the Ghaap Plateau Hydrogeological Region

- Groundwater could be used extensively for domestic water supplies. Unfortunately nothing is known about the extent of this water use sector;
- The extend to which the Ghaap Plateau Region covers the Northwest Region dictates that there should be very close cooperation with the Northern cape Region.

Actions:-

- Improve co-operation between Water Services and Geohydrology to ensure that the recommendations made during Groundwater Protocol investigations, are duly applied;

3. REPORTING OF DATA AND INFORMATION

3.1 Introduction

As stated previously the required information and type of reporting must suite the operational and strategic needs of the department in support of its mission and objectives.

However, no clear-cut definition of what and/or which information products and how often these are required is available. The following Directorates needs to be contacted to find out their needs: -

- Water Use and Conservation;
- Water Use Licensing;
- Systems Planning;
- Hydrological Services;
- Statistics South Africa needs extensive groundwater data sets in order to produce the National Water Resources Accounts.

This aspect in itself constitute a project; It is however, suggested that it be conducted in-house.

4. SUMMARY

4.1 Rural water use

There are approximately 2480 rural settlements within the area of jurisdiction of the Northwest Regional office - refer to Figure 9 for the spatial distribution of the rural

settlements. In all probability most of these settlements would be largely of wholly dependant on groundwater for their domestic supplies and thus represents a large component of the domestic water use sphere. However, very little, or no data are available on a) their dependence on groundwater, b) their vulnerability to droughts and c) the volumes being abstracted, all of which is needed to define the level of the impact on the groundwater resources of the underlying areas. Furthermore, no proactive action can be taken in terms of mitigating either vulnerability or augmentation of the supply where there are shortages.

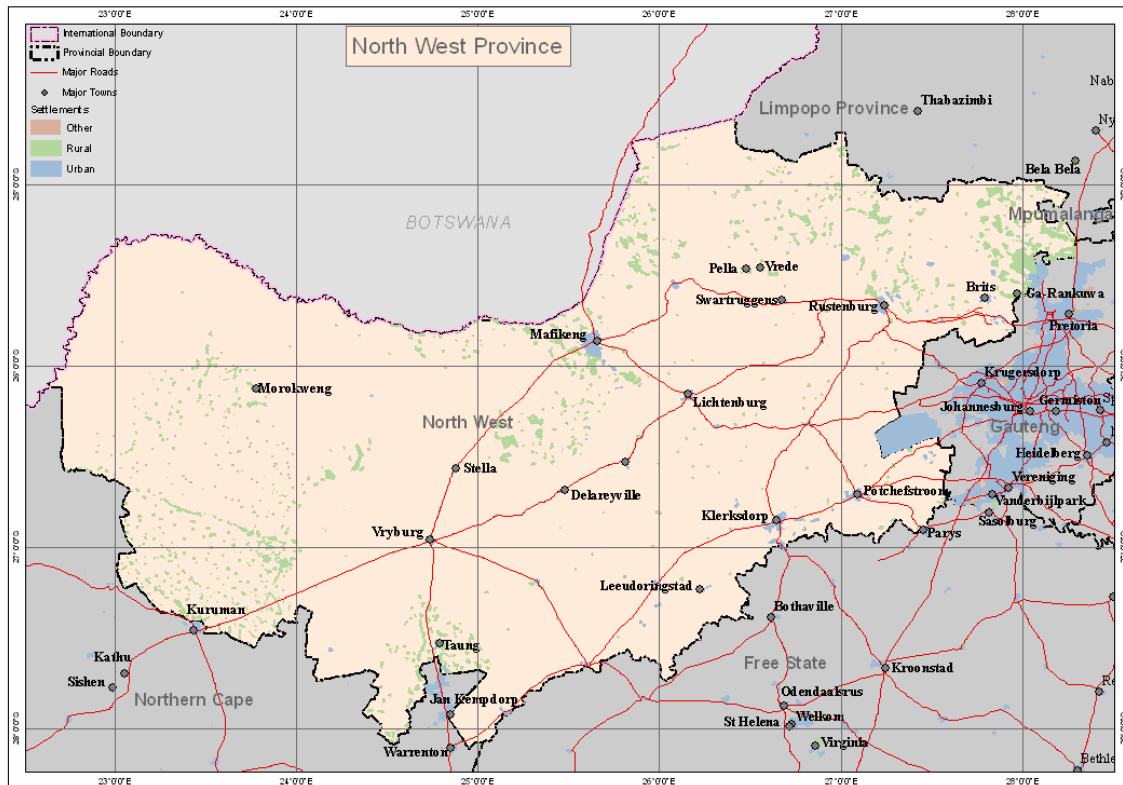


Figure 9: Spatial distribution of rural settlements in Northwest

With the above mentioned shortcomings in mind a Groundwater Resources Information Project (GRIP) is strongly recommended. The project can be broken up into four phases which will run over a four to six year period. The broad scope of each phase would be the following: -

- Phase 1 entails the drawing up of a list of available reports held with consultants and an inventory of data not yet captured onto the National Groundwater Archive. This will determine to what extent the following phases should be implemented and whether phase 2 could be skipped for instance.
- Phase 2 would be the collection of all the available groundwater data in reports, files and whatever other media and the capturing of all this onto the National Groundwater Database.
- Phase 3 would entail the verification of the geosites positions and the collection of data on newly established geosites, inter alia water levels, status of pumping equipment and water sample for chemical analysis and water use data.
- Phase 4 would entail the testing of boreholes to determine the transmissivity and the storativity of the relevant geohydrological strata (if and where

unavailable), production of relevant information products to support the district municipalities and the setting up of a well defined regional monitoring network.

The full involvement of all the DMs is an integral and indispensable part of the GRIP in Northwest Region. For a comprehensive description of the project see the

4.2 Mining Water Use

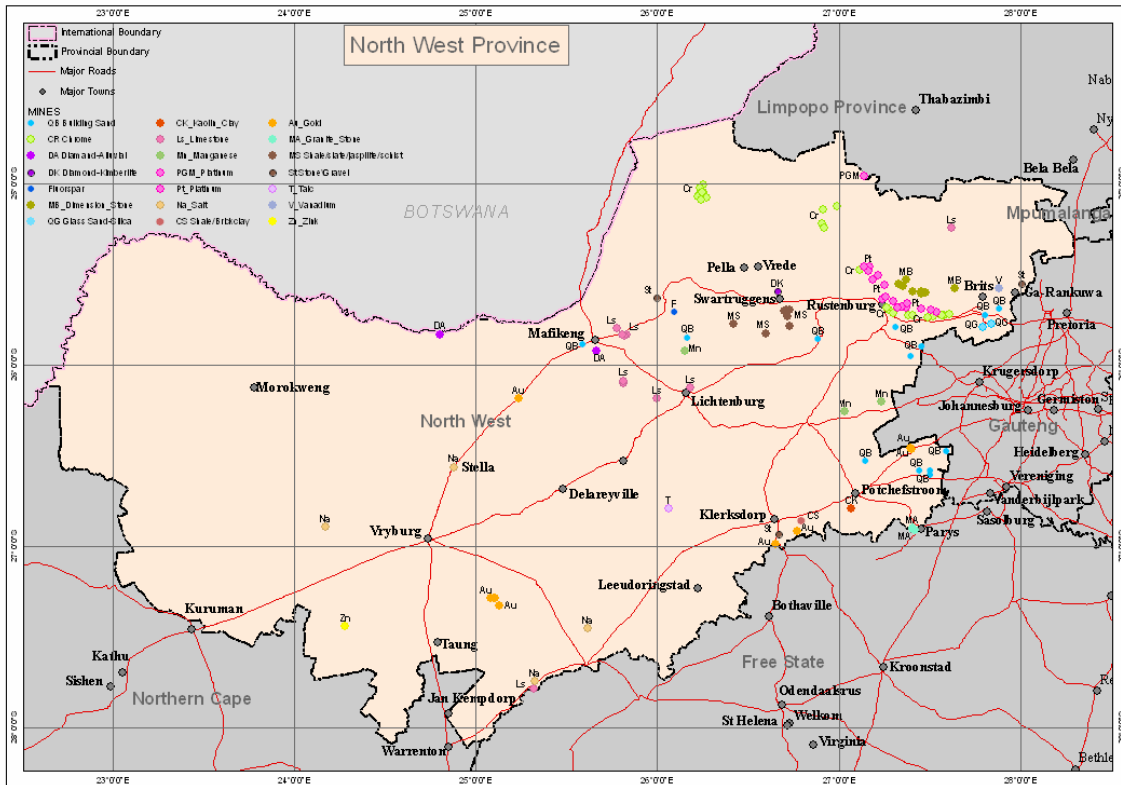


Figure 10: Distribution of mining activities in the Northwest Region

In the definition of the NWA where ‘water use’ includes quantity and quality, the mines are invariably large-scale groundwater users in terms of negative impacts. As mines close most of them will eventually start to decant acid water with a concomitant high metal content. What these metals will be depends on the minerals that were extracted.

The sources (ground- and/or surface water) that are being polluted have a value and the Waste Discharge charges should be commensurate with this value. It is thus of the utmost importance that the value of the groundwater resources in this region be valued according to techniques developed by Natural Resources Accounting fraternity.

In terms of data management closer ties with the Resource Protection & Waste staff members must be forged to ensure that the groundwater data contained in EIAs and EMPs are correctly captured in the field and submitted to the appropriate directorates for capturing.

- Collate all available groundwater-related data and capture it onto the NGA;

- Determine the value of the groundwater resources in and around the mining activities.

4.3 Agricultural water use

The following areas where groundwater is used for irrigation are known and well studied, i.e. Coetzerdam-Louwna and Tosca-Vergleë. No other large-scale abstraction of groundwater is currently known. The registration of this irrigation needs to be verified and validated. The management of these sources must be devolved down to water users associations. If they do not exist yet, they should be created immediately.

- Collate the existing data about abstraction and source capacity and create the necessary water user associations;

4.4 Other groundwater-related issues

4.4.1 Data management

A total lack of data management has been identified as one of the priorities. If this aspect is not addressed immediately, none of the above would be sustainable.

4.4.2 Groundwater Monitoring Network

Although the groundwater monitoring network in the Northwest Region was far from adequate the situation has degenerated in the last couple of years to the extent that the current monitoring is totally inadequate and needs urgent attention.

4.4.3 Regional-scale Aquifer Assessment Project

This Groundwater Resources Assessment Phase II had five components, which are a) Groundwater use, b) Classification, c) Groundwater/surface water interaction, d) Recharge and e) Planning potential. The scale of the project was at the national level although the calculations were done per quaternary catchment. The result is that information is of low resolution and of low confidence in especially in areas of low borehole coverage and/or inappropriate data.

In spite of this low confidence level the promotion of the results of this project is important as it fills a gap in our knowledge about groundwater. Most of the methodologies developed in this project can be used to improve the results by using local level data. Thus a systematic exploration of provisionally termed Regional-scale Aquifer Assessment Project should be launched to augment the data in order to improve the confidence of the national scale information products as well as allow a high confidence information product development for the Northwest region.

There are many benefits that will emanate through such a project. Although the list of benefits below is not comprehensive it gives the most beneficial ones: -

- Improved data and thus information and knowledge of the groundwater potential of the area;
- Excellent opportunity for young inexperienced geohydrologist to gain much needed experience;
- Monitoring network can be extended systematically;

4.5 Summary of actions

In order to prioritise the tasks and functions as discussed in the previous text a table with tasks and its priority follows.

Table 2: Table of prioritised long-term tasks

Task description	Actions	Priority

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APPENDIX A: DEFINITION OF THE WATER FUNCTIONS AS DEFINED IN THE NWA (1998) IN RELATION TO GROUNDWATER

1. INTRODUCTION

The functions as defined by the NWA (1998) are 'development', 'utilisation', 'protection', 'conservation' and 'management'. What was left out but underpins all these functions, is the data/information management. Data management must at all times forms an irrevocably part of these functions and will be discussed in the main text in this context.

In the following paragraphs these functions will be discussed in detail in order to create a common understanding of what is meant.

2. DEVELOPMENT

Groundwater in the South Africa, although it played an important role, was never brought into the planning stages right from the reconnaissance phase of any water supply project. The aim under this function would be to entrench groundwater into the planning processes from the Reconnaissance- through to the Feasibility Study phases with the concomitant funding of groundwater studies.

Issues under this heading relate to questions like: -

- 'Is there enough groundwater for development locally and what would it costs in relation to surface water supplies?'
- 'Can groundwater augment the surface water supplies, i.e. conjunctive use?'
- 'Why is groundwater not considered as a source of domestic water in a particular area?'
- 'Is there a potential for the further development of groundwater sources in a particular area?'
- 'Is there still some untapped groundwater sources that needs to be discovered?'

Guidelines for groundwater pre- and feasibility studies have been drawn up. These studies are mostly in the form of desk studies. However, a feasibility study could include exploration drilling in areas where not enough is known about groundwater occurrences and exploitation potential.

Most of these questions can be answered through the execution of reconnaissance and pre-feasibility studies. The aim of these studies is to put the decision to use groundwater or not, on the par with that of surface water. The 1:500 000 scale geohydrological maps can

serve as inputs to the Reconnaissance and Pre-Feasibility phase studies. However, due a lack of data in particular areas, and being a large-scale map, some generalisations had to be made on each Hydrogeological map. The guidelines for executing and implementing of groundwater feasibility studies address the shortcomings at both a local and regional scale.

Conceptual models of groundwater occurrences are important as well, as these might identify potential additional untapped aquifers.

3. UTILISATION

Is to ensure that where adequate groundwater resources are available, it is not neglected in favour of more expensive surface water schemes due to lack of an understanding of the role groundwater can play, or due to cultural issues. A case in point is the Van Rhynsdorp Municipality who, in spite of the fact that ample groundwater sources were available, insisted they be supplied from surface water sources.

Issues under this heading relates to questions like; -

- 'To what extent are the available groundwater resources being utilised to its full potential?'
- 'To what extent is a particular aquifer over abstracted?'
- 'What opportunities are there to utilise available groundwater and surface water conjunctively?'

With aquifer management in place and supported by sound data management practices, most of the above questions can be answered. Other aspects like the execution of groundwater feasibility studies and mathematical modelling, can assist in answering some of the questions posed above. The NWA (1998) of the RSA demands judicious use of the available source, whether ground- or surface water, as we live in a water scarce country.

Furthermore, in the utilisation of groundwater one must guard against the perception that groundwater and surface water are two separate sources. The hydrological cycle is a unit and double counting of the resources can lead to problems in the future. A case in point is the mined-out areas on the Highveld. The mining industry has proposed to tap flooded mines and claim that it 'new' water. Only in cases where excess run-off (high-flow periods or floods) is used to recharge depleted mine-water, can it be seen as a saving of 'lost' waters. This particular area is underlain by shale of the Ecca Group, which has a rather low groundwater

potential and conditions to enhance recharge will have to be created to establish a viable source. In the case of artificially induced recharge run-off will be affected.

4. PROTECTION

Is about save-guarding the groundwater resource of this country against pollution and over-abstraction and the aquatic-ecosystem. The aim is to maintain the quality of the water for domestic, aquatic ecosystems and agricultural, industrial and commercial use. Bredenhan and Braune (1996) equate the level of protection to the value of aquifer being protected and an aquifer classification system was thus devised by Parsons(1998).

Issues under this heading relate to questions like: -

- 'How valuable is a particular aquifer or aquifer system?'
- 'Against what must this aquifer be protected?'
- 'For what purpose must this aquifer be protected?'

It is a well-known fact that the coal mining industry is polluting surface water sources (acid mine drainage) but the extent of groundwater pollution on the Highveld still needs to be quantified. A starting point would be to draw up a coherent list of mines and industries and identify the pollution- potential of these industries also showing which f the industries are doing any monitoring and what are the monitoring ; i.e. abstraction, water level fluctuations and/or water quality.

The function of groundwater protections has very strong ties with the Water Quality Management function and the links between the department's National Groundwater Archive and Water Management System must be promoted actively.

5. CONSERVATION

Is about the long-term view of the availability of resource for the future generations. The water resources of the RSA need to be conserved for the next generations and is well encapsulated in the logo 'Some for all, forever'. In this regard the main issue would be the establishment of a water conservation culture through the e3ntrenchment of demand management practices at local and district municipal level and within WUAs. Conservation is not unique to groundwater, for example the SA Parks has been involved in conservation of the fauna and flora of the RSA for more that a century.

Conservation offers us all the best possible opportunity to co-operate in different spheres like nature conservation with multiple purposes; thus a multidisciplinary approach. A case in hand is the Mpumalanga Plateau where restrictions on the extension of plantations can safeguard, not only unique habitats, but also the groundwater sources that feed perennial rivers.

6. MANAGEMENT

To be able management one must measure. Generically the aspects to be measured can be defined as inputs, outputs and changes to the system due the aforementioned two. For groundwater these translates to recharge, abstraction (natural and artificial) and water level fluctuations.

The biggest obstacle to the management of the groundwater resources of the Northwest Region and to greater or lesser extent for the whole of the RSA, is the fact that very little is known about who is abstracting where and how much. The biggest priority in this regard thus is to determine where, by whom and how much groundwater are being abstracted, i.e. quantifying the groundwater use. Only then can coherent and systematic groundwater monitoring programmes be devised.

Issues under this heading relate to questions like: -

- 'How much groundwater is the irrigation farmers using?'
- 'Is the mining industry using any groundwater?'
- 'Do the mines pump out excess groundwater and do the dispose this water?'
- 'Do the mines who abstract groundwater affect the surrounding farmers at all?'

To be able to identify any possible negative impacts within areas of groundwater use, the behaviour of the natural system needs to be characterised. From this it is clear that different levels of monitoring are needed. Monitoring the natural conditions not only help to determine baseline conditions from which recharge can be calculated, but also can assist to evaluate and quantify the effects of changing weather patterns.

Fortunately the NWA (1998) has supplied the necessary instruments to assist the department in its management functions - these being Water Users Associations. The aim of the Act is to devolve the management of a source down to the lowest possible level, i.e. the users tapping a common source like an aquifer and being mutually dependent of this particular source. The

challenge would be to convince these users to the value of this source and the necessity to manage it for the benefit of the whole group.

7. CONTROL

The 'Control' function is in fact the regulatory function as it should be executed by the DWA thus 'water governance'. Whereas the function of 'management' refers to processes and procedures that need to be executed to ensure the sustainable utilisation of a source by the people utilising that source, i.e. for groundwater a particular aquifer or aquifer system, governance links the five previous mentioned functions to the resource base, i.e. the groundwater resources under the jurisdiction of a particular Regional Office.

The World Bank defines 'governance as looking at the balance of power and the balance of actions at different levels of authority. This translates into policies, legislation and regulations, institutions, participation and representation, knowledge and capacity and financial mechanisms'.

The White Paper as a policy on water in South Africa, which translated into NWA as the legislation, covers the first two aspects in the above definition. Furthermore the NWA also make provision for institutions like water user association, water service authorities and water services providers. However, it seems that there is a big aversion in the DWA to establish water user association with groundwater management as it primary aim. Mechanisms for the creation of regulations are not transparent at all – especially for groundwater-related matters.

The concept of 'Balance of Power' is also disturbed by the RSA Constitutions' requirement of cooperative governance.

8. DATA/INFORMATION MANAGEMENT

Broken down into the smallest possible denominators, data is about the acquisition, capturing and dissemination of data and information to support the strategic and operational decisions of the department in order to fulfil its mission and objectives.

Without active data and information management in place, none of the above endeavours will come to fruition.

North West Groundwater Master Plan

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