A Framework for Groundwater Use Authorisations as Part of Groundwater Governance in Water Scarce Areas within South Africa.

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Dedication

I hereby dedicate my thesis to Prof Gerrit van Tonder, my late promoter, mentor, teacher, supervisor and friend. Gerrit, your support, advice, comments, encouragement and mentorship before and during my project was greatly appreciated. I wish you could have been part of the advice and mentoring process of the writing of my PhD thesis. Thank you for introducing me to the field of geohydrology and especially groundwater resource management. I am forever grateful and will apply the groundwater resource management principles. You are dearly missed.

Declaration

I, Yolanda Louise Kotzé, declare that the thesis that I herewith submit for the doctoral degree PhD (Geohydrology) at the University of the Free State, is my independent work and that I have not previously submitted it for a qualification at another institution of higher education.

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Yolanda Louise Kotzé

1 July 2015

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List of Acronyms and Abbreviations

AMS	Aquifer Management System
BBBEE	Broad-Based Black Economic Empowerment
DRC	Democratic Republic of the Congo
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
FAO	Food and Agriculture Organisation
GEP	Groundwater Exploitation Potential
GIS	Geographic Information System
GRA	Groundwater Reserve Assessment
GWAP	Groundwater Assessment Project
GRDM	Groundwater Resource Directed Measures
GWULA	Groundwater Use License Application
HP	Harvest Potential
IGS	Institute for Groundwater Studies
KAMS	Kalkveld Aquifer Management System
NORAD	Norwegian Agency for Development Cooperation
NGA	National Groundwater Archive
NWA	National Water Act
NWRS	National Water Resource Strategy
OECD	Organisation for Economic Co-operation and Development
RSA	Republic of South Africa
RQOs	Resource Quality Objectives
USA	United States of America
WARMS	Water Authorisation and Registration Management System
WMS	Water Management System
WRC	Water Research Commission
WRMS	Water Resource Management System
WUAAAC	Water Use Authorisation Assessment and Authorisation Committee
WULATS	Water Use Licensing Authorisation Tracking System

Chapter 1
Introduction

1.1 Background

South Africa has adopted a law and policy framework for water which was based on the constitutional recognition of the right of access to water (Gowlland-Gualtieri, 2007:1). The National Water Act, Act 36 of 1998 (NWA) (RSA, 1998) was promulgated "to provide for fundamental reform of the law relating to water resources, to repeal certain laws and to provide for matters connected therewith". The National Government of South Africa is recognised as the custodian of all water resources in South Africa and is obligated to ensure that all water resources are protected, utilised, developed, conserved and managed in a sustainable and equitable manner.

The NWA is currently recognised internationally as one of very few acts that recognise basic human needs on which South Africa as a country can be proud of, although proper implementation of the act is lacking. The act is in line with the Constitution of the Republic of South Africa, Act 108 of 1996 (RSA, 1996) which embraces human rights such as the right of access to water, a healthy environment, health care, housing, food and social security, culture and education. All basic human needs are recognised within the Constitution.

The NWA requires the National Department of Water and Sanitation (DWS) to give the highest priority to basic human needs and ecological sustainability, or in other words, the reserve above that of agriculture and other industries (Nieuwoudt, Backeberg and Du Plessis, 2004). The NWA should be read in conjunction with the Water Services Act, Act 108 of 1997 (RSA, 1997) as the act regulates the accessibility of water and sanitation by domestic users.

The NWA does not directly distinguish nor differentiate between surface water and groundwater resources, but subsumes all water resources.

1.2 History

Groundwater in many parts of South Africa provides the sole and/or partial water supply for meeting basic human needs. In order to meet basic human needs, it is estimated that up to 68% of towns within the Free State Province rely solely and/or partially on groundwater supply. With an increase in the dependency on groundwater usage the need to properly and effectively protect, use, develop, conserve, manage and control groundwater resources has become a national priority of the custodian of all water resources, the DWS.

Groundwater resources are lacking proper management within South Africa, mostly due to a lack of knowledge and skills, especially with regard to the development, sustainable use, protection and principles of groundwater resource management. Proper and effective management of groundwater resources may contribute to the alleviation of poverty in many areas of South Africa; however, the greatest groundwater challenge is to ensure the sustainable use and management of groundwater in areas where the resource is under threat.

The over-abstraction of groundwater within certain areas of South Africa is of great concern and may have many negative consequences. The depletion of groundwater resources and the deterioration of groundwater quality have a negative health impact on large sections of rural communities that solely and/or partially rely on groundwater to meet their basic human needs. Water quantity- and quality-related problems are directly linked to many other crises such as poor school attendance, food insecurity, poor nutritional status among both children and HIV/Aids affected persons and decreased productivity (Oluoko-Odingo, 2009).

A lack of access to water directly affects the quality of life of most vulnerable populations as the simplest of domestic tasks become more burdensome. Women and children bear the brunt of these burdens as they are often responsible for the collection of water from distant and unclean water sources. The loss of time and energy in collecting and carrying water from afar only adds to the unfortunate direct health threats through poor water quality. Competing demands for water between households, communities, agriculture and industries will increase over time due to population growth as well as tension and conflict.

At the heart of the threat to future water supplies is the destruction of natural ecosystems, deforestation, groundwater depletion, land degradation and pollution, for example by anthropogenic created pollution sources, chemical and agricultural waste. Environmental damage contributes to an increase in natural disasters, climate changes and water attenuation.

Increased pressure is placed on groundwater resources due to over-abstraction of groundwater resources within the agricultural sector, industrial sector and municipal sector. In many instances, certain towns within the Free State Province, for example, are left without any drinking water. This is due to the depletion of a water resource, especially groundwater, in order to provide water for the waterborne sewage systems. Therefore, certain municipalities are faced with the challenge of sighting, developing, supplying groundwater and sustaining good water quality and quantity within a short period of time.

The decanting of old mineworks as well as known and unknown hazardous waste storages also poses a major threat to groundwater resources within the Free State Province and throughout South Africa.

Groundwater resource management can in general be defined as the:

- Implementation of programmes for the protection of natural recharge;
- Use of intentional recharge;
- Planned variation in the volume and location of abstraction over time;
- Use of groundwater storage together with surface water from local and imported water sources; and
- Protection and sustainability of groundwater quantity and quality (Tuinhof, Dumars, Foster, Kemper, Garduňo and Nanni, 2006:2).

Proper groundwater resource management will contribute significantly to the reduction of over-abstraction, an increase in sustainable groundwater abstraction and groundwater quality.

Currently, groundwater resources are governed by the DWS through the implementation of the National Water Act. The following list of main groundwater resource management tools used by the DWS, not excluding any other methods used which are not mentioned in the list, are compiled from years of working experience at the DWS:

- The National Water Act.
- Other environmental related legislation.
- Policy development, guideline and strategy development, monitoring and regulating.
- The reserve specifies the conservation of good quality water supply for basic human needs and the ecological requirements.
- Allocation of water use licenses for abstraction and discharges are compared and measured against the reserve determinations.
- Water use licensing conditions form part of a water use license.
- An integrated water resource management approach for the protection, conservation and demand of water resources.
- Other initiatives such as:
    - Feasibility studies.
    - Groundwater Assessment Projects (GWAP) to determine the current state of groundwater supply with regard to quality and quantity, the possibility of the development of additional groundwater resources and the implementation of a groundwater management and monitoring programme at municipalities across the Free State and other provinces.
    - Groundwater master plans.
    - Groundwater safety plans.
    - Reconciliation studies.
    - Development of various software, for example the Kalkveld Aquifer Management System (KAMS); the Aquifer Management System (AMS); Software for Groundwater Management

(AquiMon) as part of the Norwegian Agency for Development Cooperation (NORAD) Assisted Programme for the Sustainable Development of Groundwater Sources under the Community Water and Sanitation Programme in South Africa; the Water Management System (WMS); database containing data on surface water, groundwater and rainfall (HYDSTRA); and integrated hydrogeological analysis and reporting solution for decision-making during analysis and assessment of hydrogeological and hydrogeochemical data (CHART).

- Water Use Authorisation Assessment and Authorisation Committee (WUAAAC) and Water Use Licensing Authorisation Tracking System (WULATS).
- Establishment of water user associations.
- Catchment management agencies and forums.

The question arises whether or not the main groundwater resource management tools for the management and protection of groundwater resource quantity and quality used with special reference to the allocation of groundwater use authorisations, not excluding the above-mentioned, are proven to be effective measures to manage groundwater resources within the agricultural sector in the Free State Province and South Africa.

Research will significantly contribute to answering this question as well as finding solutions in order to improve and make especially the groundwater use authorisation process effective. This will be done by taking into consideration the various groundwater resource management approaches by all governments and all stakeholders and providing more specific parameters and variables, guidelines and conditions to aid the decision-making process within the DWS.

1.3 Problem Statement

For many years the question arose whether the most valuable variables as part of the main groundwater resource management tools for the management and protection of groundwater resource quantity and quality, are available for scrutiny by the DWS. This is done to determine whether or not a groundwater use authorisation is recommended or not, and approved or not. In South Africa, water use licenses, including groundwater, are only considered for approval after the determination of the reserve in order to meet basic human needs and preserve water for ecological integrity.

Accurate quantification of groundwater contributions to ecosystems for proper implementation of the NWA are challenging, as many aquifers in South Africa are in heterogeneous and anisotropic fractured-rock settings (Levy and Xu, 2011). The assumption that is made that there is always groundwater and surface water interaction at every surrounding area of a river in South Africa, may be questionable. In certain areas such as the Petrusburg area within the Free

State Province, where the above-mentioned assumption was foreseen, the opposite was proven. More research is however needed on this.

On occasions where a groundwater use license was *not* approved due to the distance between the borehole or boreholes and a nearby river, the outcome of the final decision of the groundwater use license application might have been the opposite if a proper framework would have been available for scrutiny. This was regardless of whether or not water is always available in the river.

Thus, the question: "Are the current groundwater allocation decision-making tools enough to make informed decisions regarding the final approval or not of groundwater use authorisations? Also, is a proper framework available for decision-making in complex groundwater scenario situations as part of the groundwater authorisation decision process in the agricultural sector in South Africa?"

In an attempt to improve the decision-making process regarding the issuing of groundwater use authorisations, the following section will describe the methodology and objectives required to overcome the uncertainty of when to allocate groundwater use authorisations.

1.4 Research Methodology

The research methodology of this study is mainly action research. Fennessy and Burnstein (2000:180) quote Baskerville and Wood-Harper (1998) who defined action research as "a cognitive process that depends on social interaction between the observers and those in their surroundings".

Butler, Feller, Pope, Murphy and Emerson (2006) noted that in action research projects, researchers collaborate with specialists to solve practical problems while expanding scientific knowledge.

Baskerville (1999:6) cites Blum (1955) who argued that action research can be described by a simple two-stage process:

- During the *diagnostic stage,* a collaborative analysis of the situation is performed by the researcher and the subjects.
- This stage is followed by the *therapeutic stage* which involves experimentation. In this stage changes are introduced and the effects are studied.

Baskerville (1999:6-7) characterises action research as:

1 *Action research aims at an increased understanding of an immediate situation, with emphasis on the complex and multivariate nature of this setting … domain.*

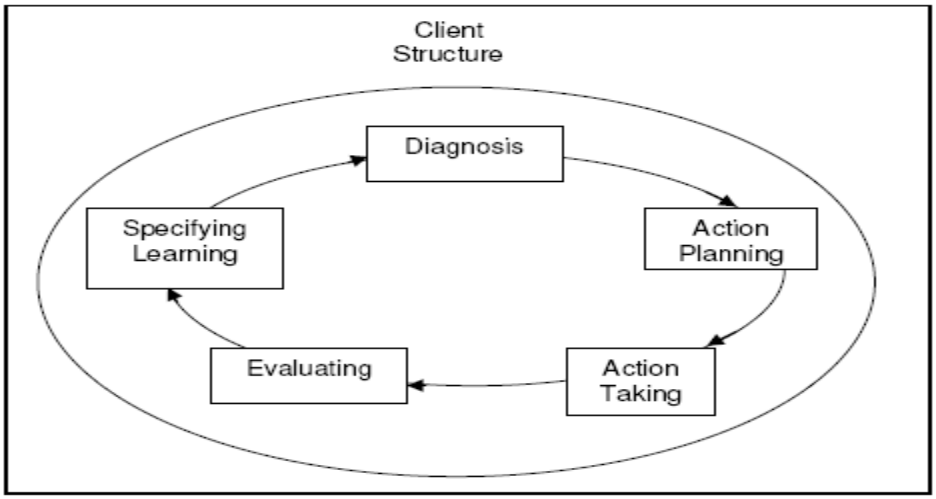
2 *Research simultaneously assists in practical problem solving and expands scientific knowledge. This goal extends into two important process characteristics: Firstly, there are highly interpretive assumptions being made about observation; secondly, the researcher intervenes in the problem setting.*

3 *Action research is performed collaboratively and enhances competencies of the respective actors. A process of participatory observation is implied by this goal. Enhanced competencies … is relative to the previous competencies of the researchers and subjects, and the degree to which this is a goal and its balance between the actors, will depend upon the setting.*

4 *Research is primarily applicable for the understanding of change processes in systems.*

The action research description details a five-phase cyclical process (Susman and Evered, 1978). The approach first requires the establishment of a research environment. Then, five identifiable stages are iterated: (1) diagnosing, (2) action planning, (3) action taking, (4) evaluating and (5) specifying learning. Figure 1.1 illustrates the action research structural cycle and components thereof.

The research environment provides the conditions under which action and change may be specified. The responsibilities of the client and the researcher to each other in a collaborative nature of undertaking should also be defined. By referring to this explanation, it is important to point out that the client will be the Department of Water and Sanitation, and the researcher will be the author of this thesis. The research environment as pilot will be the Free State Province.



Source: Baskerville (1999)

Figure 1.1: Action research structural cycle and components

Diagnosing corresponds to the identification of the primary problems that are causing the organisation's desire for change. The diagnoses will develop theoretical assumptions about the nature of the problem domain that needs solving.

Action planning is the collaborative effort of the researcher and the client to identify organisational actions to relieve or improve the specified problems. The output is a plan that establishes the target of change and the approach to change.

Action taking then implements the planned action in a collaborative manner between the researcher and the client.

A collaborative *evaluation* of the implemented plan is done to determine if the changes had the desired outcome. This includes determining whether the effects of the action were realised, and whether the problems have been relieved. Where the change was successful, the evaluation should indicate whether the actions undertaken were the sole cause of success. In the case of the action being unsuccessful the reasons should be identified and the action plan for the next iteration needs to be established.

Specifying learning is formally undertaken lastly, but is usually an ongoing activity. The organisational norms should be restructured to reflect the new knowledge gained during the research. Where the change was unsuccessful, additional knowledge should be added in preparation for the next action research cycle. Where the change was successful, the actions involved should be documented to aid future research.

Baskerville (1999) emphasises that action research produces highly relevant research results, as “it is grounded in practical action, aimed at solving an immediate problem situation while carefully informing theory”.

Due to the fact that the author of this thesis was not merely an observer but was *actively involved* in handling groundwater use licenses, the action research methodology is appropriate.

In summary, action research places emphasis on the solution of a problem. It is a systematic method of solving a problem or improving practices. Action research is concerned with the real problem faced by specialists, followed by attempts made to find solutions to the problems. It is flexible and performed in informal contexts in order to improve an existing situation. Action research does unavoidably apply scientific methods to solve problems and improve practices, judgements and decisions.

Action research refers to the use of evaluation logic and processes to assist people in government and organisations to learn how to think evaluative. This is distinct from using the substantive findings in an evaluation report.

Action research is equivalent to the difference between learning how to learn *versus* learning substantive knowledge about something. Learning how to think evaluative is learning how to learn. Learning to think and act evaluative can have an ongoing impact, especially when it is built into ongoing organisational development (Baskerville and Wood-Harper, 1998: 91).

By providing a mechanism and process for clarifying values and goals, evaluation has an impact even before data is collected.

1.5 Objectives of the Research Study

The main objective of this study is to develop a framework to improve the decision-making process regarding the allocation of groundwater use authorisations in the agricultural sector.

In order to answer the research question: “Are the current groundwater allocation decision-making tools enough to make informed decisions regarding the final approval of groundwater use authorisations, and is a proper framework available for decision-making in complex groundwater scenario situations as part of the groundwater authorisation decision process in the agricultural sector in South Africa?”, the objectives are the following:

1 To discuss groundwater governance in South Africa.
2 To discuss food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.
3 To compare and evaluate the NWA with international water laws.

4 Discuss the groundwater reserve determination process of South Africa.

5 To develop a framework regarding the allocation of groundwater use authorisations in the agricultural sector.

6 To conduct case studies.

Each of the objectives will form a stage in the study and action research methodology will be applied to each stage of the study.

Stage 1: Groundwater governance in South Africa.

- *Diagnosis*
  - Gain an understanding of the groundwater governance situation in South Africa.
  - Gain an understanding of the current groundwater governance problems.
- *Action planning*
  - Gain an understanding of current groundwater governance principles and tools in South Africa.

Stage 2: Food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.

- *Diagnosis*
  - Gain an understanding of food security, water security and the economic value of water in the agricultural sector in South Africa.
  - Gain an understanding of the current groundwater resource management problems in the agricultural sector in South Africa.
- *Action planning*
  - Gain an understanding of the current groundwater use authorisations allocation in the agricultural sector in South Africa.
  - Gain an understanding of problems that may arise if a groundwater use is not authorised in the agricultural sector in South Africa.

Stage 3: Comparison and evaluate the NWA with international water law.

- *Diagnosis*
  - Gain an understanding of the NWA and international water law.
- *Action planning*
  - Plan to develop comparison criteria.
  - Compare and evaluate the NWA with international water laws.
  - Gain an understanding of the advantages, disadvantages and implementation of the compared water legislation.

Stage 4: Determination of the Groundwater Reserve in South Africa.

- *Diagnosis*
  - Gain an understanding of the determination of the groundwater reserve in South Africa.
  - Gain an understanding of the groundwater reserve process.
- *Action planning*
  - Discuss the determination of the groundwater reserve of South Africa.

Stage 5: Development of a framework regarding the allocation of groundwater use authorisations in the agricultural sector.

- *Diagnosis*
  - Gain an understanding of the allocation of groundwater use authorisation process for irrigation purposes in the agricultural sector in South Africa.
- *Action planning*
  - Discuss the handling of groundwater use authorisation application process for irrigation purposes in the agricultural sector in South Africa.

Stage 1 to Stage 5: Case studies to demonstrate the framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa.

- *Action taking*
  - Development of framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa.
- *Evaluation*
  - Case study: In order to demonstrate the developed framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa.
- *Specifying learning*
  - Document what has been learned through Stage 1 to Stage 5.

1.6 Hypothesis of the Study

The following specific research hypothesis is proposed:

A framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa.

1.7 Outline of Chapters

The chapter outline of the study will follow the cyclical approach of the action research methodology that was proposed earlier. For Stage 1 to Stage 5, the *problem diagnosis* and *action planning* will be covered in Chapter 2, Chapter 3, Chapter 4, Chapter 5 and Chapter 6. The *action taken* stage will be covered in Chapter 7. The *evaluation* and *specify learning* stages will be covered in Chapter 8.

Listed below are brief descriptions on each of the mentioned chapters:

- *Chapter 2* provides an overview and discussion on groundwater governance in South Africa.
- *Chapter 3* provides an overview of food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.
- *Chapter 4* provides a comparison and evaluation of the NWA with international water laws.
- *Chapter 5* provides a discussion on the groundwater reserve determination process of South Africa.
- *Chapter 6* provides a framework for groundwater use authorisations for irrigation purposes in the agricultural sector.
- *Chapter 7* provide case studies to demonstrate the framework for groundwater use authorisations as part of groundwater governance in water scarce areas within South Africa.
- *Chapter 8* will conclude the study by summarising the main findings of the thesis and highlighting the contribution of this research to new knowledge.

1.8 Conclusion

This chapter introduced the question of “Are the current groundwater allocation decision-making tools enough to make informed decisions regarding the final approval of groundwater use authorisations, and is a proper framework available for decision-making in complex groundwater scenario situations as part of the groundwater authorisation decision process in the agricultural sector in South Africa?” In an attempt to improve the decision-making process regarding the issuing of groundwater use authorisations, chapter 1 described the methodology and objectives required to overcome the uncertainty of when to allocate groundwater use authorisations.

The following chapter will provide an overview and discussion on groundwater governance in South Africa.

Chapter 2
Groundwater Governance in South Africa

2.1 Introduction

> *Groundwater resources are playing an ever-increasing role world-wide in human development and well-being, in particular in developing countries. The state of these resources and the health of the aquifers that supply human uses of groundwater are closely linked to the state of groundwater governance – the local arrangement that directly impact groundwater use and aquifer pollution* (Braune and Adams, 2013:1).

Varady, van Weert, Megdal, Gerlak, Iskandar and House-Peters (2013:7) adapted Saunier and Meganck's definition in their *Dictionary and Introduction to Global Environmental Governance* (2007) to define groundwater governance:

> *Groundwater governance is the process by which groundwater is managed through the application of responsibility, participation, information availability, transparency, custom and the rule of law. It is the art of coordinating administrative actions and decision making between and among different jurisdictional levels – one of which may be global.*

Varady et al. (2013:7) further refers to Saunier and Meganck's thought formulated in 1995 by the Commission on Global Governance, namely that "governance is the sum of the many ways individuals and institutions, public and private, manage their common affairs".

Importantly, governance implies a process by which societies govern (Lautze, De Silva, Giordano and Sanford, 2011).

A fully functional, reliable and appropriate groundwater governance framework will significantly contribute towards sustainable groundwater resource development and use in order to protect groundwater supply for current and future use, and maintaining ecological and environmental integrity.

The current water governance framework of South Africa is not fully implemented. This is mainly due to a lack of understanding of the implementation principles, the urgency thereof, support and human resources.

2.2 Current Groundwater Governance Situation in South Africa

2.2.1 General

South Africa is internationally and nationally recognised as a semi-arid, water-scarce country. The annual average rainfall of South Africa is 450 mm which is well below the world average rainfall of 860 mm per annum (Pietersen, Beekman and Holland, 2011:4).

The Department of Water and Sanitation (DWS) also recognises high priority water-scarce areas. These water-scarce areas are generally referred to as the “red areas” by the DWS. Most of the “red areas” are designated catchments, sub-catchments and quaternary drainage regions which are promulgated as Government Control Areas, for example the Ventersdorp Government Control Area. The Ventersdorp Government Control Area comprises of the quaternary drainage regions C24C, C24E and C24F. There are currently also areas identified as “red areas” which are not promulgated as Government Control Areas, for example the Kalkveld. The DWS identified these “red areas” by taking into consideration that the abstraction from groundwater resources within these areas is currently exceeding the groundwater reserve.

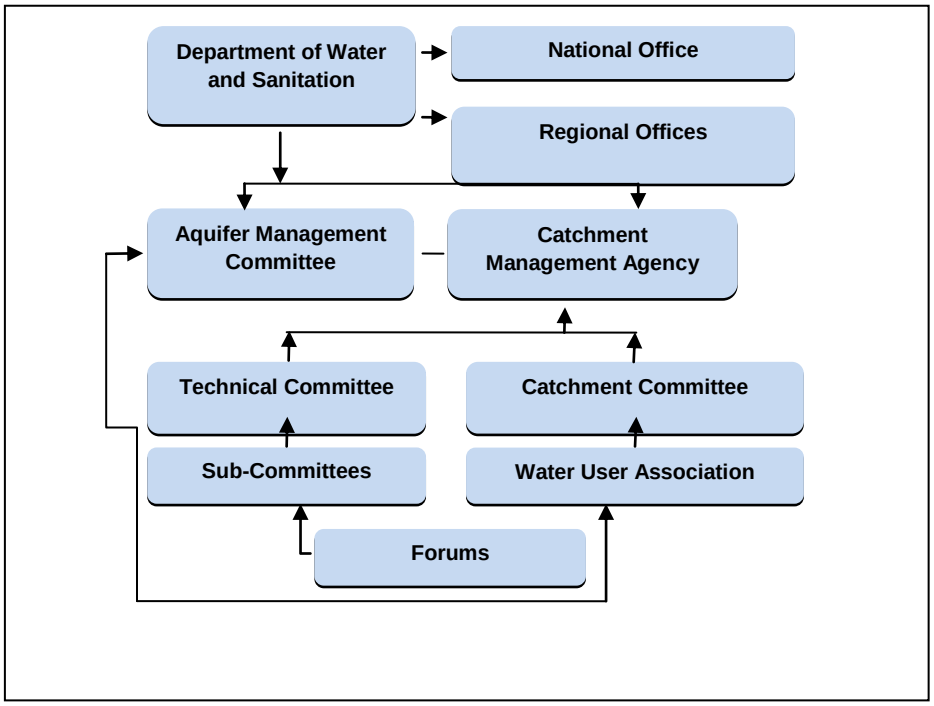
The Kalkveld comprises of the quaternary drainage regions C52G, C52H, C52J and C52K. These quaternary drainage regions cover areas of Petrusburg and Bainsvlei near Bloemfontein, both within the Free State Province. The Kalkveld Aquifer Management System was developed for use by farmers to manage their quantity and quality of groundwater resources.

Groundwater use licenses are not considered within these “red areas”, except if the groundwater use is intended for small industries such as chicken abattoirs, diamond exploration, and small scale diamond mining. Groundwater is an utmost important strategic resource for meeting basic human needs, domestic use for rural communities, bulk water supply to urban areas and the environment. Water security and food security form an integral part of groundwater as a strategic resource.

2.2.2 Institutional framework for water resource management in South Africa

The National Water Act (NWA) (RSA, 1998) provides the framework for water management within South Africa. The NWA outlines the various water management institutions and there functions.

Figure 2.2 illustrates the institutional framework for water resource management in South Africa.



Source: Pietersen et al. (2011:20)

Figure 2.1: Institutional framework for water resource management in South Africa

2.2.3 Overview and functions of water resource management institutions

2.2.3.1 Minister of Water and Sanitation

As the custodian of all water resources in South Africa, the Minister of Water and Sanitation is mainly responsible for effective water management. His responsibilities include to ensure the protection, use, development, conservation and management of all water resources in an equitable sustainable manner of which the NWA makes provision for.

2.2.3.2 Department of Water and Sanitation

The DWS is overall responsible for the implementation of the NWA.

The DWS has embarked on a process to delegate water resource management functions to various water resource management institutions in order to enable the DWS to focus more on national policy development and regulation (De La Harpe, Ferriera and Potter, 1999:7).

2.2.3.3 Catchment management agencies

The catchment management agencies are responsible for the development and implementation of catchment management strategies within all water management areas. The establishment of catchment management agencies is a time-consuming process and has yet to be established in most water management areas.

2.2.3.4 Catchment committees

The catchment committees are responsible for day-to-day management of groundwater resources within water management areas (Pietersen et al., 2011:18).

2.2.3.5 Water user associations

Water user associations are water management institutions, but their primary purpose is not water management (RSA, 1998). They are operational on local level and consist of water users who undertake water use activities for mutual benefit. Management powers and duties are delegated by the Minister of Water and Sanitation to the water user associations.

The water user associations have mainly the following functions:

- Protection of water resources.
- Prevent over-abstraction from water resources.
- Prevent unlawful water use.
- Remove any unlawful constructions placed within a watercourse.
- Prevent unlawful acts that will contribute to the degradation of water quality of a watercourse.
- General supervision over watercourses within their promulgated boundaries.
- Regulate natural and unlawful damage to a water resource.
- Investigate and record:
  - Entitlement to water use.
  - Quantity of water use.
- Construct, acquire, manage, operate and maintain waterworks necessary for draining lands and supplying water for irrigation and other purposes.
- Supervise and regulate distribution and use of water according to water use entitlements.
- Provide management, support and training services to rural communities and water services institutions.
- Encourage farmers to monitor their groundwater levels, groundwater quality, and groundwater quantity.
- The auditing of groundwater use license conditions is done by independent geohydrology consultants.
- Provide catchment management services on behalf of responsible authorities (RSA, 1998).

2.2.3.6 Forums

A forum is non-statuary body that mainly has the responsibility of facilitation and support to the catchment management agencies. The forums also have a managing and monitoring function of water resource development schemes (Pietersen et al., 2011:18).

2.2.3.8 Technical committees

Technical committees comprise of DWS personnel and specialists that discuss, provide advice and make recommendations regarding more complex water resource management issues (Pietersen et al., 2011:18).

2.2.3.9 Aquifer management committee

It is recommended that an aquifer management committee as part of the water governance framework of South Africa is established. The aquifer management committee's main responsibility – but not limited to – will be cross-boundary coordination of aquifers that spans over more than one boundary or water management area.

2.3 Groundwater Governance Problems

2.3.1 Main groundwater governance problems

The knowledge and skills do exist for most groundwater governance problems, but a major problem is the lack of human resource capacity and funding to implement the groundwater governance framework. An evaluation of the effectiveness of existing governance provisions and capacity to implement effective groundwater governance was performed by Pietersen et al. (2011:18), and provided the following conclusions:

- Hydrogeological maps and aquifer delineation with classified typology are in place.
- Groundwater governance is overall weak or non-existing.
- Groundwater monitoring and assessment of groundwater resource quantity and quality is poor.
- Provisions for groundwater resource development and groundwater use authorisations are fair.
- Compliance monitoring for groundwater abstraction and pollution is poor.
- Provisions for the establishment of an aquifer management committee or organisation are non-existent.
- Cross-sector coordination is weak or non-existent.

Groundwater governance of South Africa was evaluated against a priority list of twenty criteria (Pietersen et al., 2011:55).

The Delmas case, where numerous people got sick and some passed away as a result of an outbreak of typhoid fever and diarrhoea, is an unfortunate tragic example and result of the lack of human resource capacity and funding of groundwater resource management. The groundwater supply quality and quantity of Delmas was not properly managed which was as a result of the lack of funding and groundwater resource management by the Municipality.

> *Due to karstic geohydrological formations within the region, the whole area is very vulnerable to almost any pollution which can contaminate the groundwater. If pollution, be it industrial or sewage, is not adequately managed or prevented, irreversible damage to the groundwater quality will result, with catastrophic consequences* (Nealer, Bertram, van Eeden, van Niekerk, Tempelhoff and Coetzee, 2009:11).

The receiving surface water was being polluted after receiving discharges of poor quality from malfunctioning wastewater treatment works. The dolomite aquifer directly downstream of the natural catchment of the stream was receiving the polluted effluent from the wastewater treatment works (Nealer et al., 2009:22).

The groundwater was used for drinking water purposes and domestic use.

2.4 Groundwater Governance Principles and Tools

2.4.1 Principles for effective groundwater governance

Groundwater governance will positively benefit by applying principles developed for institutional arrangements for management of groundwater resources (Foster and Garduňo, 2013). The principles for effective groundwater governance, but not limited to, are:

- Accessible, rapid and inexpensive mechanisms for conflict resolution.
- Groundwater use entitlement sanctions for unlawful groundwater users and groundwater polluters.
- Effective compliance monitoring by the DWS.
- Effective independent groundwater quantity and quality monitoring by groundwater users with groundwater use authorisations.
- Nested stakeholder groups such as groundwater user associations in areas with geographically large groundwater resource systems.
- Arrangements for the participation of stakeholders in decision-making.
- Congruence between groundwater resource allocation and environmental constraints.
- Clearly defined boundaries for groundwater resource evaluation and allocation.

As listed in Table 2.1, there are also important aspects to consider in groundwater governance (Varady et al., 2013).

Table 2.1: Aspects to consider in groundwater governance in South Africa

Ecological aspects	Economical aspects	Socio-cultural aspects	Political and institutional aspects
Vulnerability	External costs	Ethics	Accountability
Provisioning *versus* ecosystem services	Ability to pay	Social inclusion	Consistency
Diffusivity and conduciveness	Role of public–private partnerships	Social learning	Representation
Attenuation rates	Role of private sector	Market failures	Institutional capacity
Renewability	Inadequate water use monitoring	Religious traditions	Adapt to change and uncertainty
	Water quality and quantity impacts	Groundwater perceptions	Change management
	Role of groundwater storage and water scarcity		

2.4.2 Groundwater management tools

Kathrin Knûppe (2011) interviewed eighteen groundwater governance experts from various government and non-government organisations regarding groundwater management tools in South Africa and the importance thereof. The groundwater management tools and measures as ranked by the experts are presented in Table 2.2.

Table 2.2: Groundwater management tools and measures in South Africa

Importance	Tools and measures
High importance	Implementation of existing groundwater legislation and regulations. Improve cooperation structures between different administrative levels. Improve cooperation between different sectors and agencies. Develop a nationwide information management system. Monitor pollution sources. Implement an aquifer monitoring system and populate the national database to store pertinent data such as recharge, discharge, stream flow and so forth.
Moderate importance	Improve and intensify stakeholder involvement. Raise awareness. Education and training programmes for all stakeholders. Develop new economic instruments. Implement existing economic instruments. Change land-use patterns and cropping systems. Implement groundwater protection zoning. Initiate groundwater resource development of new aquifer systems. Artificial recharge of aquifers. Rainwater harvesting. Applying conjunctive use of surface water and groundwater resources. Develop groundwater models and scenario planning.
Minor importance	Formulation of new groundwater legislation and regulations. Develop trans-boundary aquifer management systems.

It was concluded that the most important tool and measure identified is implementation of existing water legislation and groundwater regulations. In order to achieve proper and effective implementation of the act and regulations, effective implementation measures for the implementation of the NWA and regulations are of utmost importance.

According to the interview results, the development and future application of groundwater management tools are adversely affected by the insufficient appreciation of the resource, shortcomings in knowledge and information, centralised system structures and an inadequate recognition of the significance of aquifer-dependent ecosystems and services (Knûppe, 2011:71).

The strengthening of policies, legislation, institutional reform and proper recognition of groundwater resource management and groundwater governance accountability will significantly contribute in effective implementation of water legislation and groundwater regulations in South Africa.

2.5 Conclusion

This chapter provided a definition of groundwater governance and a discussion on the groundwater governance situation in South Africa. It included the institutional framework for water resource management, overview and functions of water resource management institutions, groundwater governance problems and groundwater governance principles and tools.

The next chapter will provide an overview and discussion on food security, water security, and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.

Chapter 3

Food Security, Water Security and Economic Value of Water in the Agricultural Sector versus Allocation of Groundwater Use Authorisations

3.1 Introduction

This chapter will focus on groundwater use in agriculture, groundwater pollution sources, groundwater resource management problems, food security, water security, economic value of water, groundwater use authorisations and potential problems arising if a groundwater use is not authorised in the agricultural sector of South Africa.

3.2 Background

Groundwater irrigation has rapidly grown over the past 50 years and now supplies over one-third of the world's irrigated area (Shah, 2014:8). About 57% of groundwater abstracted in South Africa is intended for agricultural irrigation, 0.22% for aquaculture and 0.25% for drinking water for livestock (Majola, 2014:32).

Groundwater irrigation that is effectively managed can make a substantial contribution to agriculture and food security, and can lift many households out of poverty. Smallholder farming can be stabilised by intensify cropping, buffering droughts and allowing farmers to diversify and access markets for high-value crops that require continuous on-farm groundwater management. Properly trained and mentored emerging farmers can substantially increase their income from the sale of milk, eggs, livestock and chickens which is also dependent on the area or district of farming.

Since 1950, growth in groundwater irrigation originates from the innovative developments and technology. Groundwater use is not limited to arid regions and recharging of shallow alluvial aquifers. It has spread to humid continents such as Asia and hard-rock areas in countries like India and Sri Lanka, where aquifer storage and yields are low (Shah, 2014:8).

In South Africa, groundwater use has increased in the private and public sector irrigation schemes. In certain circumstances, over-abstraction is on the increase. The over-abstraction of groundwater inevitably leads to lowering of water tables and depletion and environmental damage to aquifers.

Shallow boreholes run dry, wetlands dry out, streams and river flows decline and contamination increases which also threatens drinking water resources (Shah, 2014:8).

An ever-increasing population growth can place groundwater supply schemes for drinking water purposes under increased pressure.

The sustainable use of groundwater resources can significantly contribute to decrease the negative effects of over-abstraction in the agricultural sector.

Appropriate and effective groundwater governance may lead to more responsible and accountable groundwater use and groundwater resource management. This will also positively contribute to increased sustainable use, productivity and equity.

Socio-economic, socio-ecological and the political environment are of utmost importance in determining elements of an appropriate groundwater governance regime. Groundwater governance focuses more on social systems, stage of economic evolution and political organisation (Shah, 2014:9).

Groundwater management focuses on the management of groundwater resources in a sustainable manner as well as protecting groundwater resources against pollution sources.

3.3 Groundwater Use in the Agricultural Sector in South Africa

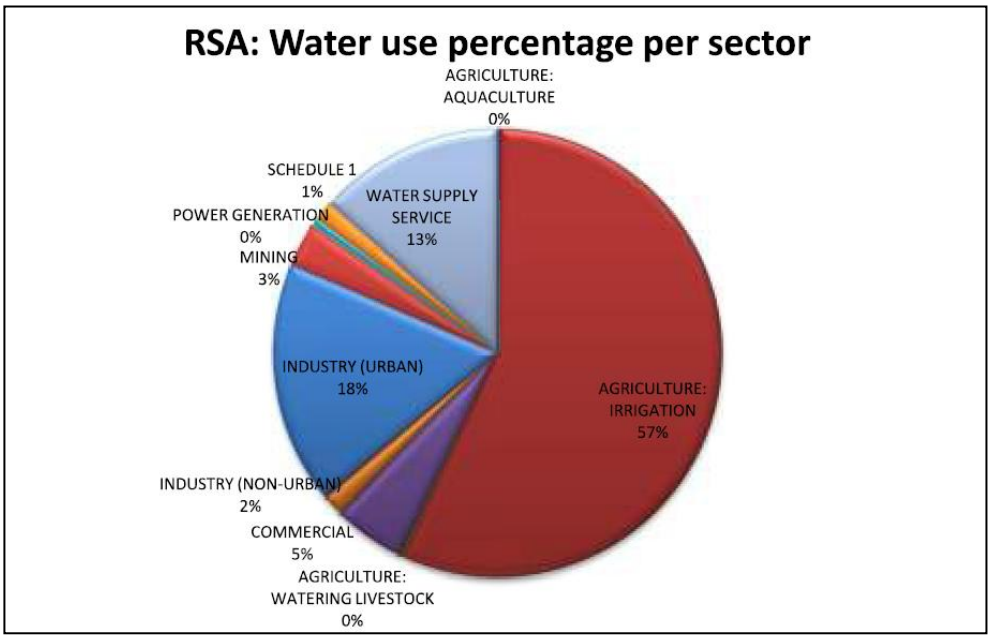
The registered groundwater use per sector in South Africa is as follows (Majola, 2014:32):

- Agriculture: 57% of groundwater use is for irrigation purposes.
- Agriculture: 0.25% of groundwater use is for drinking water for livestock.
- Agriculture: 0.22% of groundwater use is for aquaculture purposes.
- Commercial: 5.09% of groundwater is used for commercial purposes.
- Non-urban industrial: 2% of groundwater is used for non-urban industrial purposes.
- Urban industrial: 18% of groundwater is used for urban industrial purposes.
- Mining: 3% of groundwater is used for mining purposes, although dewatering is not mentioned.
- Power generation: 0.084% of groundwater is used for power generation purposes.
- Schedule 1: 1% of groundwater is used for Schedule 1 use.
- Bulk water supply: 13% of groundwater is used for bulk water supply schemes.

Taking into consideration the above-mentioned percentage usage per sector, it can be concluded that the agricultural sector makes use of the highest percentage of groundwater, followed by urban industrial use, bulk water supply schemes, commercial use, mining, non-urban industrial use, Schedule 1 use and power generation. Schedule 1 use is according to the NWA permissible water use for reasonable domestic use from any water resource to which that person has lawful access to. The percentages of groundwater use are based on the known

registered groundwater use. The non-registered and unlawful groundwater use cannot be accounted for, as it is an unknown variable.

Figure 3.1 indicates the registered groundwater use in South Africa from July 2014 up to the end of September 2014.



Source: Majola (2014:32)

Figure 3.1: Registered groundwater use in South Africa up to the end of September 2014

Table indicates the registered groundwater use in cubic metres (m^3) per sector per water management area (WMA).

Table 3.1: Registered groundwater use in cubic metres per sector per water management area

WMA Name	Aquaculture	Irrigation	Livestock watering	Commercial	Community woodlot	Industry (Non Urban)	Industry (Urban)	Mining	Power generation	Recreation	Schedule 1	Urban	Water Supply
BERG	602 460	85 114 843	849 272	1 040 234	1 895	179 125	89 261 091	331 271		74 835	53 810	481	3 626 758
BREEDE	408 365	217 708 382	355 187	1 314 998		51 268	7 538 696	8 772		161 159	138 338	26 197	4 254 124
CROCODILE (W), MARICO	750 756	166 209 652	1 364 250	4 484	81 130	1 220 013	47 853 439	13 060 391		776 754	10 312 255	204 879	11 226 490
FISH-TSITSIKAMMA	232 268	269 886 352	2 217 192	3 708 783	7 203	110 858	860 840	122 871	83 353	202 564	2 805 947	76 657	42 266 958
GOURITZ	42 142	104 564 586	1 463 390	2 711 388		110 920	5 994 494	46 057		34 644	45 832		11 205 723
INKOMATI	444 893	261 455 142	305 288	63 133 087	8 959	4 951 872	40 638 326	2 751 886		20 708	823 541	64 045 342	43 761 284
LIMPOPO	4 000	145 110 651	538 864	366 745		1 176 393	5 196 812	4 285 096	3 169 499	3 375	111 842	1 311 044	43 733 219
LOWER ORANGE		237 930 428	88 355			146 113	6 917 726	1 543 902	155 525				12 186 036
LOWER VAAL	2 916	157 100 604	164 272		51 184	154 804	10 737 914	15 599 623		1 173			14 225 886
LUVUVHU LETABA	92 620	102 938 338	10 375	8 623 911	33 841	68 564	449 660	597 489			3 737 565	22 207	47 320 721
MIDDLE VAAL	913	68 482 807	788 625			1 171 852	169 243	10 290 397			500		66 009 736
MVOTI-UMZIMKULU	58 502	61 322 360	469 937	52 631 164	46 231	23 438 847	5 358 523	25 044		10 861	153 522	1 282 838	127 116 793
MZIMVUBU-KEISKAMMA	25 946	41 371 108	281 682	13 709 992	1 562 535	102 628	119 381	95 821	3 675	136 069	478 024	111 910	64 918 797
OLIFANTS	7 420 892	176 401 543	992 841	6 522 521	94 829	24 700 826	5 642 586	81 315 015	158 815	2 916	6 959 018	1 214 250	40 115 916
OLIFANTS/DOORN		134 358 035	88 733	29 236		1 250	2 437 871	181 800		150 000	7 750		1 424 145
THUKELA	2 375	69 657 164	690 712	7 542 143	56 383	4 803 352	2 223 775	17 392	500 000	2 607	128 882		36 612 961
UPPER ORANGE		207 342 587	170 353			906 284	415 273	1 450 674					26 003 342
UPPER VAAL	83 333	94 414 921	1 006 527	2 927		8 605 324	601 820 936	11 393 340		74 297	232	6 806	1 957 048
USUTU-MHLATUZE	492 750	158 846 097	438 406	86 424 658	261 637	2 563 185	22 052 145	8 216 420		38 754	86 787	4 178	52 560 017
Grand Total	**10 665 131**	**2 760 215 600**	**12 284 259**	**247 766 271**	**2 205 825**	**74 463 478**	**855 688 730**	**151 333 259**	**4 070 867**	**1 690 716**	**25 843 845**	**68 306 789**	**650 525 955**

Source: Majola (2014:36)

It is important to note that the blank cells are an indication of data that was not available during the compilation of the report by Majola (2014).

3.4 Groundwater Pollution Sources in the Agricultural Sector

3.4.1 Agricultural activities and negative effects

Agricultural activities may produce a wide range of impacts on soils, surface water and ground-water. The environment is negatively affected through deterioration of natural resources.

Harmful effects are listed, but not limited to, the following:

- Deterioration of drainage water and irrigation return flows through salinisation.
- Soil salinisation due to water logging in areas with insufficient drainage.
- Soil losses and sedimentation as a result of erosion from poor water resource management.
- Movement of toxic elements through the soil.
- Point and non-point pollution from agricultural chemicals.
- Changes in the groundwater systems (Candela, Rao, Margiotta and Rebouças, 1998:31).

As noted by Candela et al. (1998:31), the harmful effects contribute to increased conflict between rural development and the environment in developing countries where crop production is not always seen as a first priority.

Table 3.2 indicates the agricultural activities and negative effects thereof.

Table 3.2: Agricultural activities and negative effects

Activities	Physical										Others			
	Land use	Soil erosion	Soil salinisation	Slope stability	Energy cost	Surface water quantity	Groundwater quantity	Surface water quality	Groundwater quality	Soil pollution	Landscape	Disease carrier	Public Health	Ecosystem
Origin of water	*		*		*	*	*	*	*	*	*	*	*	*
Type of crops	*							*	*	*	*			*
Irrigation	*	*	*		*	*	*	*	*					*
Drainage	*				*	*	*	*	*					*
Fertilisers								*	*	*			*	*
Pesticides								*	*	*			*	*
Intensive agriculture	*	*	*		*	*	*	*	*	*	*	*	*	*
Farming								*	*			*	*	*
Ploughing	*	*		*	*	*	*				*			*

Source: Candela et al. (1998:32)

3.4.2 Point and non-point sources of pollution

Point source of pollution is pollution originating from a single source, such as underground sewage systems. Point source pollutants in groundwater are usually found in a plume that has the highest concentrations of the pollutant nearest to the source and decreasing concentrations further away from the source. Point sources of pollution from agriculture may include, but is not limited to:

- Livestock feeding.
- Feedlots.
- Storage, handling, mixing and cleaning areas for pesticides, fertilisers and petroleum.
- Commercial watering points (Zoller, 1994:1).

Non-point sources of pollution do not originate from a single source. Non-point source pollution occurs as water moves across the land or through the ground and picks up natural and anthropogenic made pollutants which can then be deposited into lakes, rivers, wetlands, coastal waters and groundwater. The water that carries non-point source pollution may originate from natural processes such as precipitation and anthropogenic activities like agricultural irrigation.

Non-point source pollution is spread out throughout a large area and it is difficult to trace the exact origin of these pollutants. Most of these pollutants originate from activities on the land and natural characteristics of the soil, topography and climate. In agricultural areas where irrigation is used for crops, soil, pesticides, fertilisers, herbicides and insecticides it can be transported to surface water and groundwater. Bacteria, micro-organisms and nutrients such as nitrogen and phosphorus are common non-point source pollutants from agricultural livestock areas. Other pollutants from non-point sources include salt from irrigation practices and acid drainage from abandoned mines (Zoller, 1994:1).

3.4.3 Groundwater resource management problems in the agricultural sector

The most important groundwater resource management problem occurring in the agricultural sector is an increasing demand for crop irrigation which may lead to over-abstraction of groundwater resources. Long-term over-abstraction usually leads to depletion of groundwater resources and negative adverse effects on the environment.

Shah (2012:4) emphasises that “groundwater is also prone to the tragedy of the commons as individual short-term interests prevailing over long-term communal concerns and its effective management requires collective action”.

The above-mentioned situation leads to:

- Counterproductive competition between groundwater irrigation users.

- Conflicts in rural areas.
- Negative impacts on natural aquifer discharge such as spring-flows and riverbed flows, resulting in negative impacts on downstream surface water-flows.
- Degradation of important groundwater dependent ecosystems (Shah, 2012:5).

In managing the over-abstraction of groundwater resources in agriculture – as the main groundwater resource management problem – the following interventions, but not limited to, are proposed for the purpose of this study:

- Sanctions against groundwater users with groundwater use authorisations which over-abstract and are acting unlawful.
- Include groundwater resource management principles within groundwater use authorisations as part of the conditions.
- Introduce stringent penalties if the conditions of the groundwater use authorisation are not adhered to.
- Monitoring and recording of groundwater levels by the groundwater user.
- Monitoring and recording of the abstraction volume by the groundwater user.
- Monitoring and recording of the groundwater quality by the groundwater user.
- Perform aquifer pump testing at least at five-year intervals in order to ensure that the sustainable yield is still valid according to the previous aquifer pump testing. If the sustainable yield differs from the original sustainable yield, the new sustainable yield should be used for groundwater abstraction for irrigation purposes.
- Determine the likelihood of surface water–groundwater interaction in alluvial drainage channel aquifers.
- Determine whether recharge of groundwater resources within specific quaternary drainage regions are taking place in a relatively short period of time, or over long periods of time. This is very important for the issuing of groundwater use authorisations in identified “red areas”, or in other words, high priority water-scarce areas in South Africa.

3.4.4 Food security in South Africa

Although provision is made for food and water security in various legislation of South Africa, there is still a perception that crop production and agricultural water use is not always seen as an immediate priority. In the current political situation in South Africa the agricultural sector is perceived to be a threat due to the Apartheid regime of the past.

Often political issues regarding land reform is higher on the priority list. The researcher agrees that provision should be made for land reform, but not at a cost of food and water security in South Africa. All citizens and non-citizens in rural communities, towns and cities will adversely

be affected on the long-term through malnutrition, hunger and increased poverty if land reform is not properly managed and poorly implemented.

Small-scale farming cannot produce enough food for millions of South Africans, but can, however, provide produce to local markets. Large-scale farming significantly contributes in the provision of produce to national markets, local markets and international markets.

Food security is defined as a situation where “all people at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, quoted in the CSIR report, 2010:55). Food security is based on food availability, access to food, use of food and stability (CSIR, 2010:55).

3.4.5 Water security in South Africa

Water security is defined as “the capacity of a population to safe-guard sustainable access to adequate quantities and acceptable quality of water for sustaining livelihoods, human wellbeing, and socio-economic development, for sustaining protection against water-borne pollution and water related disasters and preserving ecosystems in a climate of peace and political stability” (Lal, 2015:1530).

Table 3.3 indicates the key aspects of water security.

Table 3.3: Key aspects of water security

Key aspects	Explanation
Access	To safe and sufficient water to meet all basic human needs.
Protection	Of livelihoods, human rights, cultural and recreational.
Preservation and protection	Of ecosystems in water allocation and values management systems to maintain and enhance ecosystems goods and services.
Water supplies	For socio-economic development and activities.
Collection and treatment	Of contaminated water to protect human life and the environment, and recycle the water for safe reuse.
Collaborative approaches	At national and international levels for equitable and trans-boundary water resources.
Ability	To cope with risks and uncertainties of water-related hazards such as floods, droughts, and pollution.
Effective governance and accountability	With consideration of all stakeholders.

Source: Lal (2015:1530)

Water security exists when all people, at all times, have physical and economic access to sufficient, safe and clean water that meet all their basic human needs (Lal, 2015:1530).

According to Lal (2015:1530) the most important principles for water security are the following:

- *Water availability:* The availability of an adequate quantity of good quality water.
- *Water access:* Access by individuals and communities to sufficient water through legal, political, economic and social arrangements at local, regional, national and international levels.
- *Utilisation and retention:* Utilisation of water for domestic use, healthcare, food production and processing and recreational use.
- *Stability:* Ensuring that water is always available through sustainable use and good water governance and water management.

As a result of political issues and poor water governance and water management, groundwater and surface water security in South Africa is volatile and uncertain. Water security in the agricultural sector secure food security, thus without water security, the production of crops and meat in agriculture will be limited and not secured.

3.4.6 Economic value of water in the agricultural sector in South Africa

3.4.6.1 Farming regions

South Africa is divided into district farming regions. Intensive crop production is found in winter rainfall and high summer rainfall areas, cattle ranching in the Bushveld and sheep farming in the more arid regions (Goldblatt, 2011:2).

Climate–soil combinations leave only 12% of South Africa suitable for the production of rain-fed crop and South Africa has only 3% fertile lands. Most of the land surface, 69% thereof, is suitable for grazing and livestock farming is the largest agricultural sector in South Africa (Goldblatt, 2011:2).

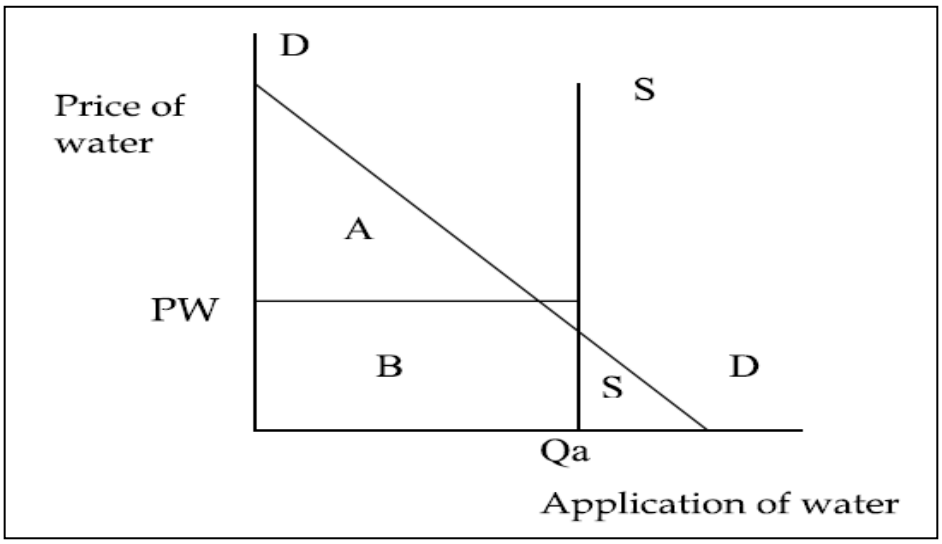
Agriculture is the foundation of developing economies. South Africa needs to ensure a healthy agricultural industry that contributes to the country's gross domestic product, food security, social welfare, job creation and ecotourism, while adding value to raw produce. Farming practices depend on sustainable farming methods, long-term productivity, profitable yields and the wellbeing of farmers and farm workers (Goldblatt, 2011:1).

3.4.6.2 Water economics

Water has two main economic principles; the consumption principle and the factor of production in agriculture. The demand for irrigation water is a derived input demand and irrigation water is a factor of production.

An input demand is derived from the demand of the product, profitability of crops, the production function as water plant efficiency and supply conditions of other factors of production such as water saving technologies (Nieuwoudt, Backeberg and Du Plessis, 2004:165). The total income generated by the application of water can be measured by the integral area under the input demand function of water. The value of an additional unit of water is expressed by the value of the marginal product (Nieuwoudt et al., 2004:166).

Figure 3.2 indicates the concepts where DD is the demand for water, Qa the availability of water, supply is SS, A+B is the total value of water and B = Rent or Residual.



Source: Nieuwoudt et al. (2004:166)

Figure 3.2: Resource demand for water

No cost is shown for water. If costs were available, it will be deducted from value. The total per unit value is (A+B)/Q which is an average concept, while the rent or residual value per unit is B/Q = Pw. Pw is the price of water.

In a functioning water market, the price of water rights is captured by Pw. These rights can be expressed as rental income such as annual income or a capitalised value of an asset. In a water market the price of water rights represents the contribution of water after all costs have been deducted, including water charges.

The total value (Area A+B) and marginal value (B) provide different information to stakeholders. In a cost/benefit analysis the area A+B is compared to the cost of providing water such as dams to ascertain whether benefits exceed costs.

The marginal value is critical in utilising the resource in an efficient manner. Reallocation of use will promote societies' income if water has a greater efficiency use in one area than in another (Nieuwoudt et al, 2004:166).

Whether the total contribution or the marginal contribution is estimated in a study depends on the technique used. In a crop budget, total cost is deducted from total income, yielding the total and average contribution of water (Area A+B).

Programming techniques provide information on the value of the marginal product of water given by the shadow price of the water which is the marginal value (B/Q). The latter technique can also be used to derive the total and average value of water (Nieuwoudt, 2004:166).

Production functions provide information on the value of the marginal product of water, although average value can also be derived. The willingness to pay approach estimates average consumer surplus, which is an approximation of market values and estimates marginal value B/Q. If water is rented, the trading price is B/Q or if it is sold, the selling price is the capitalised value of B or B/Q, if expressed as cubic metre (m^3) (Nieuwoudt et al., 2004:166).

The input/output analysis estimates that one cubic metre of water increases the value of output by R1.50 in agriculture (Nieuwoudt and Backeberg, 2011:704). The value of output may give preference to groundwater allocation during an increase in water scarcity.

3.4.7 Groundwater use authorisations in the agricultural sector

Various water use authorisations for groundwater are recognised and issued in South Africa under the National Water Act (NWA) (RSA, 1998) with emphasis on groundwater:

- *Existing lawful water use*
  Existing lawful water use for groundwater is identified if groundwater abstraction took place after 1 October 1996 and before 1 October 1998. Currently, the applications are handled as late registrations. When compulsory licensing is going to be implemented, the late registrations will be converted to groundwater use licenses, of which the volume will be confirmed during a verification and validation process.

- *General authorisation*
  Groundwater abstractions authorised under general authorisations are limited and are mainly for domestic watering, stock watering, non-commercial irrigation purposes and small scale exploration purposes. On limited occasions commercial irrigation is authorised under general authorisations, depending on the extent of the farm. This is mainly applicable to very large farms. General authorisation volumes may, however, change as the general authorisations are currently under revision.

- *Groundwater use licensing*
  - Groundwater abstractions exceeding the general authorisation limits, as determined on quaternary drainage regions, form part of groundwater use licenses. This includes, in certain circumstances, non-commercial irrigation where the general authorisation is too limited as a result of the extent of the property such as various smallholdings.
  - Groundwater abstractions for bulk water supply, mine dewatering and irrigation schemes are part of groundwater use licensing. A distinguishing is made distinguished between single water use license applications and integrated water use license applications. In order for the DWS to determine the level of geohydrological assessment required for every groundwater license application, various requirements according to the three-level index system for assessments exist. They are categorised according to A, B and C requirements. However, many DWS regional office personnel do not make use of the index system, as they are not aware that the system exists.
  - The index system can be a very expensive exercise, especially in the small-scale abstraction agricultural sector where a license may be required.
  - An Excel^{TM} spread sheet assessment methodology is also used in conjunction with information acquired from the water resource management system (WARMS) database to establish the total water allocation in a quaternary drainage region.
  - The harvest potential (HP), groundwater exploitation potential (GEP), groundwater reserve assessment (GRA) and information from the reserve determination are also used for decision-making, including all technical reports and available data. License conditions are incorporated into approved groundwater use licenses.
  - The WULATS was developed for tracking of license applications.

- *Controlled activities*

  According to Section 37 of the NWA, the irrigation of any land with waste or water containing waste generated by a waterworks or any industry, activities that can modify the atmospheric precipitation, a power generation activity that alters the flow regime of a water resource, recharging an aquifer with waste or water containing waste and activities as declared under Section 38 of the NWA, are handled as controlled activities. Other examples of controlled activities are artificial recharge and hydro fracturing.

3.4.8 Potential problems arising if groundwater use is not authorised in the agricultural sector

The Organisation for Economic Co-operation and Development (OECD, 2001:5) perceives a farm or smallholding function as an economic unit when it:

- Engages in agricultural production activities;
- Engages in non-agricultural activities such as small industrial activities;
- Aims to value the final production of all agricultural products; and
- Provides agricultural services.

If a groundwater use authorisation application is not authorised, a farm or smallholding may become a non-economic unit depending on the area of farming. If the farm or smallholding is, for example, in an area where rainfall is extremely low and groundwater is the sole reliant resource, it is inevitable that it will become a non-economic unit. In most cases the farmer will then continue with groundwater abstraction in order to make a living, thus resulting in unlawful groundwater use. This is especially seen at smallholdings.

It is not always possible to authorise an application if there is not sufficient groundwater available and if the resource is under stress. However, the DWS may consider providing small equal amounts of groundwater in such areas, without damaging the groundwater resource. This may lead to a decrease of unlawful groundwater use in those areas.

3.5 Conclusion

It is concluded that the agricultural sector makes use of the highest percentage of groundwater, followed by urban industrial use, bulk water supply schemes, commercial use, mining, non-urban industrial use, Schedule 1 use and power generation.

Agricultural activities may produce a wide range of impacts on soils, surface water and ground-water. Point and non-point sources of pollution were defined and elaborated on.

The most important groundwater resource management problem occurring in the agricultural sector is an increasing demand for crop irrigation which may lead to an over-abstraction of groundwater resources especially during dry periods. Food security and water security was defined.

Water has two main economic principles; the consumption principle and the factor of production in agriculture. Various water use authorisations for groundwater are recognised and issued in South Africa under the National Water Act (NWA) (RSA, 1998), with emphasis on groundwater. The main problem that arises if a groundwater use authorisation application is not authorised was identified.

The following chapter will provide a comparison of and evaluation on the NWA with international water laws.

Chapter 4

Comparison and Evaluation of the National Water Act (Act 36 of 1998) with International Water Laws

4.1 Introduction

Before a comparison and evaluation of the National Water Act (NWA) (RSA, 1998) with international water laws can be performed, the process of developing an act and policy before the promulgation should be mentioned and illustrated. The main aim is to give an understanding of the process and to emphasise that the development of an act is complicated and requires not only knowledge regarding the particular field of legislation, but also dedication and input from various stakeholders, specialists and the general public.

The comparison and evaluation of various water laws will significantly contribute to an understanding of the NWA, water laws of Africa and international water laws.

Chapter 4 will focus on the following:

- Process of law and policy development.
- Identification of comparison criteria.
- Comparison and evaluation of the NWA with international water laws.
- Gain an understanding of the advantages, disadvantages and implementation of the compared water laws.
- Groundwater legislation framework for effective groundwater governance.

4.2 Process of Law and Policy Development

The development of policies and laws is a time-consuming process and involves a number of phases during which key issues are identified, debated, considered and negotiated before finalised as a policy, or promulgated as law.

A law is defined as a legal document that constitutes of standards, principles and procedures that must be adhered too. Non-adherence can lead to fines, prosecution and even jail sentencing (Education and Training Unit [ETU], online).

A policy constitutes of objectives and aims which the national government would like to achieve. In order to ensure that the objectives and aims are achieved, methodology is included into a policy. A policy document is not law, but will identify new laws in order for the national government to achieve the set objectives and aims. Laws are guided by government policies (Education and Training Unit [ETU], online).

4.3 Identification of Comparison Criteria

By reading through all of the considered water laws, common criteria were identified. This was done in order to perform a comparison and evaluation of twenty-two water laws. The following criteria for comparison and evaluation were identified:

- Clear and understandable purpose of each act.
- Main focus areas of each act.
- Is food and water security a priority of each act?
- Is provision made in each act separately for groundwater and surface water resources?
- Is provision made in each act for water use authorisation applications?
- Responsible authority for processing water use applications.
- Is an approval system in place for water use authorisation applications?

4.4 Comparison and Evaluation of the National Water Act with International Water Laws

The comparison and evaluation of the NWA with international water laws will assist with the determination whether or not the NWA needs to be updated and improved. The main focus point of the comparison and evaluation will especially be groundwater resources. It is important to note that acts and regulations of various counties may have changed after the comparison and evaluation of the NWA with water laws of Africa and international water laws.

Table *4.1* compares and evaluates the NWA with twenty-one international water laws.

The international water laws were selected for comparison and evaluation on the basis of availability of international water laws as well as language which is also a contributing matter. As South Africa is an African country, the main focus was on the water laws of African countries.

Table 4.1: Comparison and evaluation of the NWA with international water laws

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
Angola	Water Act (Law 6/02 of 2002) *Pages 1 to 38*	Yes	*General* principles of legal system to the use of water resources, extent of application, ownership of water, general principles of water resources management, inventory of resources, coordination and institutional organisation, water conservation and violations. *It* gives the right to ensure environmental protection and conservation of areas of partial protection. *It* provides a list of water management principles, particularly the harmonisation of the water management policy with land use planning for the development of general plans for the development and use of water resources in basins (Water Act, 2002:1).	Yes	Yes	Yes	Yes	The Ministry of Water Affairs	Yes
Australia	Water Act (Act 137 of 2007) *Pages 1 to 553* It is important to note that Australia has various water laws. Most provinces have their own water laws.	Yes	*To* enable the Commonwealth with Basin States to manage basin water resources for national interest. *To* give effect to relevant international agreements to the extent to which agreements are relevant to use and management of basin water resources, and to provide for special measures in accordance with those agreements, to address the threats to the basin water resources. In giving effect to agreements, to promote use and management of basin water resources that optimises economic, social and environmental outcomes, and ensure the return to environmentally sustainable levels of abstraction for water resources that are over allocated or overused. *To* protect, restore and provide for ecological values and ecosystem services of the Murray-Darling Basin by taking into account the impact that the taking of water has on watercourses, lakes, wetlands, groundwater and water-dependent ecosystems that are part of basin water	Yes	Yes, all efforts are made to improve water security for all uses of basin water resources.	Yes	Yes	Licensing authorities	Yes

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			resources and on associated biodiversity. *To* maximise net economic returns to the Australian community from the use and management of the basin water resources and to ensure that management of basin water resources takes into account the broader management of natural resources in the Murray-Darling Basin. To achieve efficient and cost effective water management and administrative practices to basin water resources. *To* provide for collection, collation, analysis and dissemination of information regarding Australia's water resources and the use and management of water in Australia (Water Act, 2007:1).						
Botswana	Water Act (Act 40 of 1967) *Pages 1 to 16*	Yes	*Department* of Water Affairs and the Water Utilities Corporation are responsible for managing water supply systems. The Ministry of Agriculture constructs small dams in farming areas used for livestock and assists user groups. In the rural areas, the district councils under the Ministry of Local Government, Lands and Housing, oversee the water supply to rural villages. *Farmers* contribute 15% to dam construction costs. The ministry gives grants to syndicates to finance a portion of the costs of sinking boreholes for livestock watering. *User groups* operate and maintain boreholes, but don't pay for the water. *Small scale irrigation schemes* are promoted together with the utilisation of treated effluent for irrigated crop production. *The* main objective is to estimate water demand and availability as well as the development potential of the water resources.	Yes	Yes	Yes	Yes	Water Apportionment Board	Yes

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			Related legislation comprises of the Water Act, the Water Utilities Corporation Act, the Aquatic Weeds (Control) Act and Orders, the Boreholes Act, the Waterworks Act, the Town Councils (Public Sewers) Regulations and the Mines and Minerals Act (Matlock, 2012a: online).						
Canada	Canada Water Act, 1985 *Pages 1 to 16*	Yes	*Provides* for the management of water resources, including research, planning and implementation of programmes relating to conservation, development and utilisation of water resources. *Water* demand increases rapidly and more knowledge is needed of nature, the extent and distribution of those resources, of the present and future demands and of the means by which those demands may be met. *Pollution* of the water resources is significant and is a threat to the health, well-being and prosperity of the people and to the quality of the environment. As a result, it is a matter of urgent national concern to take measures for water quality management and comprehensive programmes by the Government of Canada in cooperation with provincial governments. *To* provide for research and planning with respect to those resources and for their conservation, development and utilisation to ensure optimum water use (Canada Water Act, 1985:1).	Yes	Yes	Yes	Yes	Provincial Government	Yes
Democratic Republic of the Congo (DRC)	No formal water law	None	*Under customary law and land rights, the use-rights to surface water and groundwater are included. A* water code was developed in 2010 with guiding principles for the development of a suite of policy instruments to plan and manage the efficient use of water resources. *These* include a national water policy that takes into	None	None	None	None	*None*	None

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			account the objectives of all subsectors, national and provincial water action plans prioritising interventions and implementation modalities as well as drainage basin and area based development plans. *The* code mandates the elaboration of a broad water resources management, most notably a national public water services strategy that would *inter alia* define the sector's decentralised institutional framework. *The* constitution of the DRC indicates that the state owns all of the country's natural resources, including water. The government has been working on a comprehensive water law for several years as the DRC does not have a formal water law. *Responsibility* for water resources and water management is fragmented among different ministries, coordinated by the national action committee on water and sanitation. *The* primary ministries exercising authority over water resources are the Ministry of Energy, Ministry of Agriculture, Ministry of Rural Development and Ministry of the Environment, Nature Conservation and Tourism (Partow, 2011:21).						

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Germany	Amended version of Federal Water Act, 2002 *Pages 1 to 59*	Yes	*Provisions* are made for the water management of permanently or temporarily confined flowing or standing water, and unconfined water from natural springs and surface water; the sea between the coastline at mean high water or the seaward limits of the surface water and the seaward limits of the coastal sea; and water which is below the surface of the ground in the saturation zone and in direct contact with the ground or groundwater. The provisions of this act also apply to all parts of water (Federal Water Act, 2002:1).	Yes	Yes	Yes	Yes	Authorisa-tion Agency	Yes
Ghana	Water Resources Commission Act, 1996 (Act 522) *Pages VII-4001 to VII-4012*	Yes	*The* act makes provision for the establishment of a water resource commission, to provide for composition and functions on the regulation and management of the utilisation of water resources in Ghana and for related matters. *Ministries* dealing with water and irrigation include the Ministry of Food and Agriculture, the Ministry of Works and Housing and the Ministry of Environment, Science and Technology. *Institutions* involved in water management within the Ministry of Works and Housing are the Water Resources Commission which is the leading institution involved in water resource management in the country. *The* Ghana Water Company Limited is responsible for water sources that it abstracts for treatment and subsequent distribution to consumers. In some cases, it builds dams on which water supply schemes of large cities are based. It has the mandate to manage such water sources, including the relevant catchment areas for the benefit of the Ghanaian public. The Community Water and Sanitation Agency which is responsible for water supply to	Yes	Yes	Yes	Yes	District Assembly	Yes

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			rural communities and small towns, deals with household sanitation and hygiene promotion and has offices all over Ghana. *Within* the Ministry of Environment, Science and Technology, the following institutions are involved in water management: the Environmental Protection Agency by virtue of its mandate and functions is one of the institutions that is involved in some aspects of water resources management. It maintains and enforces standards for wastewater discharge into water bodies. It also ensures, through the concept of Environmental Impact Assessments that the negative impact of development projects are reduced through the monitoring of the companies' mitigation plans. The Water Research Institute, Aquatic Biology and the Water Resources Research Institute, all part of the Council for Scientific and Industrial Research, has a mandate to perform research on water and related resources (Kundell, 2008a: online). The draft water policy identifies the availability and ease of access to water in sufficient quantities for cultivation of food crops, watering of livestock and sustainable freshwater fisheries as a major precondition for the achievement of food security and self-sufficiency in food production. This is done in order to meet the nutritional needs of the population (Kundell, 2008a: online).						
Lesotho	Water Resources Act (Act 22 of 1978) *Pages 264 to 272*	Yes	*Provision* is made for the use, control and conservation of water resources. The Irrigation Section in the Engineering Division of the Crops Department of the Ministry of Agriculture and Food Security is involved in the investigation of new irrigation technologies that can be applied in Lesotho. *The* Engineering Division of the Crops Department of	Yes	Yes	Yes	Yes	Water Administra-tion	Yes

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			Ministry of Agriculture and Food Security provides planning, design and implementation support for, amongst many others, irrigation. *The* Agronomy and Horticulture Divisions of the Crops Department of Ministry of Agriculture and Food Security also have links to irrigation development. *The* Soil and Water Conservation Division of the Department of Conservation, Forestry and Land Use Planning of Ministry of Agriculture and Food Security are involved in irrigation development as far as dam planning, design and construction is concerned, and engage in small dam design and implementation (Water Resources Act, 1978:1). *The* Extension Division of the Department of Field Services of Ministry of Agriculture and Food Security is involved in irrigation through its decentralised District Agricultural Offices. *The* Agricultural Research Division of the Department of Field Services of Ministry of Agriculture and Food Security has an Irrigation Unit in its Engineering Section. One of its aims is to provide smallholder farmers with appropriate irrigation technologies and services to improve irrigation systems and productivity. The need for proper water resource management is one of the most important problems in Lesotho. *The* National Environmental Policy of Lesotho recognised the sustainable development of small-scale irrigation schemes, based on surface water resources via the construction of small dams and aversion of rivers. The main legislation in the water sector is the Water Resources Act of 1978 which provides for use, control and						

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			conservation of water resources. *Another* part of legislation dealing with water resources is the Lesotho Highlands Water Project Treaty between Lesotho and South Africa. The treaty provides for the protection of the quality and quantity of water in the Lesotho Highlands Water Project area, but does not consider other relevant components of the utilisation of shared water courses between the two countries (Kundell, 2008b: online).						
Malawi	Water Resources Act (Act 15 of 1969) as amended by Water Resources Act (Act 29 of 1970) *Pages 1 to 12*	Yes	*Makes* provision for the control, conservation, appointment and use of water resources. *Regulates* the allocation of rights to use public water and provides for the establishment of a Water Resources Board to administer the water rights and servitudes, and to inspect waterworks. *The* development of irrigated agriculture is supported by the Ministry of Agriculture and Irrigation, the Ministry of Water Development, the Department of Environmental Affairs, the Water Resources Board, the Department of National Parks and Wildlife, the Department of Forestry and training institutions. *The* Ministry of Water Development facilitates the development and management of water resources in Malawi as well as ensuring access to safe water and related sanitation services, the provision of safe drinking water to rural communities and the collection of hydrological data and catchment protection. *The* Water Resources Board is responsible for the granting of water rights for abstractions and discharge of effluents as well as for monitoring the adherence to the water rights. For the development of irrigation schemes, water rights for abstraction and discharge of wastewater drained from	Yes	Yes	No	Yes	Water Resources Board	Yes

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			irrigation schemes have to be granted by the Board. *The* Department of Environmental Affairs ensures that the implementation of projects does not result in the degradation of the environment. For all irrigation schemes of more than 10 ha environmental impact assessments are performed. The Department of National Parks and Wildlife and the Department of Forestry are responsible for the protection of catchment areas that fall within their jurisdiction. *Both* the Irrigation Act 2001 and the Water Resources Act 1969, provide for the formation of water user associations and/or irrigation management authorities to promote the local community or farmers' participation in the development and management of irrigation and drainage, and the proper utilisation of available water resources. Policy issues are addressed by the National Irrigation Policy and Development Strategy developed by the Department of Irrigation, the Water Policy of 1996, the Water Resources Management Policy and Strategy of 2000 developed by the Ministry of Water Development and the Environmental Management Policy of 1996 (Kundell, 2008c: online).						
Mauritius	Groundwater Act, 1970 *Pages 1 to 4*	Yes	*Provisions* are made for the management of aquifers. *The* Central Water Authority under the Ministry of Public Utilities is responsible for the control, development and conservation of water resources as well as distribution of water to the industrial and domestic use. *The* Water Resources Unit under the Ministry of Public Utilities is responsible for the coordination of all activities concerning water resources management, water rights, licensing and control of water user permits.	Yes	Yes	Yes	Yes	Water Resources Unit under the Ministry of Public Utilities	Yes

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			The Irrigation Authority studies the development of irrigation and prepares irrigation schemes for specific areas, in order to implement and manage irrigation projects and undertake research on optimum water use. *Water* allocation for all sectors is determined by a High Powered Committee comprising of all stakeholders in the water sector. Water requirements are computed every month for planning water releases from the reservoirs. Groundwater levels are monitored by the Water Resources Unit**.** The Water Resources Unit also imposes restrictions during dry months to avoid over-abstraction. *Farmers* in the public irrigation schemes group themselves into Water User Associations or Water User Cooperative Societies under the Registrar of Association Act or the Cooperative Act, respectively. The Irrigation Authority has a Transfer Management Agreement with the Water User Associations or Water User Cooperative Societies where day-to-day operations is entrusted to the association or society. Farmers are at present billed annually on the basis of the cropped area. For the future it is envisaged to levy large planters on the basis of volume of water abstracted. *Water* supply for irrigation is regulated by the River and Canal Act of 1863, the Groundwater Act of 1970 and the Irrigation Authority Act of 1979. Abstraction of water from rivers requires a water right duly granted by the Supreme Court. The Water Resources Unit recommends water rights for applicants. Groundwater abstraction and drilling of a borehole requires authorisation from the Water Resources Unit. The volume of water allowed to be abstracted over a specific period forms part of a groundwater license (Kundell, 2007a: online).						

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Mozambique	Water Law, 1991 *Pages 1 to 29*	Yes	*The* National Directorate for Agricultural Hydraulics within the Ministry of Agriculture and Rural Development coordinates activities relating to irrigation and drainage, and performs studies, executes agricultural hydraulics projects and supports smallholder irrigation development. The Fund for Agricultural Hydraulics Development is responsible for promoting, fostering and funding the hydro-agricultural works or other activities related to irrigated agricultural development. The National Water Directorate within the Ministry of Public Works and Housing is responsible for policy-making and implementation, overall planning and management of the country's water resources as well as the provision of water supply and sanitation services (Water Law, 1991:1). *At* national level, water management is the responsibility of the National Water Directorate, while at regional level it is the responsibility of the five Regional Water Administrations. The Regional Water Administrators control irrigation systems and collect water fees (Kundell, 2007b: online). By law, the Ministry of Public Works and Housing is responsible for water management. Guiding principles are the following: Water resources, although renewable, are not inexhaustible and it is therefore necessary to manage, control and preserve the resources. Water is an economic resource which deserves an appropriate economic and social value. Water and irrigated land are public assets whose use depend on a license; and the hydrographic basin is a geographical water management unit for hydro-agricultural purposes which have to abide by ordinations established in the basin usage plans (Kundell, 2007b: online). *Government* ensures integrated water management in agriculture and rural development; promotes irrigated	Yes	Yes	Yes	Private use is given by concession or through law. Common use is free and exempted from licence or con-cession. Regulation for licensing water rights for private use is not yet approved. Priority of common use over the private use of water.	None	No

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			agriculture and the respective research, adaptation and adequacy of appropriate technologies, empowers the development of irrigation systems for the family sector so as to transform agricultural production to one that is gradually integrated in the market; promotes and fosters the entrepreneurial sector in irrigated agriculture, including small, medium and large enterprises; activates the development of the irrigation potential in Mozambique through the promotion of new irrigation systems, of medium and large scale; establishes technical and financial mechanisms to prevent and mitigate the occurrences and the impact of cyclic droughts; promotes decentralisation and participation of the beneficiaries, communities and the local authorities in the integrated water resources management and operation of infrastructures; and acknowledges the role of women in agriculture, creating a stimulus for their economic and social affirmation through their participation as beneficiaries of irrigated agriculture (Kundell, 2007b: online).						
Namibia	Water Resources Management Act, 2004 (No. 24 of 2004) *Pages 1 to 67*	Yes	*Equitable* access to water resources by every citizen, in support of a healthy and productive lifestyle. Access by every citizen, within a reasonable distance from their place of abode, to a quantity of water sufficient to maintain life, health and productive activities. *Essentiality* of water in life and safe drinking water as a basic human right. Harmonisation of human needs with environmental ecosystems and the species that depend upon them, while recognising that those ecosystems must be protected to the maximum extent. *Integrated* planning and management of surface and groundwater resources in ways which incorporate the planning process, economic, environmental and social	Yes	Yes	Yes	Yes	Basin Manage-ment Committee	Yes

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			dimensions. *Openness* and transparency by making water resources information accessible to the public. Management of water resources so as to promote sustainable development. *Recognition* of the economic value of water resources and of the need for their development to be cost-effective. Furthering a process of human resources development and building of competency in water resources decision-making. Facilitating and encouraging awareness programmes and participation of interested persons in decision-making. Consistency of water resources decisions with firm and specific mandates from government that separate policy-making from operational and regulatory roles. *Prevention* of water pollution, and the polluter's duty of care and liability to make good. Meeting Namibia's international obligations and promoting respect for the country's rights with regard to internationally shared water resources. In particular, to the abstraction of water for beneficial use and the discharge of polluting effluents and regional diversity and decentralisation to the lowest possible level of government consistent with available capacity at such level. *Ownership* of surface water and groundwater resources belongs to the State. The State ensures water resource management and use to the benefit of all people. The Department of Water Affairs within the Ministry of Agriculture, Water and Rural Development is responsible for water resource development projects, including irrigation planning and development. The National Development Corporation executes new government developments and manages schemes.						

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			The Water Resources Management Act, 2004 (No. 24 of 2004) makes provision for the management, development, protection, conservation and use of water resources; establishment of Water Advisory Council, the Water Regulatory Board and the Water Tribunal, and to provide for incidental matters.						
Nigeria	Nigeria Water Resources Decree (Decree 101 of 1993) *Pages 1 to 10*	Yes	*Provision* is made for the right to use and manage all surface and groundwater for the purpose of developing the country's water resources and coordinating their distribution, use and protection. The federal government has authority over water shared by more than one state; otherwise, each state has authority to regulate the water resources within its boundaries. The federal government also has control of the country's dams. The act permits people access to water for domestic use from public access sources. Those with statutory or customary rights to land can use water from any groundwater source or water course for domestic use, watering livestock, or personal irrigation systems. State-level water legislation and local water boards govern water use. *Water* is considered a national asset and resource common to all, the use of which shall be subject to national control. The water resources are managed to achieve optimum, long-term, environmentally sustainable social and economic benefits for society. Provision is made for water use rights. *Planning* and management of Nigeria's water resources take place within a framework that facilitates awareness and participation among all users at all levels. Water resources are assessed, developed, apportioned and managed in such a manner as to enable all users to have equitable access. Operational management of water	Yes	Yes	Yes	Yes	Administra-tive Decree	Yes

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			resources and services are decentralised to the lowest practicable level in accordance with the established eight hydrological areas as the basic units of water resources management in Nigeria. Fees are charged for commercial extraction of water. To date, these principles have not been supported by federal legislation. *National* guidelines for regulating water supplies were prepared and states of Nigeria are encouraged to adopt the contents as state law. Only Lagos has done so. Tenure issues in urban and peri-urban areas. Water charges are based on the volume of water consumed, or on a flat rate, and the rates are subsidised. In most rural areas water is supplied to the population free of charge. Water scarcity is common in towns and cities. *Under* customary law, a grant of land confers rights to all products of the land, including water resources. People can take water for domestic use from lakes, rivers, wells and boreholes. There are no restrictions on rights to use large bodies of water. Use of small bodies of water often requires permission of the clan or household occupying the land with the water resource. Anyone improving a spring or other water source earns rights to that water source. Water-related disputes tend to be resolved by traditional dispute-resolution procedures, such as the use of customary leaders and tribunals, mediation, arbitration and adjudication (Nigeria Water Resources Decree, 1999:1).						
South Africa	National Water Act (Act 36 of 1998) *Pages 1 to 91*	Yes	*Provision* is made for fundamental reform of the law relating to water resources, to repeal certain laws and to provide for matters connected therewith. Provision is made for basic human needs and equitable access to water. It redresses results of past racial and gender discrimination; efficient, sustainable and beneficial use of water in the	Yes	Yes	Yes	Yes	Yes	Yes, but unstructured and small groundwater use can proceed

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			public interest; facilitates social and economic development; provides for the growing demand for water use; protects aquatic and associated ecosystems and their biological diversity; reduces and prevents pollution and degradation of water resources; meets international obligations; promotes dam safety; manages floods and droughts; and establishes suitable institutions ensuring appropriate community, racial and gender representation (NWA, 1998:1). *The* NWA recognises the following: Water in different forms is scarce and unevenly distributed as a national resource; Water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water and use of water resources; the national government's overall responsibility for and authority over the South African water resources and their use, including the equitable allocation of water for beneficial use, the redistribution of water and international water matters; the aim of water resource management is to achieve sustainable use of water for the benefit of all users; the protection of the quality of water resources is necessary to ensure sustainability of the country's water resources in the interest of all water users; the need for the integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to a regional or catchment level so as to enable everyone to participate. *The* NWA does not directly distinguish, nor differentiate, between surface water and groundwater resources. However, Section 1(1) (ii) defines the term "borehole"; Section 1(1) (xxvii) defines water resource that includes a watercourse, surface water, estuary or aquifer; Section 24 deals with licences for use of water found underground on						without authorisation

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			property of another person; and Section 139(2) (c) deals with the establishment of a groundwater management system.						
Sweden	Water Law (Law 1983:291) *Pages 1 to 128*	Yes	*Provision* for the protection and preservation of water as a common natural resource is made and is applicable to water projects and waterworks. This law has also provisions on the protection of water-supply; regulation of management and conservation of water resources; for rights relating to use of water, irrigation, drainage, water supply; and resolution of disputes to water (Water Law, 1983:1).	Yes	Yes	Yes	Yes	Irrigation Association	Yes, but unstructured.
Swaziland	Water Act, 2003 (Act number 7 of 2003) *Pages 1 to 36*	Yes	*The* act makes provision for the establishment of the National Water Authority; water resources master plan; by-laws; water permits; borehole drilling permit; pollution control; and miscellaneous. The Ministry of Natural Resources and Energy is responsible for the assessment, monitoring, management and allocation of water resources in Swaziland (Water Act, 2003:1). *The* Groundwater Unit of the Geological Surveys and Mines Branch is responsible for drilling boreholes and monitoring the withdrawal of underground water. The Swaziland Water Service Corporation is responsible for urban and peri-urban water supply and sanitation. *The* Swaziland Environment Authority is responsible for pollution control and allocation of compliance certificates after proponents of development projects have submitted environmental impact assessment reports and comprehensive mitigation plans. The Ministry of Agriculture and Cooperatives constructs small earth dams and assists farmers with the utilisation of water resources. *Swaziland* does not have a clear policy on water use and	Yes	Yes	Yes	Yes	Swaziland Environmental Board	Yes

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			management. The overall management of water resources is on an ad hoc basis through several legislations, among a number of ministries as well as other institutions outside the government that are aimed at solving specific issues without due consideration of harmonisation. *At* present, land owners with title deeds on riparian lands are entitled, by virtue of the deed, to abstract water from the stream flowing alongside or within their properties as well as underground water. The Water Act of 1967 is the main legislation that regulates the apportioning and use of water, but it only applies to title deed land and thus excludes all communal land, which constitutes 54% of total land in Swaziland. *The* Swaziland Administration Order of 1998 empowers the Ngwenyama (King in Council) to issue orders to be followed in Swazi Nation Land, and can be used as a tool for managing water resources in communal land. Among other things, these orders require the prevention of any pollution of the water in, or injury to, any dam, stream, watercourse, waterhole, well, borehole, or other water supplies and to prevent the obstruction of any stream (Zaikowski, 2008: online).						
Tanzania	Water Utilisation (Control and Regulation Act 1974) *Pages 1 to 18*	Yes	*The* act makes provision for water rights; ownership of and inherent rights to the use of water; granting of water rights; and revision, determination and diminution of water rights. *The* Irrigation Section within the Ministry of Agriculture and Food Security is responsible for irrigation development. The Water Division within the Ministry of Water and Livestock Development is responsible for the design, construction, equipment, maintenance and operation of laboratories, water planning, water supply, water research,	Yes	Yes	Yes	Yes	Central Water Board	Yes, although unstructured.

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
			sewerage and sanitation. *The* Central Water Board within the Ministry of Water and Livestock Development is the principal advisory body to the government on matters pertaining to the utilisation of water nationally, and to the allocation of water rights. It is given executive power over pollution control. *The* responsibility for managing the water resources of the country lies with the Ministry of Water and Livestock Development. Water resource management involves water resource development, water allocation, pollution control and environmental protection. Water resources are managed on the basis of river basins. *It* is stipulated that all water in mainland Tanzania is vested in the United Republic of Tanzania and the Minister responsible for water development is empowered to regulate the use of water from any source in any area of the country on a national basis, to declare such a source to be a national water supply for the purpose of the act. *In* July 2002, the Government issued the National Water Policy with objectives to establish a comprehensive framework for sustainable development and management of water resources and for participatory agreements on the allocation of water use. The Government will not be in charge of executive functions such as the actual delivery of the services as it is the responsibility of local government authorities. Central statements of the policy are that "water will be subject to social, economic and environmental criteria" and that "every water use permit shall be issued for a specific duration" (Matlock, 2008: online).						

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
Uganda	The Water Statute (Statutes Supplement 7 of 1995) *Pages 1 to 80*	Yes	*The* two major policies of the Government of Uganda impacting on water are the National Water Policy (1999) and the Plan for Modernisation of Agriculture (2000). The National Policy for the Conservation and Management of the Wetlands (1995) gives a basis for the planning and development of rice irrigation. The Constitution of Uganda 1995 vests in the State and the State has the duty to protect important natural resources, including water, and to take all practical measures to promote a good water management system (Water Statute, 1995:1). *The* act provides for the use, protection and management of water resources and supply, and for the constitution of water and sewerage authorities. The National Environment Statute 4/1995 provides for the sustainable management of the environment and it establishes the National Environment Management Authority (Matlock, 2009: online). *The* provision and maintenance of water supplies are vested in the district councils in liaison with the ministry responsible for natural resources. The Water Resources Regulations 9/1997 provide for the procedure through which one can obtain a water permit (Matlock, 2009: online).	Yes	Yes	Yes	Yes	Government Statute	Yes, although approval system are not fixed. Is changed by Water Policy Committee, Water Authorities, and Director and Minister.
United Kingdom	United Kingdom Water Act, 2003 *Pages 1 to 237*	Yes	*Provisions* are made for the abstraction and impounding of water; applications for licences; modification of licenses; claims and compensation; water resources management schemes; miscellaneous; supplementary; regulations, orders and schedules. *Provisions* are also made for the establishment and functions of the Water Services Regulation Authority and	Yes	Yes	Yes	Yes	Environment agency	Yes

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
			the Consumer Council for Water, and for the abolition of the office of the Director General of Water Services; land drainage and flood defence; contaminated land so far as it relates to the pollution of controlled waters; to confer on the Coal Authority functions in relation to the discharge of water from coal mines; and for water licences (United Kingdom Water Act, 2003:1).						
United States of America (USA)	Differs from state to state	Mostly not so clear	*Water* law in the USA differs from state to state. *Public* waters, including watercourses, have traditionally included tidal waters and navigable waterways. *Other* surface water that flows across non-public land from rain, floodwaters and snowmelt, before those waters reach public watercourses. *Groundwater*, sometimes called subterranean, percolating, or underground water. *Public* regulation of water, including flood control, environmental regulation: state and federal, public health regulation and regulation of fisheries. *Related* to all of the above-mentioned is interplay of public and private rights in water which draws on aspects of eminent domain law and the federal commerce clause powers. Water project law: the highly developed law regarding the formation, operation and finance of public and quasi-public entities which operate local public works of flood control, navigation control, irrigation and avoidance of environmental degradation. *Treaty* rights of native Americans governing these topics originates from all layers of law. Some derives from common law principles which have developed over centuries, and which evolve as the nature of disputes	Unclear	Yes	Yes	Yes, only in some cases, but can substantially differ	Unclear	Yes and no, but can substantially differ

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
			presented to courts change. For example, the judicial approach to landowner rights to divert surface waters has changed significantly in the last century as public attitudes about land and water have evolved; Some derives from state statutory law. Some derives from the original public grants of land to the States and from the documents of their origination. Some derives from state, federal and local regulation of waters through zoning, public health and other regulation.						
Zambia	Zambian Water Act (Act 13 of 1994) *Pages 1 to 17*	Yes	*Water* rights are recognised through common law of property rights system (Zambian Water Act, 1994:1). *The* Technical Services Branch of the Department of Field Services of the Ministry of Agriculture and Cooperatives is the main institution mandated to plan and develop all aspects related to irrigation and water management. The Ministry of Energy and Water Development houses the Department of Water Affairs and the Water Development Board of Zambia, both of which are mandated to deal with water resources development and management. The Water Development Board of Zambia allocates water rights, even though no water charges have been levied on any irrigation abstractions. All land allocations for any development purposes, including irrigation, are the responsibility of the Ministry of Lands (Matlock, 2012b: online). *Water* management is relatively poor due to the absence of water management regulations and the Water Board committee has no capacity to enforce existing water rights regulations and fees. The Water Policy of 1994 recognises water as an economic good by drafting a water tariff legislation to cover the provision and allocation of water	Yes	Yes	Yes	No. Water rights recognised through common law of property rights system	None	No

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
			resources for consumptive and non-consumptive use. For agriculture, the policy recognises water use for irrigation, livestock watering and aquaculture. Other uses include hydropower generation, water transport, water recreation and tourism, industrial and health. *Access* to land and water is open to all. Procedures for acquisition must be followed. In recognition of the importance of the irrigation sector and its needs for a suitable legal framework, the Government is in the process of revising the Water Act to accommodate the needs of the irrigation and other water-using sectors. Two land tenure systems, customary tenure and statutory tenure, exist according to the draft Land Policy of 2002. Customary land forms the bulk of Zambia's land (94%) and is under ruling of traditional chiefs and their headmen. Statutory land is under state control and comprises 6% of the total land. A first draft Irrigation Policy is available. The National Development Plan of 1989-1993 placed emphasis on the development, promotion of small-scale and large-scale irrigation programmes through developing dams, irrigation infrastructure, and economically sustainable irrigation systems for small-scale farmers. This expanded the electricity grid to cater for the irrigation areas, and prepared a National Water Resources Master Plan while expanding the area under irrigation (Matlock, 2012b: online).						
Zimbabwe	Zimbabwe Water Act (31/1998, 22/2001, 13/2002, 14/2002)	Yes	*Provisions* are made for the issuing of water permits; development of policies, and the utilisation and protection of water resources; ensure availability of water to all citizens for primary purposes and to meet the needs of aquatic and associated ecosystems; and to ensure equitable and efficient allocation of the available water	Yes	Yes	Yes	Yes	Zimbabwe National Water Authority	Yes

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
	Pages 1 to 65		resources. *The* Ministry of the Rural Resources and Water Development and the Ministry of Rural Resources and Infrastructural Development is the custodian of water rights. They develop policies on water development. The Department of Water Development develop national policies and standards for the planning, management and development of the nation's water resources. It acts as a policy and regulatory unit on water within the Ministry. The Zimbabwe National Authority plays an important role in the management of the water permit system and the operationalisation of water pricing (Ornes, 2012: online). *Specific* national policy objectives include growth in the irrigated area, particularly in the smallholder sector with minimal negative impacts on the environment and human health; equitable allocation and efficient use of scarce water resources; establishment of a water pricing structure which is consistent with cost and social efficiency; establishment of an effective institutional structure; and implementation of drought mitigating strategies (Ornes, 2012: online). *Recent* milestones in water- and land-related legislation are reforming the water sector to ensure a more equitable distribution of water and stakeholder involvement in the management of water resources; water can no longer be privately owned. The "priority date water right system" has been replaced by water permits of limited duration which will be allocated by Catchment Councils; water is now treated as an economic good and the "user pays principle" applies and pollution of water is now an offence and the "polluter pays" principle applies (Ornes, 2012: online).						

Country	Water law	Is the purpose of the act clear and under-standable?	Main areas of focus	Is food security a priority?	Is water security a priority?	Is provision made separately for groundwater and surface water?	Is provisions made for water use authorisation applications?	Responsible authority for processing water use applications	Is an approval system in place for water use authorisation applications?
			The Zimbabwe National Water Authority plans and manages water resources on a catchment basis and involves all stakeholders, management of the water permit system, operationalisation of water pricing, operating and maintaining existing infrastructure and the execution of development projects.						

4.4.1 Conclusions and discussion on the comparison and evaluation of the National Water Act with international water laws

The following criteria were used for comparison and evaluation:

- Clear and understandable purpose of each act.
- Main focus areas of each act.
- Is food and water security a priority of each act?
- Is provision made in each act separately for groundwater and surface water resources?
- Is provision made in each act for water use authorisation applications?
- Responsible authority for processing water use applications.
- Is an approval system in place for water use authorisation applications?

4.4.1.1 Clear and understandable purpose of each act

In twenty of the water laws, the purpose of each act is clear and understandable. However, the purpose of the acts of the USA is mostly unclear and the DRC has no formal water law.

4.4.1.2 Main focus areas of each act

In twenty of the water laws, the main focus areas of each act are clear and understandable. The purposes of each act consist of the need, aims and objectives of each country, respectively. The main focus areas of the USA remain mostly unclear and the DRC has no formal water law.

4.4.1.3 Is food and water security a priority of each act?

Provision is made for food and water security in twenty of the water laws. The food security for the USA remains unclear, although the water security is clear. The DRC has no formal water law and therefore food and water security do not reflect.

Although provision is made for food security and water security in the NWA of South Africa, political issues regarding land reform are often higher on the priority list. The researcher agrees that provision should be made for future land reform in South Africa, but not at the cost of food and water security.

The researcher foresee that if land reform is not properly managed and is poorly implemented, all citizens and non-citizens in rural communities, towns and cities will adversely be affected over the long-term through malnutrition, hunger and increased poverty.

4.4.1.4 Is provision made in each act separately for groundwater and surface water resources?

Nineteen of the water laws made separate provision for groundwater and surface water resources. For the DRC, Malawi and South Africa provision is not separately made for groundwater and surface water resources. Although provision is not made in the NWA of South Africa, provision is made in the general authorisations of South Africa.

4.4.1.5 Is provision made in each act for water use authorisation applications?

Seventeen of the water laws made provision for water use authorisation applications. The DRC has no formal water law. In Mozambique, private water use is given by concession or through law. Common use is free and exempted from licences or concession. The regulation for licensing water rights for private use is not yet approved. The priority is of common use over the private use of water. In Sweden, provision is made for water use authorisation applications, but it is unstructured and small groundwater use can proceed without authorisation. In the USA, provision is made for water use authorisation, but in most cases differs substantially. In Zambia, no provision is made for water use authorisations and water rights are recognised through the common rights systems.

4.4.1.6 Responsible authority for processing water use applications

- Angola: The Ministry of Water
- Australia: Licensing authorities
- Botswana: Water Apportionment Board
- Canada: Provincial Government
- DRC: No formal water law in place
- Germany: Authorisation Agency
- Ghana: District Assembly
- Lesotho: Water Administration
- Malawi: Water Resources Board
- Mauritius: Water Resources Unit under the Ministry of Public Utilities
- Mozambique: None
- Namibia: Basin Management Committee
- Nigeria: Administration Decree
- South Africa: Department of Water and Sanitation (DWS) with WUAAAC
- Sweden: Irrigation Association
- Swaziland: Swaziland Environmental Board
- Tanzania: Central Water Board

- Uganda: Government Statute
- United Kingdom: Environmental Agency
- USA: Unclear
- Zambia: None
- Zimbabwe: Zimbabwe National Water Authority

4.4.1.7 Is an approval system in place for water use authorisation applications?

Most counties have an approval system in place for water use authorisation applications. Although Sweden has an approval system in place, it is unstructured. Tanzania has an approval system in place, but it is also unstructured. Uganda has an approval system in place, but the approval system is not fixed. The approval system is continuously changed by the Water Policy Committee, Water Authorities, Director and Minister of Uganda. In the USA, the provision for an approval system differs substantially from state to state.

4.5 Advantages, Disadvantages and Implementation of the National Water Act

> *Twelve years after the passing of the NWA, and in particular following the development of the associated groundwater management guidelines for resource allocation, South Africa's government is still confronted by many obstacles to the achievement of the stated objectives of equity, efficiency and sustainability. Groundwater resources and associated goods and functions are still undervalued and are not being utilised to their full potential. Consequently, the question that needs to be asked is: Why are current groundwater legislation, regulations and guidelines neither being enforced nor soundly implemented on the ground? The motivations behind water legislation in general and groundwater regulations and guidelines in particular, are mostly difficult to take into account and implement on a regional level and they are overlooked or neglected by the responsible implementing agencies. This situation is often related to social and cultural constraints which are related to stakeholders' attitudes and traditional ways of thinking… as well as to uncoordinated and fragmented groundwater governance regimes.*
>
> *Legislation alone is rarely the only solution to complex groundwater challenges. Education, raising awareness, cooperation networks and stakeholder involvement are crucial factors in achieving successful, i.e. sustainable, resource regulation and management* (Knûppe, 2011:70).

South Africa's National Water Policy, and its supporting legislation, the NWA, are recognised internationally as being amongst the most progressive initiatives in the area of water resource management. The policy may provide a model for many countries in the world to shift and adapt to newer realities of managing scarce natural water resources, in an environment which is

uncertain and continually changing, influenced by processes such as climate change, as well as regional and localised processes (Pietersen, Beekman and Holland, 2011:15-16). The NWA provides a powerful set of regulatory tools for groundwater assessment, planning and management. The National Water Resource Strategy (RSA DWAF, 2004b) provides an implementation framework for the NWA, but is incomplete regarding groundwater governance provisions. The National Groundwater Strategy 2010 (RSA DWA, 2010) addresses these groundwater management related deficiencies in the National Water Resources Strategy of 2011.

4.6 Groundwater Legislation Framework for Effective Groundwater Governance

The researcher believes that a groundwater legislation framework is of utmost importance in groundwater governance. The basis is provided for development of policies and decision-making principles. The legal framework may significantly contribute to regulating access to groundwater resources, set criteria for groundwater allocation, protection of groundwater resources and the establishment of groundwater management tools and groundwater monitoring programmes.

4.7 Conclusion

The development of policies and laws is a time-consuming process and involves a number of phases during which key issues are identified, debated, considered and negotiated before being finalised as a policy or promulgated as law. Common criteria were identified in order to perform a comparison and evaluation of twenty-two water laws.

The comparison and evaluation of the NWA with international water laws will assist in the determination whether or not the NWA needs to be updated and improved. The main focus point of the comparison and evaluation will especially be on groundwater resources.

In twenty of the water laws, the purpose of each act is clear and understandable. The purpose of the acts of the USA is mostly unclear and the DRC has no formal water law. Twenty of the water laws make provision for food and water security. The food security of the USA remains unclear, although the water security is clear. The DRC has no formal water law and food and water security therefore do not reflect. Although provision is made for food and water security in the NWA of South Africa, political issues regarding land reform are often higher on the priority list. The researcher agrees that provision should be made in future for land reform in South Africa, but not at the cost of food and water security.

Nineteen of the water laws made separate provision for groundwater and surface water resources. In the DRC, Malawi, and South Africa provision is not separately made for

groundwater and surface water resources. Although provision is not made in the NWA of South Africa, provision is made in the general authorisations of South Africa. Seventeen of the water laws made provision for water use authorisation applications. The DRC has no formal water law. In Mozambique, private water use is given by concession or through law. Common use is free and exempted from licences or concession. Regulation for licensing water rights for private use is not yet approved. The priority is of common use over the private use of water. In Sweden, provision is made for water use authorisation applications, but it is unstructured and small groundwater use can proceed without authorisation. In the USA, provision is made for water use authorisation, but differs substantially in most cases. In Zambia, no provision is made for water use authorisations.

Most counties have an approval system in place for water use authorisation applications. Sweden has an approval system in place, although unstructured. Tanzania also has an approval system in place, but it is also unstructured. Uganda has an approval system in place, but the approval system is not fixed. The approval system is continuously changed by the Water Policy Committee, Water Authorities, Director and Minister of Uganda. In the USA, the provision for an approval system differs substantially from state to state.

A groundwater legislation framework is of utmost importance in groundwater governance and forms the basis for the development of policies and decision-making principles.

The following chapter provides an overview of the determination of the groundwater reserve in South Africa.

Chapter 5

Determination of the Groundwater Reserve in South Africa

5.1 Introduction

The National Water Act (NWA) (RSA, 1998:1) recognises and acknowledges the following:

- Water is scarce and is an unevenly distributed resource which occurs in different forms, and is part of the hydrological cycle.
- Water is a natural resource that belongs to all the people of South Africa, although the National Government is the custodian of all water resources.
- The National Government is overall responsible for South African water resources and their use, including the equitable allocation of water for beneficial use, the redistribution of water and international water matters.
- The main aim of water resource management is to achieve the sustainable use of water beneficial to all.
- The protection of the quality of water resources ensures sustainability of the water resources in the interest of water users.
- The need exist for the integrated management of water resources and the delegation of management functions to a regional or catchment level in order to enable the public and stakeholders to participate.

Tools and expertise are available to enable the Minister to implement the NWA. The Department of Water and Sanitation (DWS), together with relevant stakeholders, developed procedures and methods to address the groundwater reserve.

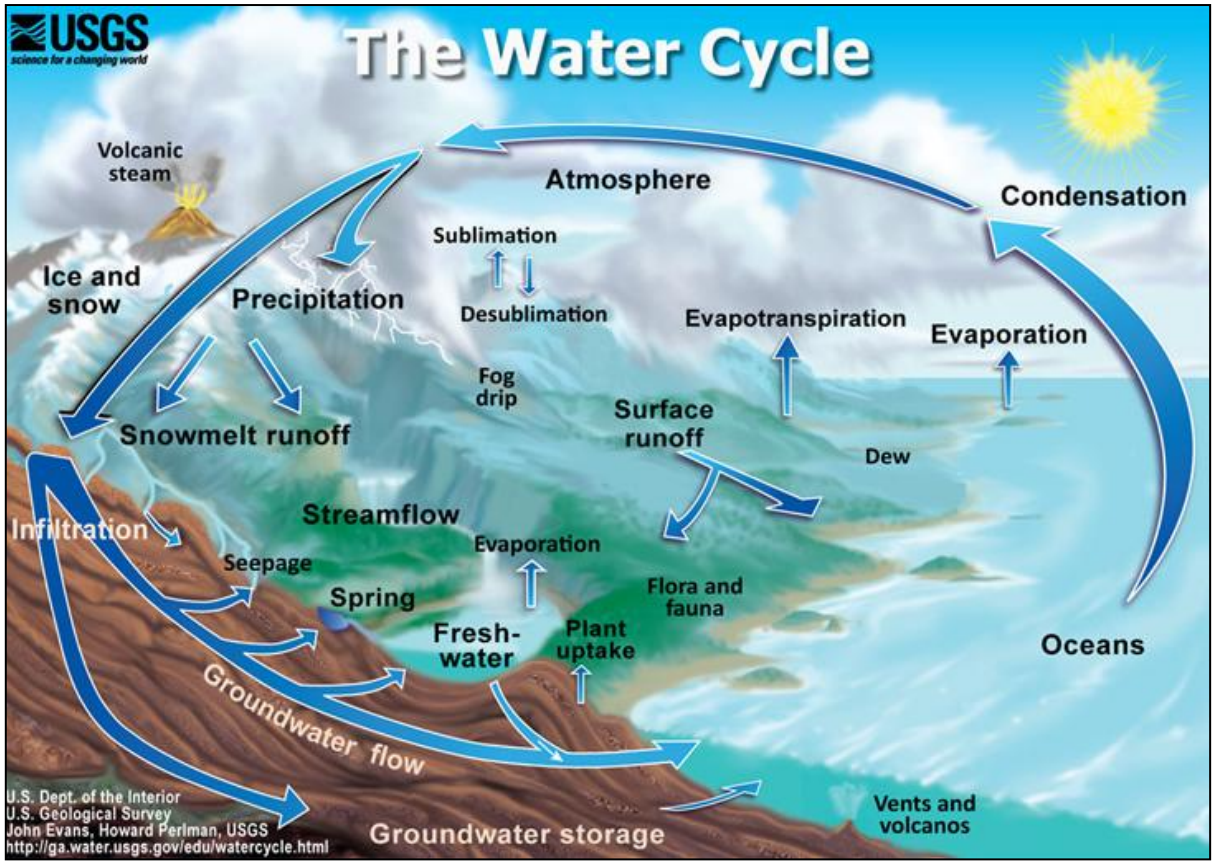
Chapter 5 focuses on the following:

- The NWA.
- Resource directed measures.
- Assumptions on which the groundwater resource directed measures are based.
- Groundwater reserve determination assessment steps.
- Post-groundwater reserve determination activities.
- Levels of the groundwater reserve determination measures.
- Classification of groundwater-dependent ecosystems and the degree of dependency.
- Groundwater reserve determination measures: Methods, tools, and data.
- Layout for reporting the outcomes of the groundwater reserve determination measures assessments.

5.2 The National Water Act

The Constitution of South Africa (RSA, 1996) and Agenda 21 (http://www.un.org/esa/agenda21/natlinfo/countr/safrica/eco.htm) form the basis of water management in South Africa. The NWA was promulgated in 1998 to implement the water policy (RSA DWAF, 2004a).

The NWA deals with the management of water resources and to ensure that there will be water for basic human needs and economic development. The NWA recognises the interdependency of all the components of the water cycle and that these should be managed as a single resource (RSA DWAF, 2004a). Please refer to Figure 5.1 for the demonstration of the hydrological cycle.



Source: USGS (online).

Figure 5.1: Hydrological cycle

The Water Services Act (RSA, 1997) provides for the right to access basic water supply and sanitation and is a framework for delivery of water services to people of South Africa.

The Constitution of the Republic of South Africa (RSA, 1996) emphasises that:

Everybody has the right to an environment not harmful to their health and well-being, to have an environment protected for the benefit of present and future generations and to have access to sufficient food and water.

South Africa is divided into water management areas, as is indicated in Figure 5.2.

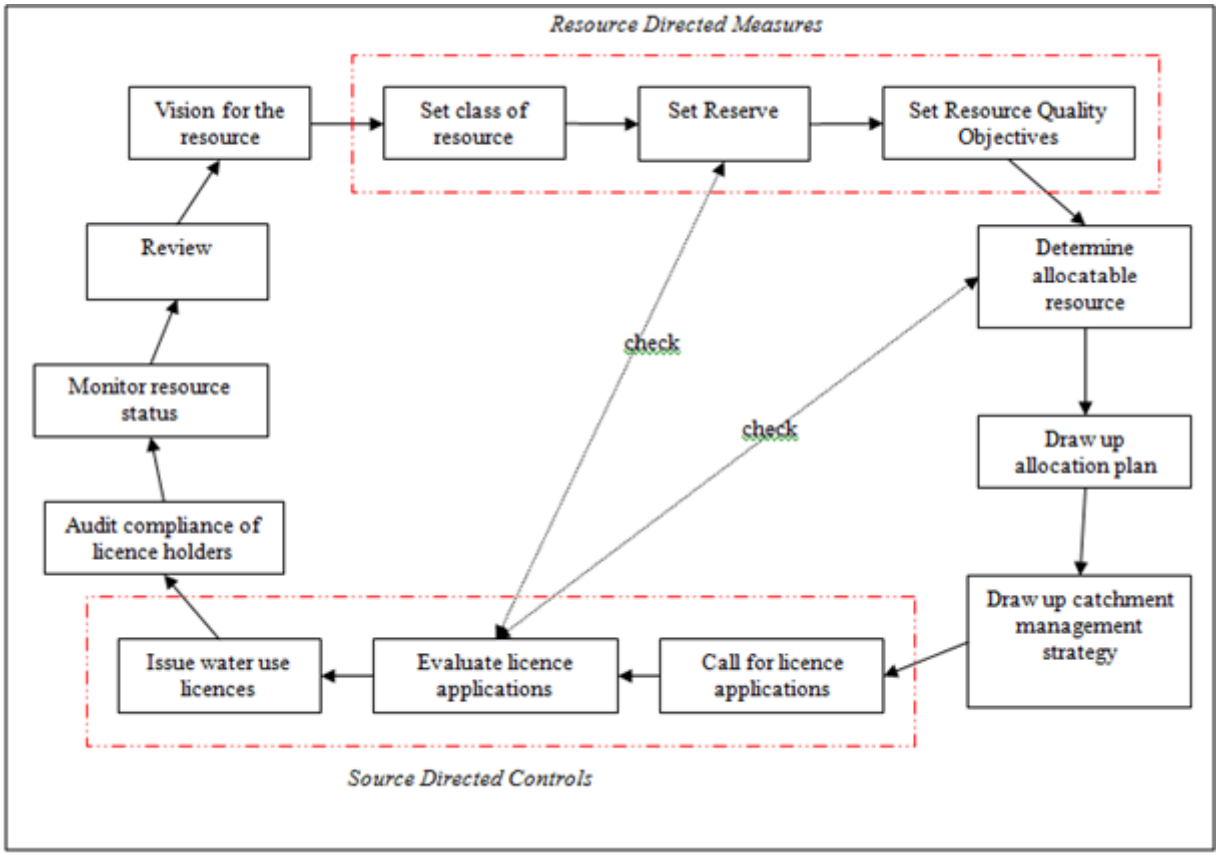
Source: RSA DWS (2014: online)

Figure 5.2: Water management areas of South Africa

The NWA provides tools for decision-making in order to attain a balance between the using and protection of a water resource. The decision-making tools are as follows:

- Classification systems.
- The reserve.
- Resource quality objectives.
- Pollution prevention and remediation.
- Emergency situations (RSA, 1998:15).

The water resource management process of the DWS is indicated in Figure 5.3.



Source: MacKay (1999:IM1/2)

Figure 5.3: Water resource management process

The NWA makes provision for the following water use authorisations:

- *Schedule 1 use*: Authorisation is for people who use small volumes of water for domestic use, watering gardens and animals as well as for the storing and using of rainwater from roofs. An application for Schedule 1 use is not required.
- *General authorisation*: According to Section 39 of the NWA and as published on 26 March 2004 in the Government Gazette 2004, users may use water without a license if the volume is within the provisions of the general authorisations (RSA DWA, 2004). In terms of the general authorisation, water users must register their use. A general authorisation will continue until compulsory licensing is enforced. This will result in the withdrawal of the general authorised use and the continuation of existing lawful groundwater use.
- *Late registration*: Groundwater use between 1 October 1996 and 31 September 1998 is seen as an existing lawful water use. An existing lawful water use is usually verified and validated before it is registered as a late registration. The groundwater use can continue until compulsory licensing is enforced. Compulsory licensing will be enforced if there is not enough groundwater

for all groundwater users and if the groundwater resource is considered stressed. All groundwater users, except for Schedule 1 users, will have to apply for a license.

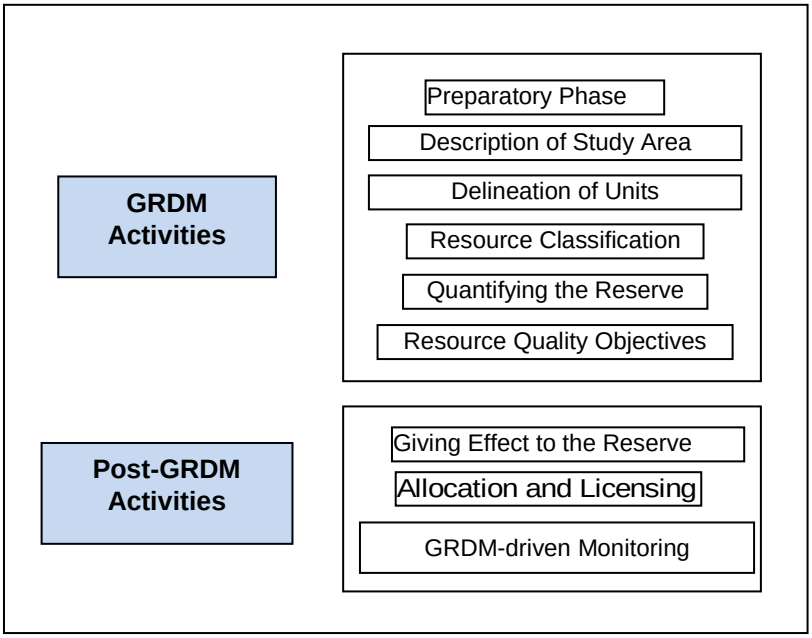
- *Licensing*: When the abstraction of groundwater use exceeds the general authorisation provisions and limits as stated in the NWA for example greater than 10m^3 per day abstraction, a groundwater use license application is required. In government control areas, application for a groundwater use license is compulsory as general authorisation provisions and limits are not applicable in those areas. A groundwater use license entitles a groundwater user to use groundwater within the conditions of the license. The conditions may be reviewed every five years, and forty years are the maximum time that a groundwater use license may be issued (RSA, 1998:27).

5.3 Groundwater Resource Directed Measures (GRDM)

5.3.1 Introduction

The main objective of the GRDM is to protect all water resources, together with sustainable principles. The resource directed measures comprise of the components of classification, reserve and resource quality objectives.

Figure 5.4 indicates the method followed in the GRDM studies.



Source: MacKay (2004)

Figure 5.4: Groundwater reserve determination measures studies

5.3.2 Assumptions

The GRDM studies conducted by DWS are based on the following assumptions:

- Groundwater systems are resilient and may or may not recover from pollution instances.
- Groundwater resources can be developed and used sustainability without significantly impacting the ability of groundwater resources to sustain the reserve.
- The ability of a geohydrological system to satisfy basic human needs and ecological reserve is not impacted if regional groundwater levels do not decline significantly over a long period of time, and ambient groundwater quality remains within natural limits.
- The sustainable rate at which groundwater can be abstracted is a function of the average long-term annual recharge.
- The volume of groundwater held in storage acts as a buffer during dry periods.
- It is assumed that recharge and groundwater abstraction are relatively evenly distributed throughout significant water resources.
- The validity of each GRDM study must be reviewed at least every five years, using monitored data from the study area.
- The GRDM assessments are performed by qualified and experienced specialists in the field of geohydrology who, in turn, will collaborate with other specialists such as hydrologists and ecologists (MacKay, 2004).

5.3.3 Groundwater reserve determination assessment steps

Table 5.1 indicates the groundwater reserve determination measures assessment steps.

Table 5.1: Groundwater reserve determination measures assessment steps

Phase	Main purpose	Intended for
Preparatory phase	• Initiate a GRDM assessment. • Set the level of confidence. • Appoint a GRDM study team.	• Compulsory licensing. • License applications.
Description of study area	• Appoint a GRDM assessment team. • Gather existing geohydrological data. • Describe the study area in terms of its physical and geohydrological characteristics in detail according to the level of assessment. • Develop an understanding of geo-hydrological conditions in the area and linkages to other components of the GRDM. • Geohydrological report of the area, including maps and tables, documenting the climate, topography, drainage, geology, geohydrology, groundwater use, surface–groundwater interaction and groundwater-dependent ecosystems.	• Desktop or rapid assessments. • Readily available data on the 1:500 000 scale, geohydrological maps of South Africa forms the basis of the assessment. • In the case of a comprehensive assessment and iterative process of data collection, fieldwork and data analysis could result in a substantial geohydrological report.
Delineation of resource units	• Demarcate significant water resources in the study area. • Record the name and size of each resource unit on the GRDM assessment data sheet. • Delineate groundwater resource units based on quaternary catchment boundaries, aquifer type and other physical, management and functional criteria.	• Initiate the study and set the level of the GRDM assessment. • Perform a desktop GRDM study. • A scoping study may be undertaken if more detailed information is required before the level can be set. • Compile a map indicating the extent of the groundwater resource. • Record the name of each unit and its aerial extent in the GRDM assessment data sheet
Resource classification	• Define the present status category and water resource category of each groundwater resource unit using the prescribed categorisation system. • The output will be included into the process for setting the management class for each significant water resource.	• Using the understanding of geohydrological conditions in an area, the difference between reference conditions and present conditions must be assessed. • A set of guiding tables is used to determine the present status category and water resource category of each groundwater unit. • Categorisation is based on quantifiable and non-quantified parameters and expert judgement.

Quantification of the reserve	• The volume of groundwater that can be abstracted from a groundwater unit without impacting the ability of the groundwater system, must be quantified. • The recharge to the unit must be quantified by making use of appropriate methods. • The groundwater contribution to baseflow and groundwater-dependent ecosystems must be quantified by making use of appropriate methods. • The basic human needs of the unit must be quantified to be met from groundwater.	• Record the groundwater component of the reserve on the GRDM assessment data sheet. • Calculate the reserve as a percentage of recharge and the groundwater allocation.
Setting of resource quality objectives (RQOs)	• Set RQOs for each resource unit using rules for selected classes. • Based on the conceptual understanding of the area, select measurable indicators as RQOs such as water levels, total dissolved solids, faecal coliforms and the level at which they should be maintained.	• Record the groundwater component of the reserve on the GRDM assessment data sheet. • List RQOs to guide management and monitoring activities.
Review	• Overcome data shortage problems expected in many of the catchments. The review includes experienced practitioners in the GRDM process in an efficient manner. • Checking and standardising GRDM assessments.	• Define resource quality objectives for each resource unit. • Record the groundwater component of the reserve on the GRDM assessment data sheet

Source: MacKay (2004)

5.4 Post-Groundwater Reserve Determination Activities

The setting of the resource quality objectives are technically-, socio-economically and efficiency-driven. The allocation of water and monitoring requirements will be considered after the reserve has been set (MacKay, 2004).

The post-GRDM activities that will take place are the implementation of the set resource quality objectives; monitoring of the quantity, quality and water levels of the groundwater resources; and the allocation of groundwater in a sustainable manner without negatively impacting the reserve.

5.5 Levels of the Groundwater Reserve Determination Measures

According to MacKay (2004), there are four levels of the GRDM:

5.5.1 Desktop assessment

- Readily available data and information are used.
- Results are extrapolated from previous detailed assessments.
- Low intensity information is required.

- Take a few hours to complete.
- Yield results of very low confidence.
- Is the first step in the GRDM process and is a useful planning tool.

5.5.2 Rapid assessment

- Is similar to the desktop assessment, but include a short field trip to assess the present state.
- The rapid assessment is used to assess individual licence applications with low impact in unstressed catchments or catchments of low ecological importance and sensitivity.
- A rapid assessment should not take more than two weeks to complete.

5.5.3 Intermediate assessment

- An intermediate assessment yield results of medium confidence.
- Require field investigations by experienced specialists and take about two months to complete.
- Intermediate assessments are used to assess individual license applications of moderate impacts in relatively stressed catchments.

5.5.4 Comprehensive assessment

- A comprehensive assessment produces high confidence results and is based on site-specific data gathered by a team of specialists.
- A comprehensive assessment is used for compulsory licensing as well as for individual license applications that may have a large impact in any catchment, or a relatively small impact in ecologically important and sensitive catchments.

5.6 Classification of Groundwater-Dependent Ecosystems and Degree of Dependency

According to Boucher and Parsons (1980:3), groundwater may provide an important linkage between terrestrial ecosystems and aquatic ecosystems. Sinclair (2001:5) classifies groundwater-dependent ecosystems and the degree of dependency:

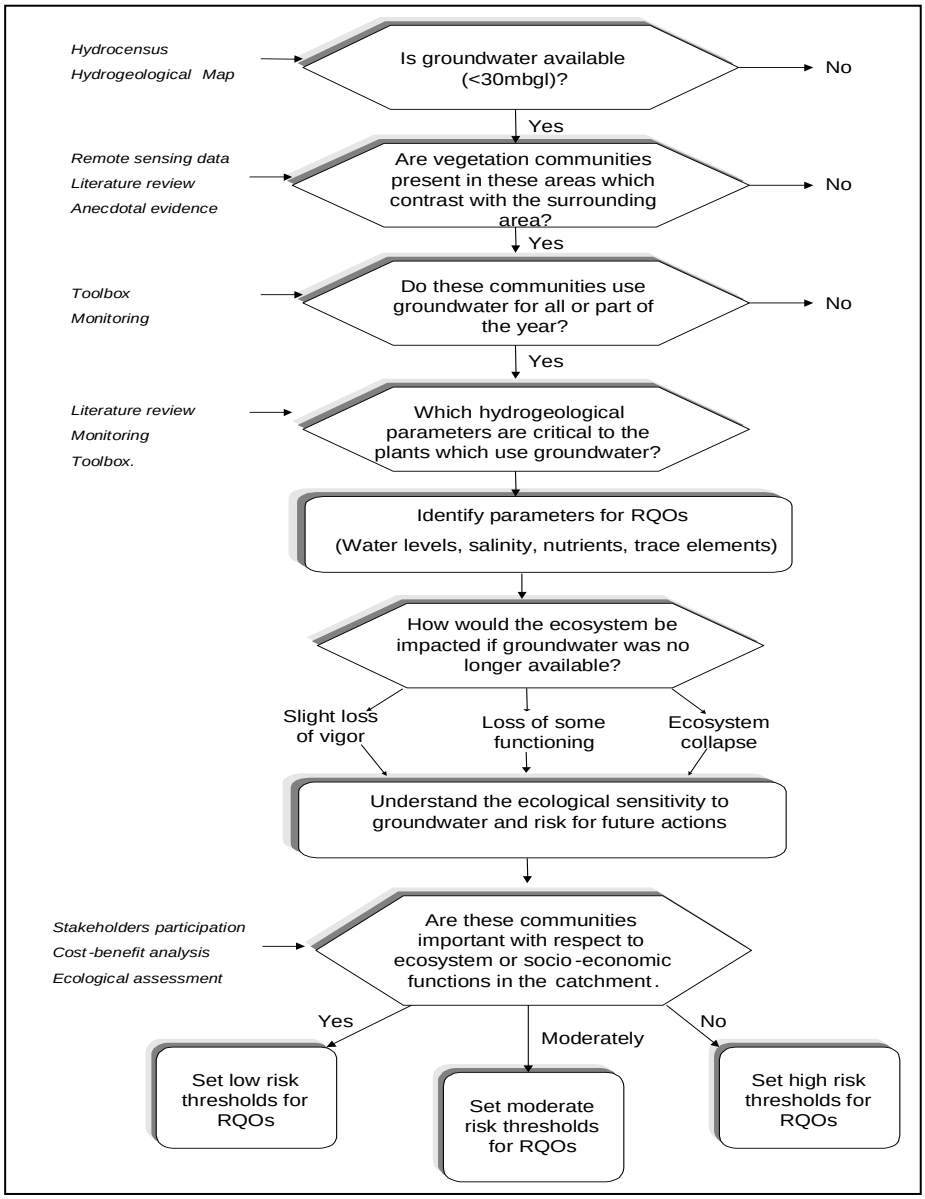
- *Terrestrial vegetation:* Terrestrial vegetation communities and dependent fauna have seasonal or episodic dependence on groundwater.
- *River baseflow systems:* Aquatic and riparian ecosystems are ecosystems that exist in or adjacent to streams that are fed by groundwater baseflow.
- *Aquifer and cave ecosystems:* Aquatic ecosystems occupy caves or aquifers.

- *Wetlands:* Aquatic communities and vegetation are dependent on groundwater-fed lakes and wetlands.
- *Terrestrial fauna:* Terrestrial fauna is native animals that directly use groundwater, rather than rely on it for habitat.
- *Estuaries and near-shore marine ecosystems:* Coastal, estuarine and near-shore marine plant and animal communities have some dependence on the discharge of groundwater.

The degree of groundwater-dependency ecosystems are classified as follows (Brown, Colvin, Hartnady, Hay, Le Maitre, and Rieman, 2003:4):

- *Entirely dependent:* Ecosystems would collapse if groundwater fluxes were to diminish or be slightly modified.
- *Highly dependent:* Moderate changes to groundwater discharge or water tables would lead to substantial decreases in either the extent or condition of ecosystems.
- *Proportionally dependent:* A unit change in the groundwater system would result in a proportional change in the condition of the ecosystem.
- *Facultative dependency: C*hanges to a groundwater system would have a minor effect on the condition of the ecosystem.
- *No dependence:* Ecosystems are independent of groundwater.

A preliminary protocol is followed when it is necessary to identify groundwater-dependent vegetation and to set resource quality objectives. Figure 5.5 indicates a flow diagram used as the preliminary protocol to identify groundwater dependent vegetation and to set resource quality objectives.



Source: Colvin, Le Maitre, and Hughes (2002:1)

Figure 5.5: Flow diagram used as preliminary protocol to identify groundwater-dependent vegetation and to set resource quality objectives

5.7 Groundwater Reserve Determination Measures: Methods, Tools and Data

A summary is provided of various methods, tools and data that can be used to quantify various components of the groundwater reserve determination measures.

Table 5.2 indicates methods for calculating components of the water balance.

Table 5.2: Methods for calculating components of the water balance

Component	Definition	Method	References/Software
Groundwater inflow (I) and outflow (O) across catchment boundaries	• Areas along the boundary where groundwater enters or leaves the catchment. • The catchment boundary acts as a groundwater water divide, and it is only in low-lying areas that groundwater will enter or leave the system.	• Groundwater levels in an aquifer usually follow surface topography. • Bayesian interpolation techniques can be used, and a groundwater contour map can be plotted. • After constructing the Bayesian groundwater level contour map, there are two methods that can be used to estimate *I* and *O:* numerical flow models and Darcy's Law.	*Reference* • Darcy's Law can be obtained from Kruseman and De Ridder (1991:10). • The transmissivity or hydraulic conductivity needed in the flow calculations can be obtained from literature (Kruseman and De Ridder, 1991:11) or pumping test data. *Software* • TRIPOL (van Tonder, van Sandwyk and Buys, 1996:9) can be used to perform the Bayesian interpolation. • Processing Modflow for Windows (PMWIN) version 5, a numerical flow model (Chiang and Hinzelbach, 1999).
Groundwater abstraction	• Withdrawing water from the aquifer, normally by means of a borehole.	• Databases, such as the National Groundwater Archive (NGA) and Water Resource Management System (WRMS), can be used. A hydrocensus would also give an indication of abstraction rates. If a useful database does not exist, information, such as land use maps (for estimating irrigation) and population maps (for estimating drinking and industrial uses) can be used to estimate the existing abstraction rates.	• For more information concerning databases, refer to the DWS website, www.dwa.gov.za
Recharge	• Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation.	• Chloride method, saturated volume fluctuation method, cumulative rainfall departure method, isotopes and maps.	*Reference* • Bredenkamp, Botha, van Tonder, and van Rensburg (1995:18) discuss these methods in detail. *Software* • An EXCEL-spreadsheet programme, RECHARGE (van Tonder and Xu, 2000:7) can be used to determine the net groundwater recharge. *Maps* • Vegter's (1995) groundwater recharge map can be used.

Component	Definition	Method	References/Software
Flow from surface water bodies	• Surface water bodies can recharge or discharge groundwater. The exchange rate of water is usually controlled by the difference in hydraulic heads (water levels) and resistance of the media between the groundwater and surface water bodies.	• See groundwater inflow (I) and outflow (O) across catchment boundaries.	• See groundwater inflow (I) and outflow (O) across catchment boundaries.
Basic human needs	• The least amount of water required satisfying basic water requirements; this is currently set at 25 ℓ/capita per day.	• The amount of groundwater needed for basic human needs can be determined by multiplying the number of people dependent on groundwater by 25 ℓ/capita per day. Future changes in the groundwater-dependent population must also be considered.	*Reference* • Water Services Act, Act 108 of 1997.
Ecological requirements	• The amount of groundwater needed to sustain aquatic ecosystems.	• In the case of a line source (e.g. river), determine groundwater component of baseflow using the Herold method. It is important to note that these values must be scaled according to the various reaches within a river. • In the case of a point source, determine the groundwater flow towards the source by means of Darcy's law or a numerical flow model.	*Reference* • Herold method (Vegter, 1995). Data needed to calculate baseflow can be obtained from WR90 (Midgley, Pitman, and Middleton, 1994) or Hughes (2003), or field data. *Software* • Base flow can be calculated using reserve spreadsheets. • For point sources, see flow across catchment boundaries.

5.8 Layout for Reporting Outcomes of Groundwater Reserve Determination Measures Assessment

An example of the layout of a report for reporting the outcomes of the GRDM assessments includes:

5.8.1 Introduction

The introduction includes background information on the reserve undertaken as well as on the specific water use activity with the relevant sections under which the water use license application was submitted.

5.8.2 Preparation phase

The confidence level of the reserve determination of the groundwater quantity and quality that was undertaken is mentioned under this heading.

5.8.3 Description of catchment

The catchment is identified and the climate, rainfall, geology, hydrogeology and median borehole yields are discussed. The recharge, as well as the extent of the catchment, is mentioned. The activities within the catchment are described along with the water environment, present ecological status and classification. The impact of human activities is considered as well as the total population residing within the study area.

5.8.4 Delineation

The delineation of the study is described and discussed and the quaternary catchment of concern is identified.

5.8.5 Classification

Information is provided on which the classification of the groundwater resources are based. The groundwater use within the study area is discussed. Possible problems related to the state of the groundwater resources are mentioned. The final classification category of the groundwater resources within the specific catchment is then categorised.

5.8.6 Quantification of the reserve

- **Recharge:** The recharge of the study area is estimated and discussed.
- **Baseflow:** The groundwater component of baseflow is determined and classified. The method used as well as the ecological reserve requirement, is discussed.
- **Basic human needs reserve:** The total population in the specific catchment area, as well as the basic human needs component of the reserve, is discussed.
- **Quantity and quality component:** The groundwater quality component of the reserve is generally sourced from the National Groundwater Archive (DWS) database and specialist reports. Maps are also used to determine the hydrogeological environment and the general mean groundwater quality.
- **Reserve determination:** The results of the level of the reserve performed of the groundwater quantity component of the ecological reserve and the basic human needs reserve should be presented in a table. The estimation of the groundwater quality should also be included in a table. The results on the reserve determination are then discussed.

5.8.7 Resource quality objectives

Within the context of the intended water use, no groundwater quality deterioration of more than 10% of the ambient groundwater quality is allowed. Appropriate groundwater monitoring of quantity, quality and groundwater levels is required to ensure that the resource quality objectives which were set, are met.

5.8.8 Conclusions

The type of reserve determination is discussed and the applicability thereof for the specific water use activities, as applied for in the groundwater use license, are mentioned. The ecological reserve requirement is mentioned as calculated equivalent to the mean annual groundwater recharge. The basic human need component of the reserve was determined and is mentioned as a percentage of recharge. The total volume of the groundwater required for the reserve are set and mentioned as the percentage of the mean annual groundwater recharge. The required groundwater is then compared to the groundwater reserve requirement.

Confidence of the reserve determination is then expressed and should also provide adequately for the terrestrial aquatic environment. Concerns with regard to site-specific groundwater quality should be addressed in the recommendations section.

5.8.9 Recommendations

If the groundwater use license application is successful, license conditions are attached to the groundwater use license together with groundwater monitoring requirements. The conditions and requirements of the groundwater use license will depend on the specific activity for which the groundwater will be used.

5.8.10 Map

A map of the study area is generated and attached to the report for perusal purposes by DWS officials. The example of the layout of a report for reporting the outcomes of the GRDM assessments is based on the researchers' experience while working as senior geohydrologist at the Department of Water Affairs and Forestry in the Free State Regional Office. (Refer to Appendix A for an example of a valid report issued by the resource directed measures office.)

5.9 Countries that Make Use of Groundwater Resource Directed Measures Assessments

The use of GRDM assessments by international countries differs extensively from country to country, and information of the use thereof is extremely limited.

Some geohydrologists do not support the groundwater reserve determination; however, the protection of current and future groundwater requirements for the ecological component and basic human needs component cannot be ignored and should not be neglected.

> *In essence, a combination of groundwater contribution to baseflow and basic human needs met from groundwater is the volume of groundwater required to sustain the reserve. However, because the reserve bucket analogy is inappropriate for groundwater, and the groundwater component of the reserve is best represented by a groundwater level rather than a volume, the concept of recording the groundwater component as a reserve is problematic. It is preferable and practical to determine the volume of groundwater that can be abstracted from a resource unit without impacting the ability of groundwater to sustain the reserve. This is referred to as groundwater allocation* (RSA DWAF, 1999:10).

5.10 Conclusion

The NWA deals with the management of water resources and in ensuring that there will be water for basic human needs and economic development. The NWA recognises the interdependency of all the components of the water cycle and that these should be managed as a single resource (RSA DWAF, 2004b).

The Water Services Act (RSA, 1997) provides for the right to access basic water supply and sanitation and is a framework for delivery of water services to people of South Africa.

The Constitution of the Republic of South Africa (RSA, 1996) emphasises that:

> *Everybody has the right to an environment not harmful to their health and well-being, to have an environment protected for the benefit of present and future generations and to have access to sufficient food and water.*

The NWA makes provision for Schedule 1 use, general authorisations, and existing lawful water use as late registrations and licences. The pre-GRDM and post-GRDM activities were discussed. The assumptions on, which the GRDM assessments are based, were listed.

The GRDM steps; levels of GRDM, groundwater-dependent ecosystems; degree of ecosystems dependent on groundwater; GRDM methods, tools and data; layout of reporting outcomes of a GRDM assessment; and countries which makes use of GRDM assessments were discussed.

The following chapter deals with the development of a framework for processing groundwater use authorisation applications in the agricultural sector.

Chapter 6

A Framework for Processing Groundwater Use Authorisation Applications in the Agricultural Sector

6.1 Introduction

Chapter 6 provides a framework for processing groundwater use authorisation applications in specifically the agricultural sector. The agricultural sector is recognised as the largest groundwater use sector in South Africa; however, no formal framework exists specifically for this sector to handle and process groundwater use authorisation applications by the Department of Water and Sanitation (DWS) officials for irrigation purposes.

The framework provided in this chapter is for use by officials dealing with groundwater use authorisation applications in agriculture, geohydrologists and groundwater resource management personnel. This chapter provides a framework for the processing of groundwater use authorisations such as existing lawful water use as late registrations; Schedule 1 use, general authorisations; and groundwater use licenses. The transfer of ownership application of a current registered use will be briefly discussed.

The limitations of this framework are that it is intended only for groundwater use authorisation applications for irrigation purposes, and that no integrated groundwater use license applications are included.

The motivation that this framework, is only intended for irrigation purposes in the agricultural sector, is that there are far too many problems associated with the handling and processing of groundwater use authorisation applications for irrigation purposes in the agricultural sector. The problems will be discussed and intervention measures will be recommended.

6.2 Background

The National Water Act (NWA) (RSA, 1998) provides various principles that are relevant to the consideration of water use authorisation applications. The following concepts are relevant when considering applications for water use authorisation:

- The indivisibility of water as part of the hydrological cycle is scientifically recognised, and a water resource is defined in Section 1 of the NWA as being all water found in the various phases of this hydrological cycle. This includes the portion of water found underground. This ensures that the entire water resource is treated in an integrated water resource common to all.

- The national government, through the Minister of Water and Sanitation, is the custodian of all water resources. The Minister is generally responsible for the protection, use, development, conservation, management and control of water of all water resources. Decisions must be made in such a manner that the integrity of the groundwater resource is not adversely affected, but are made in a just and equitable manner that promotes sustainability.
- To achieve effective resource protection, resource directed measures and source directed controls. Resource directed measures set clear objectives for the desired level of protection for each component of the groundwater resource through a resource classification system. Source directed controls aim to control the source of potential impacts on the water resource.
- Water is recognised as an economic good as all authorised use of water are charged for through a pricing strategy for water use charges under Section 56(1).
- Source directed controls, such as the protection of water, are strongly emphasised. The protection of water resources are enforced through a system of source directed measures, including the registration of sources of impact, standards for waste discharges and best management practices. The use of directives and fines, and the ability to suspend or revoke licenses are effective options for dealing with cases of pollution. In groundwater resources, pollution prevention is of utmost importance as remediation of groundwater resources can be very difficult and expensive. Under certain circumstances remediation of the groundwater resource is not possible and the specific source is rendered not suitable for use.
- The groundwater reserve comprises that quantity and quality of groundwater is required to satisfy basic human needs and to protect aquatic ecosystems for continued sustainable use.
- Optimum use occurs when groundwater is used to achieve the most desirable combination of social, economic and environmental objectives, irrespective of whether such use is consumptive or non-consumptive.
- Groundwater use should be in the public interest and should be subject to a system of allocation that promotes optimal use for the achievement of equitable and sustainable economic and social development (RSA DWAF, 2007a:2).
- It is recognised that groundwater management must take place at catchment level and therefore makes provision for the establishment of catchment management agencies.
- The Minister of DWS exercises powers and duties of catchment management agencies in all water management areas until catchment management agencies are established.
- The national water resource strategy describes how water resources will be protected, used, developed, conserved, managed and controlled in accordance with policy and law.

- Provision is made in the NWA for a public participation process and decision-making, guarantees the right to appeal against decisions and for water use licenses (RSA DWAF, 2007a:3).

6.3 Regional and National Water Use Authorisation Assessment Advisory Committees

Water Use Authorisation Assessment Advisory Committees (WUAAACs) offer advice during presentations regarding water use authorisations at the committee.

The WUAAAC meetings are held at regional and national levels. The frequency, membership and attendance of these meetings are determined by the number of applications received, the water uses, and by the delegated powers with regard to the complexity and types of use activities applied for.

The main objective of the regional WUAAAC is to provide a platform for technical discussions, and to make recommendations to the Minister regarding water use authorisation applications, or to the official to whom decision-making has been delegated. Authorisations that have been recommended for approval at the regional WUAAAC meetings will be tabled at the next scheduled National WUAAAC meeting for final approval and to ensure consistent application of the policy and process.

The National WUAAAC may recommend the delegation of signatory powers from the Chief Director: Water Use to the regional level if satisfied with the functional capacity of the respective regional WUAAACs.

The primary objectives of the national WUAAAC meetings are to:

- Ensure consistent application of policy with regard to integrated licences.
- Ensure the legality of licence conditions.
- Facilitate timely evaluation and recommendations of water use authorisation applications.
- Identify policy gaps.
- Make recommendations towards rules for licenses and policy issues.
- Take note of authorisations issued by delegated offices.
- Address problems and propose solutions associated with the internal assessment process.
- Make recommendations to the Chief Director: Water Use or other delegates regarding the issuing of water use authorisations (RSA DWAF, 2007a:4).

6.4 Existing Lawful Water Use Application Process

6.4.1 Existing lawful water use as part of late registrations

Groundwater use is recognised as an existing lawful water use if groundwater abstraction or groundwater resource development took place between the period of 1 October 1996 and 31 September 1998. An existing lawful water use is usually verified and validated before it is registered as a late registration.

The groundwater use can continue until compulsory licensing is enforced. Compulsory licensing will be enforced if there is not enough groundwater for all groundwater users and if the groundwater resource is considered stressed. All groundwater users, except for Schedule 1 users, will then have to apply for a license.

6.4.2 How existing lawful groundwater use is determined

6.4.2.1 How existing lawful groundwater use is determined

An existing lawful groundwater use is recognised when groundwater abstraction or groundwater resource development took place between the period of 1 October 1996 and 31 September 1998. This groundwater use must be registered as a late registration. Before the late registration process can be followed, the extent of the existing lawful groundwater use must be determined. The farmer must apply for validation and verification of his or her groundwater use.

In the event that a late registration was already done, the validation process will take place of the registered groundwater use. The DWS works together with the groundwater users in order to determine whether the groundwater use is accurately registered and lawful. Through the validation process the details of the registered volume is checked as to what the current water use is, and certified as correct or incorrect. With the verification process the actual groundwater volume that was used lawfully under the previous legislation is verified (RSA DWAF, 2006:6).

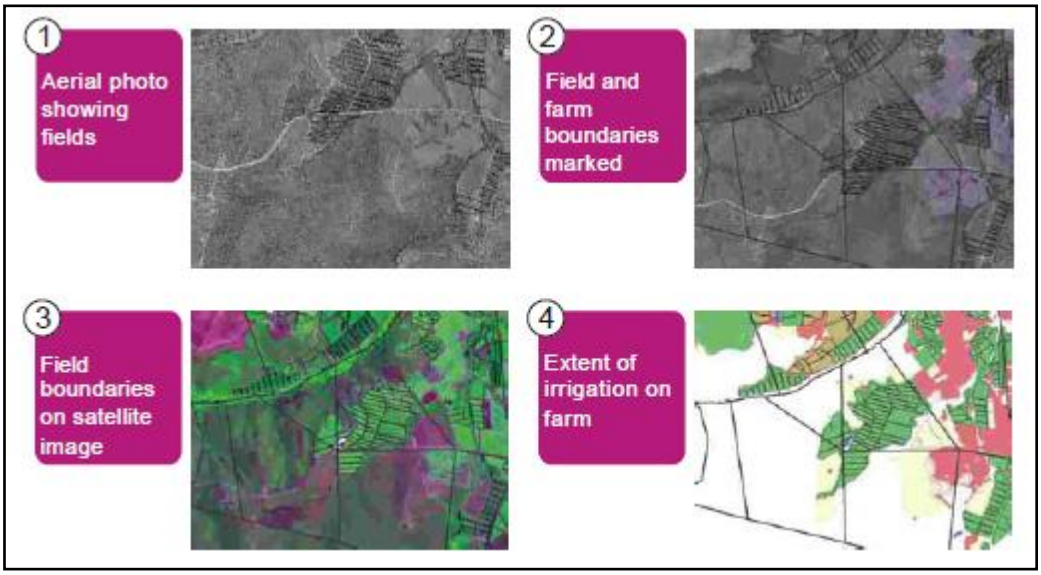
Through the validation process the following are determined:

- The volume of groundwater abstracted annually.
- The source of the water.
- The volume of groundwater stored annually.
- The extent in hectares of crops being irrigated.
- The irrigation method used.
- The type of crops under irrigation.

6.4.2.2 Steps of the validation process

Step 1: The DWS builds a data base or preferably a geographic information system as a management tool to collate and ensure the accuracy of all relevant water use information for all registered water users. The information is taken from many different sources, including registration documents, field surveys and remote sensing methods such as satellite imagery, aerial photography, ortho-photographs and topo-cadastral maps.

Figure 6.1 indicates examples of an aerial photo, marked field and farm boundaries, satellite image and the extent of irrigation on the respective farm.



Source: (RSA DWAF, 2006:8)

Figure 6.1: Examples of an aerial photo, marked field and farm boundaries, satellite image and the extent of irrigation on the respective farm

The SAPWAT3 computer software is mostly used to determine the actual water use of irrigated areas. SAPWAT3 is a model used for estimation of crop water requirements (Water Research Commission, 2008).

Step 2: DWS compiles validation tables of water use. These tables include the extent of irrigation of the farm, information on registration, satellite image, SAPWAT3 model results and the DWS groundwater actual use calculated for irrigation purposes in the qualifying period.

6.4.2.3 The verification process

With the verification process, the actual groundwater volume that was used lawfully under the previous legislation is verified (RSA DWAF, 2006:6). The responsible authority examines

previous legislation which might have limited the groundwater use in the qualifying period. Again, a water use table is compiled for the extent of the existing lawful groundwater use.

A public meeting is held for all stakeholders and the verification process is explained. Stakeholders are encouraged to ask and give input questions during the meeting. After the initial steps of the verification process, a Section 35 letter with specific timeframes are given as notice to the individual stakeholder asking him or her to apply for verification of the extent of their groundwater use (RSA DWAF, 2006:12). (Refer to Appendix B for an example of a Section 35 letter.)

In the event that there is a dispute regarding the validation process, the farmer must provide additional information as proof to DWS for consideration. When the final existing lawful groundwater use is determined, any unlawful use identified will follow the process of illegal groundwater use and must be stopped. Appeal against the final outcome of the validation and verification process may be directed to the water tribunal for further handling of the dispute.

When the researcher was employed at DWS, and was also involved in stopping of illegal groundwater abstraction, it was clear that when crops were already on the fields, DWS could not immediately stop the water use. Legal advice was sought on various occasions with the same feedback that the DWS may be held responsible for financial loss when irrigation is immediately stopped.

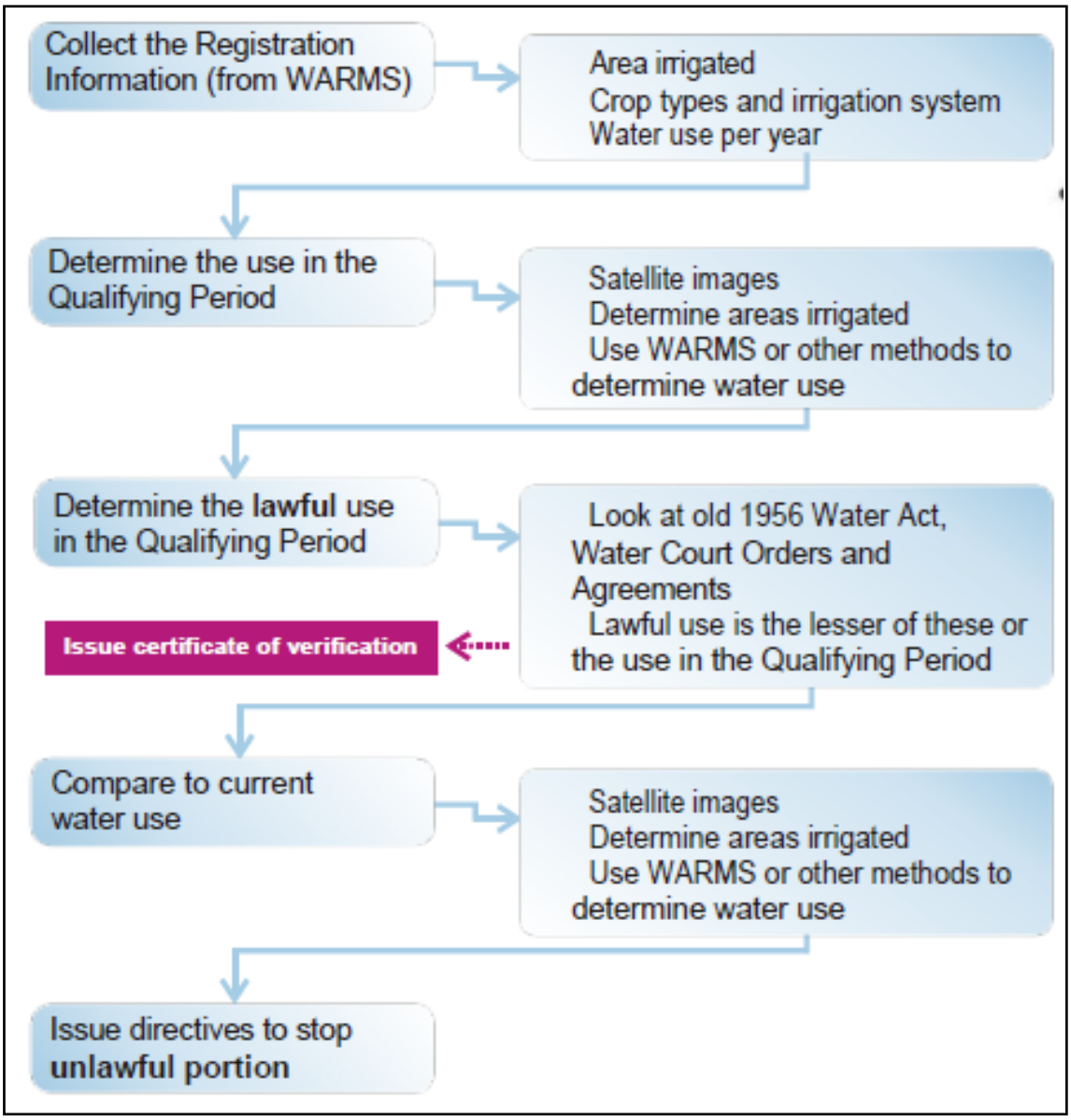
The DWS firstly has to issue a pre-directive to stop the use within a certain period of time. When the use was not stopped within that period as stipulated in the pre-directive, a directive was issued. The legal division of DWS was unfortunately not actively involved to take the matters further.

The Compliance and Enforcement Sub-Directorate, however, did help with the investigation of the illegal use. Unfortunately, most of the time the directives led to minimal action, after which DWS will advise a farmer or farmers whose groundwater resources were adversely affected by the illegal use to open civil cases against the perpetrator. DWS do however assist illegal groundwater users to become legal by applying for a groundwater use authorisation. If the authorisations are granted, very stringent conditions are included in the authorisation to which the water user must adhere to. If not, he or she may face fines or jail sentencing.

When the validation and verification process has been completed and an existing lawful groundwater use is registered, a certificate outlining the extent of the existing lawful water use is issued. (Refer to Appendix B for an example of a registration certificate.) Verification can also be introduced within a specific catchment area and forms the baseline for the compulsory licensing

process. An example includes the Upper Orange Water Management area and the Middle Vaal Water Management area of the DWS Free State Regional Office.

Figure 6.2 summarises the verification process.



Source: (DWAF, 2006:15)

Figure 6.2: Summary of the verification process

6.4.3 Application forms and supporting documentation for registering the existing lawful water use under a late registration

Table 6.1 indicates the required forms and supporting documentation that must be submitted together with the late registration application.

Table 6.1: Required forms and supporting documentation that must be submitted together with the late registration application according to the experience of the researcher

Owner of farm or smallholding	Forms to be completed	Supporting documentation
Individual	• DW756_Individual • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• Pay application fee as determined by DWS. • Certified copy of identity document. • Certified copy of title deed. • Any documentation as proof that financial expenses were incurred for the groundwater resource development and irrigation activities during the qualifying period. • Photos of infrastructure if the flood irrigation method was used. • VAT number, if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable).
Trust	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• Pay application fee as determined by DWS. • Certified copy of identity document. • Certified copy of title deed of farm. • Certified copy of trust deed. • Legal document for signature authority. • Any documentation as proof that financial expenses were incurred for the groundwater resource development and irrigation activities during the qualifying period. • Photos of infrastructure if the flood irrigation method was used. • VAT number if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable).
Company or Business	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• Pay application fee as determined by DWS. • Certified copy of identity document. • Certified copy of title deed. • Proof of company or business registration. • Legal document for signature authority. • Any documentation as proof that financial expenses were incurred for the groundwater resource development and irrigation activities during the qualifying period. • Photos of infrastructure if the flood irrigation method was used. • VAT number if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable).

6.4.4 Main problems encountered with the registering of existing lawful water use under a late registration in the agricultural sector

The main problems encountered with the registering of existing lawful water use under a late registration in the agricultural sector are:

- Flood irrigation is often overlooked even when sufficient proof was provided that it was used as an irrigation method in the qualifying period. As a result the existing lawful water use is not recognised and the use is deemed as illegal use. This problem can be mitigated by a field visit to inspect available infrastructure and other proof.
- Theoretically the period of processing should take no longer than a few months, but currently and very unfortunately the processing can easily take up to five years to complete. This is mainly due to a shortage of personnel and a lack of dedicated personnel to perform the validation and verification process on request. Often personnel are available, but due to their workload and by not being dedicated to a specific task, they cannot perform the field visit and validation and verification process. Usually the officials will then wait until their regional office performs validation and verification on catchment level.

6.5 Schedule 1 Use

Schedule 1 entitles a person to acquire water for reasonable domestic use, for small gardening that is not for commercial purposes, for livestock drinking water, or for fire-fighting. This schedule also permits the storing and using of run-off water from the roof (RSA DWAF, 2007a:3).

No formal application process is required.

6.6 General Authorisation Applications

According to Section 39 of the NWA and as published on 26 March 2004 in the Government Gazette 2004, users may use water without a license if the volume is within the provisions of the general authorisations (RSA DWA, 2004). In terms of the general authorisation, water users must register their use. A general authorisation will continue until compulsory licensing is enforced. This will result in the withdrawal of the general authorised use and the continuation of existing lawful groundwater use under a license.

6.6.1 Groundwater general authorisation process

The groundwater needs requirement of the farmer is determined during the pre-consultation phase. During this pre-application meeting, the official will determine the quaternary drainage region in which the farm is situated, the volume of groundwater which may be allocated in cubic

metres per hectare, the extent of the farm, the type or types of crops which the farmer wish to plant, the irrigation method and the water requirement for the crops.

In the event of the groundwater requirement falling within the provisions of the general authorisations within the specific quaternary drainage region, the official will advise the farmer on how to proceed with the preparation of the general authorisation application forms, together with the required supporting documentation.

A simple calculation is used to determine the volume of groundwater in cubic metres for which will be applied for.

Information provided as an example:

- Quaternary drainage region: A10A.
- Volume of groundwater which may be allocated in cubic metres per hectare: 75 m^3/ha.
- Extent of the farm: 395 ha.
- Type of crop to be planted and when: Maize will be planted during October.
- Irrigation method: Centre pivot.
- The water requirement of the specific crop: 634 mm.

395 ha × 75 m^3 = 29 625 m^3/ha per annum as general authorisation.
Total hectares of maize that can be planted = 29 625/6 340 = 4.67 ha.

Table 6.2 indicates the required forms and supporting documentation that must be submitted together with a general authorisation application and was done in accordance with the experience of the researcher.

Table 6.2: Required forms and supporting documentation to be submitted together with a general authorisation application according to the experience of the researcher

Owner of farm or smallholding	Forms to be completed	Supporting documentation
Individual	• DW756_Individual • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• There is currently no application fee payable as determined by DWS. • Certified copy of identity document. • Certified copy of title deed. • Photos of infrastructure if the flood irrigation method was used. • VAT number, if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • If the applicant is not the owner of the farm,

Owner of farm or smallholding	Forms to be completed	Supporting documentation
		the owner must provide a letter of consent giving the applicant permission to apply for a general authorisation on his or her farm as well as signature authority to sign the application forms.
Trust	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (If applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• There is currently no application fee payable as determined by DWS. • Certified copy of identity document. • Certified copy of title deed of farm. • Certified copy of trust deed. • Legal document for signature authority. • Photos of infrastructure if the flood irrigation method was used. • VAT number, if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from the Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • If the applicant is not the owner of the farm, the owner must provide a letter of consent giving the applicant permission to apply for a general authorisation on his or her farm as well as signature authority to sign the application forms.
Company or Business	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• There is currently no application fee payable as determined by DWS. • Certified copy of identity document. • Certified copy of title deed. • Proof of company or business registration. • Legal document for signature authority. • Photos of infrastructure if the flood irrigation method was used. • VAT number if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • If the applicant is not the owner of the farm, the owner must provide a letter of consent giving the applicant permission to apply for a general authorisation on his or her farm as well as signature authority to sign the application forms.

As soon as the applicant completed all the application forms and gathered all the required supporting documentation, he must submit the full application to the nearest DWS regional office. Each DWS regional office has one entry point for accepting applications.

The official must go through the application in order to determine if the application forms together with the supporting documentation is in order, and that no documentation is outstanding.

6.6.2 Main problems encountered with general authorisations

The main problems encountered with general authorisations are the following:

- Back log of applications. This problem can be mitigated by not accepting incomplete applications, and the provision of dedicated personnel to handle the general authorisation applications. The official should advise the applicant to gather the outstanding documentation before submission. Thereafter, the official can accept the general authorisation application.
- The period of processing should take no longer than a few months, but currently and unfortunately so the processing can easily take up to three years to complete.

6.7 Transfer of Ownership or Water Trading of Existing Groundwater Use Authorisations

In the past when a farm or smallholding was sold, existing groundwater use authorisations could be transferred to the new owner. Unfortunately, with the New Water Policy Review document that came into effect on 31 January 2014, any existing water use authorisation expires when the farm or smallholding is sold. The selling of a property with a registered groundwater use falls within the same category of water trading as the registered surface water use. Water trading is no longer permitted (RSA DWS, 2014b:8).

The researcher foresees the cancellation of transfer of ownership applications of existing registered groundwater use will have extremely negative effects on the agricultural sector. The farm or smallholding will be rendered as a non-economic unit and the groundwater use will immediately be seen as illegal use. The new owner will have to apply for a new groundwater use authorisation that cannot be guaranteed. The economic value of agricultural land will also be negatively influenced and crop production may decrease. This may have a negative impact on the availability of food in South Africa.

6.8 A Summary of the Groundwater Use License Application Process for Irrigation Purposes

6.8.1 Groundwater use license application process for irrigation purposes on farms and smallholdings

Section 21(a), *Taking water from a water resource*, and Section 21(b), *Storing of water,* is applicable under this section for the application of a groundwater use license for irrigation purposes in the agricultural sector.

The purpose of groundwater use license applications is to positively contribute to the management of groundwater resources and to minimise negative impacts on the groundwater resources.

The groundwater use license application process is as follow:

6.8.1.1 Determination of needs

The applicant identifies the need to apply for a water use authorisation and approaches DWS for guidance. DWS can also approach the farmer to apply for a compulsory license.

The need is identified through a discussion with the farmer and the type of groundwater use authorisation application is determined. The official then gives guidance regarding the forms that must be completed and the specialist studies and other supporting documentation that is required.

6.8.1.2 Information gathering

The information gathering step consists of the completion and signing of the application forms. Required specialist studies are performed and other supporting documentation is gathered.

Table 6.3 indicates the required forms and supporting documentation that must be submitted together with a groundwater use license application for irrigation purposes and was compiled in accordance with the experience of the researcher.

Table 6.3: Required forms and supporting documentation to be submitted with a groundwater use license application

Owner of farm or smallholding	Forms to be completed	Supporting documentation
Individual	• DW756_Individual • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs	• An application fee of R114.00 is payable to DWS. • Certified copy of identity document. • Certified copy of title deed. • Photos of infrastructure if the flood irrigation method was used.

	• DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• VAT number if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from the Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • Letter from Department of Land Affairs indicating whether or not there is a land claim on the farm. • Geophysical investigation for groundwater development and pollution prevention (as and when applicable). • Drilling of boreholes (as and when applicable). • Sanitary seal around the borehole for pollution prevention (as and when applicable). • Lockable borehole cap and marker pole. • Geohydrological report. • Hydrocensus within at least a 1 km radius. • DWS public participation process. • Aquifer pump testing that must include the calibration test, constant rate test and recovery test in order to determine the sustainable yields of the respective boreholes. • Recommendation of type of pump to be installed. • Groundwater samples for macro- and micro-analysis compared to drinking water standards. • Groundwater monitoring plan of quantity, quality and groundwater levels. • Monitoring record book must always be available. • Monitoring of rainfall. • Section 27 motivation according to the NWA. • Letter from accountants indicating the annual turnover on the farm. • BBBEE* certificate indicating the BBBEE level on farming activities. • If the applicant is not the owner of the farm, the owner must provide a letter of consent giving the applicant permission to apply for a groundwater use license on his or her farm as well as signature authority to sign the application forms.
Trust	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use occurs • DW902_Details of property owner	• An application fee of R114.00 is payable to DWS. • Certified copy of identity document. • Certified copy of title deed. • Certified copy of trust deed. • Legal document for signature authority. • Photos of infrastructure if the flood irrigation

	• DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	method was used. • VAT number if applicable. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • Letter from Department of Land Affairs indicating whether or not there is a land claim on the farm. • Geophysical investigation for groundwater development and pollution prevention (As and when applicable). • Drilling of boreholes (As and when applicable). • Borehole logs (As and when applicable). • Sanitary seal around the borehole for pollution prevention (As and when applicable). • Lockable borehole cap and marker pole. • Geohydrological report. • Hydrocensus within at least a 1km radius. • DWS public participation process. • Aquifer pump testing that must include the calibration test, constant rate test and recovery test in order to determine the sustainable yields of the respective boreholes. • Recommendation of type of pump to be installed. • Groundwater samples for macro- and micro-analysis compared to drinking water standards. • Groundwater monitoring plan of quantity, quality and groundwater levels. • Monitoring record book must always be available. • Monitoring of rainfall. • Section 27 motivation according to the NWA. • Letter from accountants indicating the annual turnover on the farm. • BBBEE certificate indicating the BBBEE level on farming activities. • If the applicant is not the owner of the farm, the owner must provide a letter of consent giving the applicant permission to apply for a groundwater use license on his or her farm as well as signature authority to sign the application forms.
Company or Business	• DW758_Company, business or partnership, national or provincial government • DW760_Taking water from a water resource • DW762_Storing water (if applicable) • DW901_Details of property where water use	• An application fee of R114.00 is payable to DWS. • Certified copy of identity document. • Certified copy of title deed. • Proof of company or business registration.

	occurs • DW902_Details of property owner • DW784_Taking water from a water resource – Pump technical data • DW787_Taking water from a water resource – Irrigation field and crop information	• Legal document for signature authority. • Photos of infrastructure if the flood irrigation method was used. • VAT number if applicable. • Company registration number. • Letter giving a consultant permission to make enquiries regarding the application and communicate with DWS on behalf of the applicant (if applicable). • Soil potential certificate from Department of Agriculture, Forestry & Fisheries if the soil is virgin soil. • Letter from Department of Land Affairs indicating whether or not there is a land claim on the farm. • Geophysical investigation for groundwater development and pollution prevention (as and when applicable). • Drilling of boreholes (as and when applicable). • Borehole logs (as and when applicable). • Sanitary seal around the borehole for pollution prevention (as and when applicable). • Lockable borehole cap and marker pole. • Geohydrological report. • Hydrocensus within at least a 1 km radius. • DWS public participation process. • Aquifer pump testing that must include the calibration test, constant rate test and recovery test in order to determine the sustainable yields of the respective boreholes. • Recommendation of type of pump to be installed. • Groundwater samples for macro- and micro-analysis compared to drinking water standards. • Groundwater monitoring plan of quantity, quality, and groundwater levels. • Monitoring record book must always be available. • Monitoring of rainfall. • Section 27 motivation according to the NWA. • Letter from accountants indicating the annual turnover on the farm. • BBBEE certificate indicating the BBBEE level on farming activities. • If the applicant is not the owner of the farm, the owner must provide a letter of consent giving the applicant permission to apply for a groundwater use license on his or her farm as well as signature authority to sign the application forms.

* Broad-Based Black Economic Empowerment

The requirements for a groundwater use license application for abstraction under Section 21(a) of the NWA may be used as guidance to determine the amount of information necessary for each new groundwater use license application. This is based on the amount of recharge that is used by the applicant in relation to the specific property. (Refer to Appendix B.) Unfortunately, many officers in the DWS regional offices do not use this as guidance, mostly due to the lack of knowledge regarding geohydrology or they just do not know about the existence of these developed requirements. Many officials handling groundwater use license applications are not geohydrologists.

There are various South African National Standards documents available as guidelines for the development, maintenance and management of groundwater resources in South Africa. For example:

Part 1: The location and siting of water boreholes (SANS 10299-1:2003), or new version if applicable, is advisable to be used for the development, maintenance and management of groundwater resources.

Part 2: The design, construction and drilling of boreholes (SANS 10299-2:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 4: Test-pumping of water boreholes (SANS 10299-4:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 5: The design, selection, and performance of pumping equipment for production boreholes (SANS 10299-5:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 6: The installation and commissioning of pumping equipment for production boreholes (SANS 10299-6:2009), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 7: The rehabilitation of water boreholes (SANS 10299-7:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 8: The management of water boreholes (SANS 10299-8:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

Part 9: The decommissioning of water boreholes (SANS 10299-9:2003), or new version if applicable, is advisable to use be used for the development, maintenance and management of groundwater resources.

6.8.1.2.1 Structure of the geohydrological report

Fieldwork must be performed during geohydrological studies. There is, however, other possible sources of data that may be sourced during the desktop study of the geohydrological report.

Table 6.4 indicates various data sources which may be required during the geohydrological study and as was experienced by the researcher.

Table 6.4: Various data sources required during the geohydrological study to be submitted with a groundwater use license application

Data Needed	Data and Information	Source
Study area	Quaternary catchment boundaries	WR90
Population data	Population statistics	Central Statistical Services
Land Use	Various land use activities	Farmer
Conservation areas	Protected fauna and flora and other species	Department of Environment Affairs
Water sources	Various information	DWS
Physiography	Topographical maps 1:250 000 1:50 000	Directorate: Surveys and Land Information
Climatic data	Rainfall data Evaporation data	Weather Bureau WR90 SA Atlas of Agrohydrology and Climatology
Geology	Geological maps 1:250 000 1:50 000 (if available)	Council for Geoscience
Geology Physiography	Remote sensing maps and data Satellite images Aerial photographs	Satellite Applications Centre Directorate: Surveys and Land Information
Soils	Soil maps	Department of Agriculture, Forestry and Fisheries Agricultural Research Council WR90
Drainage	Flow data Wetland inventory	DWAF Department of Environmental Affairs and Tourism WR90
Vegetation	Various information available	National Botanical Institute WR90
Geohydrology	Hydrogeological maps National groundwater maps Harvest potential map Groundwater vulnerability map 1:500 000 geohydrological maps	Water Research Commission DWS
Geohydrological data	Geohydrological data National groundwater database Hydrochemical database Geohydrological reports	DWS National Groundwater Information System DWAF Regional Offices Water Research Commission Local authorities, consultants, other sources

As a result of her experience, the researcher suggests that the following basic information must at least be included into a geohydrological report:

- **Introduction**
  - Terms of reference.
  - Project team.
  - Sources of data.
  - Work undertaken.
- **Background Information**
  - Locality and extent of study area (map), including quaternary catchments and catchment areas.
  - Population and sources of water.
  - Land use (map), including urban, agricultural, forestry, mining and industry.
  - Conservation and protected areas (map).
  - Water sources, including dams, interbasin transfer schemes and groundwater.
- **Physiography and Climate**
  - Topography map, including slope, geomorphological classification and mountain ranges.
  - Climate, including rainfall (volumes, seasonality) and evaporation (volumes, seasonality) (map).
  - Geology (map), including lithology, stratigraphy and structure.
  - Geophysical investigation.
  - Soils.
  - Drainage, including rivers, dams and lakes, wetlands, springs and vleis, mean annual runoff, baseflow and baseflow indices, groundwater contribution to baseflow and instream flow requirements information.
  - Vegetation (map), including types and classification, for example Low and Rebelo, riparian vegetation types and eco-regions (map).
- **Geohydrology**
  - Aquifer types (primary, secondary) (map).
  - Hydraulic characteristics and range of parameters.
  - Typical drilling targets.
  - Boreholes and borehole characteristics (depth, yield and construction) (map).
  - Groundwater abstraction and use (domestic, industrial, agricultural and mining).
  - Groundwater levels and depth to groundwater, groundwater level contour map and hydraulic gradient (map), typical seasonal and annual fluctuations of groundwater levels – particularly in the vicinity of surface water bodies.

- Groundwater quality (Piper or Durov diagrams, contour maps, statistical analyses and description).
- Source and potential sources of groundwater contamination.
- Known incidences of groundwater contamination in a catchment.
- Recharge.
- Groundwater potential, including harvest potential.
- Surface–groundwater interaction, including groundwater contribution to baseflow and groundwater-dependent ecosystems.
- Aquifer classification (sole source, major, minor, poor) (map).
- Aquifer vulnerability (map).
- Aquifer stress status.
- Conceptual geohydrological model of study area, including a water balance.
- Groundwater flow.
- Hydrocensus.
- Monitoring plan for groundwater quantity, groundwater quality, groundwater levels and rainfall.
- Conclusions and recommendations.

6.8.1.2.2 Section 27 motivation according to the National Water Act

Section 27 motivation of the NWA must include the following:

- The applicant's water use entitlements.
- A description of the race and gender ownership and control of the groundwater use.
- An explanation of the efficient and beneficial use of water in the public interest.
- A description of the socio-economic impact of the issuing or refusal of the license.
- The strategic importance of the water use to be authorised.
- A description of the investments related to the water use already made.
- An explanation of the duration of the undertaking to which the license is required.
- The following factors will also be considered:
  - Any catchment management strategy applicable to the water resource.
  - The class and resource quality objectives of the water resource.
  - The quality of the water in the resource required for the reserve and international obligations.
- In addition, where multiple authorisations are required, a water use authorisation may only be issued once these multidisciplinary criteria have been addressed in an integrated manner.

6.8.1.2.3 Basic contents of a groundwater monitoring plan

Flowing from the researcher's experience, the following aspects are to be considered when developing a groundwater monitoring plan for groundwater quantity and groundwater quality:

- Introduction.
- Background and rationale.
- Focus and scope of the groundwater monitoring plan.
- Groundwater monitoring concepts and general aspects.
- Design procedure.
- Set-up of the groundwater monitoring plan for the farmer.
- Best option for a groundwater monitoring plan.
- Purpose and approach to identify possible groundwater problems.
- Preliminary characterisation of the area where the farm or smallholding is situated.
- Preliminary characterisation of the aquifers in the area.
- Preliminary assessment of the groundwater situation.
- Preliminary evaluation of the results and specification of key monitoring issues.
- Define a sustainable monitoring scale.
- Determine the hydrogeological situation
- Determine the direction of groundwater flow.
- Assess the groundwater quality as background reference.
- Monitoring objectives for groundwater quality and quantity.
- Consider monitoring points.
- Use existing boreholes and if required, new boreholes.
- Determine annual costs involved in implementing the monitoring programme.
- Orientate the farmer regarding the monitoring programme that he must implement and sustain.
- Capacitate the farmer on how to do the monitoring himself.
- Assist the farmer to obtain the necessary equipment for the monitoring programme.
- Data management plan for data recording, storage, processing, validation and the sending of the data at intervals to the Department as determined by DWS.

6.9 Request the Reserve Determination from the Directorate: Resource Directed Measures

Refer to Appendix B for an example of a reserve determination request letter that the official should draft. A list of requirements of documents that must be submitted together with the reserve determination request letter is included as well.

6.10 Assessment, Evaluation and Inputs from the Reserve Determination when Received

On receipt of the reserve determination the groundwater use licensing application evaluation template should be used (as indicated in Appendix B).

6.11 Record of Recommendation

After performing the assessment and evaluations according to the reserve determination received, a record of recommendation is compiled. (Refer to Appendix B for an example of a record of recommendation.)

6.12 Water Use Authorisation Assessment Advisory Committee

After performing the assessment and evaluations according to the reserve determination received, the record of recommendation for the groundwater use license application is presented at the regional WUAAAC for technical advice and inputs.

After the meeting the record of recommendation together with the groundwater use license application is sent to the DWS national WUAAAC for a final decision.

6.13 Issuing a Groundwater Use License

In the event of the groundwater use license application being approved, the final record of recommendation, together with a license and conditions, is compiled.

The final record of recommendation together with a license and conditions is then sent to the respective DWS regional office for capturing on the Water Authorisation and Registration Management System. Thereafter, a registration certificate with the details and conditions of the groundwater use license is printed and sent via registered post to the applicant. The applicant is required to sign the letter of receipt and send it back to the respective DWS regional office. The new groundwater user will receive bills for the groundwater registered volume. The user is billed for the registered groundwater use and not the actual groundwater use.

6.14 Declining of a Groundwater Use License

In the event of the groundwater use license application being declined, the applicant may launch an appeal to the respective DWS regional office and take the matter further to the Water Tribunal for a final decision.

6.15 A Framework to Understand and Process a Groundwater Use License Application for Groundwater Abstraction for Irrigation Purposes

In order to visualise how the handling and processing of a groundwater use license application for irrigation purposes proceeds, diagrams, in the form of frameworks are used as illustrations and are divided into various stages.

6.15.1 Stage 1: Process before a groundwater use license application for irrigation purposes is lodge.

The farmer as applicant identifies the need to apply for a groundwater use license application (GWULA) for irrigation purposes. He or she approaches then DWS for advice.

Figure 6.3 summarises the groundwater use license application stage 1 for irrigation purposes.

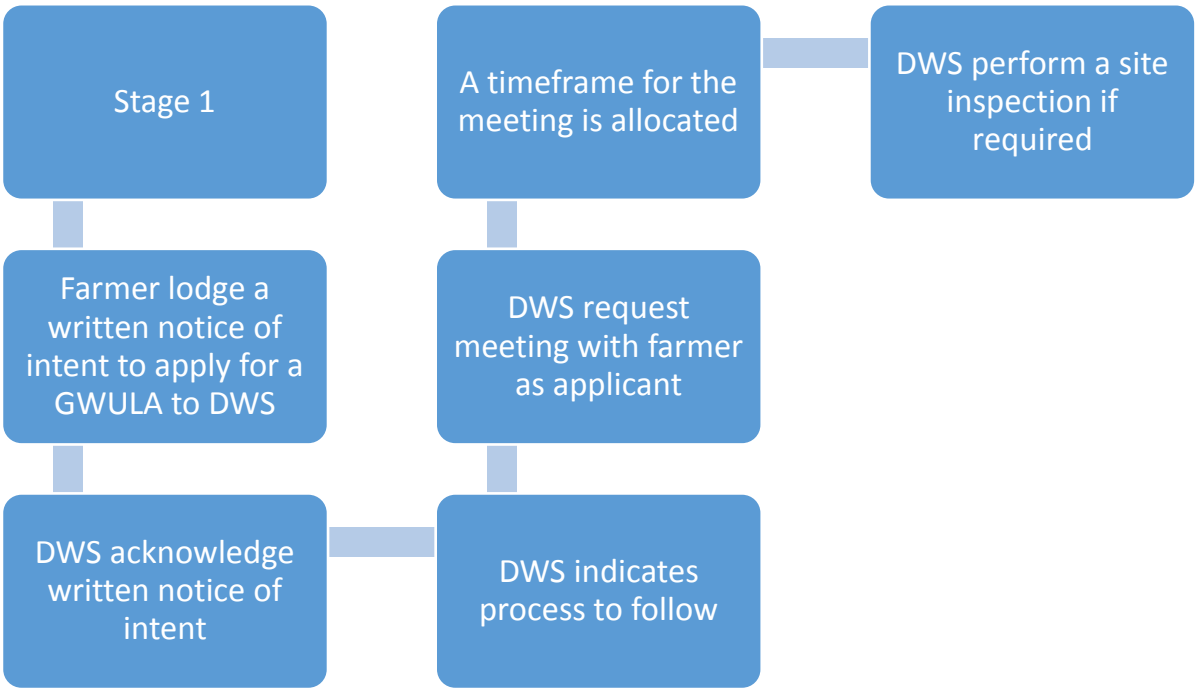


Figure 6.3: Stage 1 of the GWULA process

Figure 6.4 summarises the groundwater use license application stage 2 for irrigation purposes.

6.15.2 Stage 2: Preparation and submission of GWULA

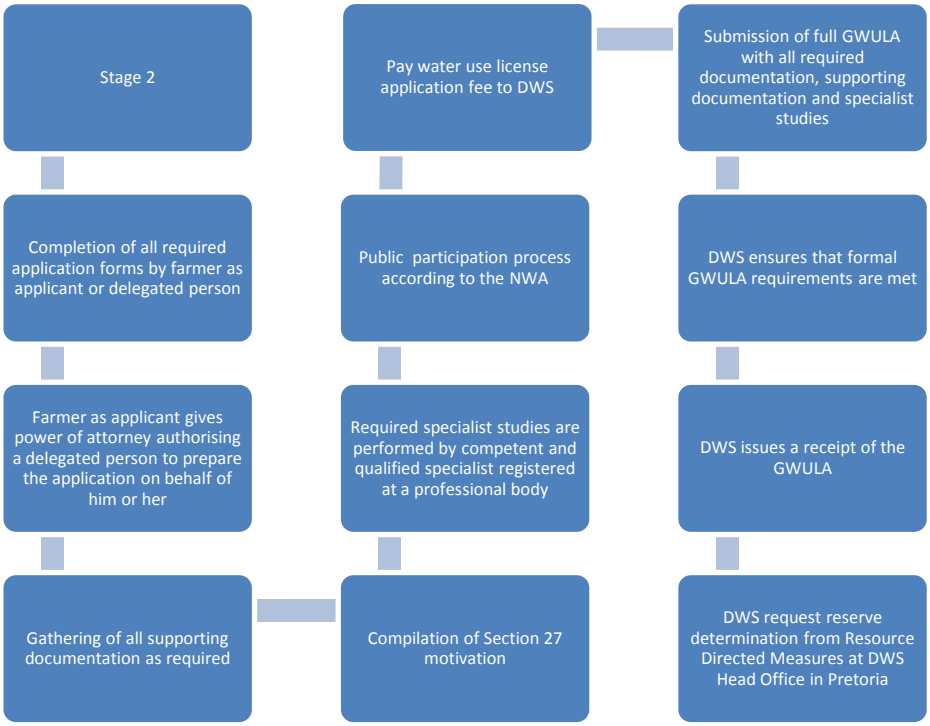


Figure 6.4: Stage 2 of the GWULA process

6.15.3 Stage 3: Assessment of the GWULA

Figure 6.5 summarises the groundwater use license application stage 3 for irrigation purposes.

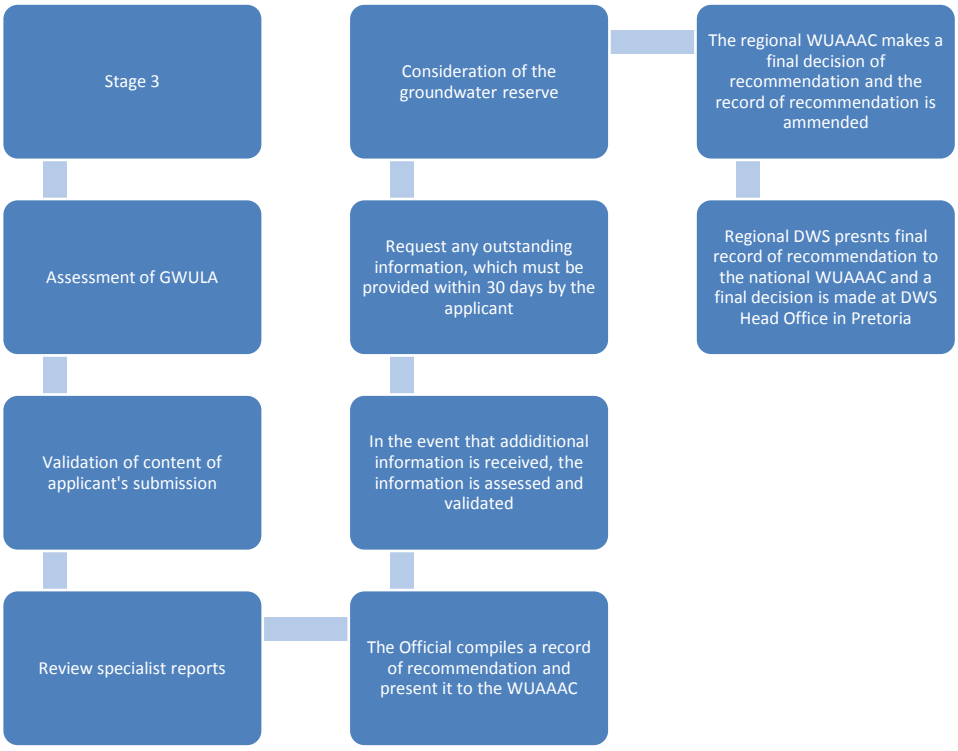


Figure 6.5: Stage 3 of the GWULA process

6.15.4 Stage 4: Issuing or non-issuing of a GWULA

Figure 6.6 summarises the groundwater use license application stage 4 for irrigation purposes.

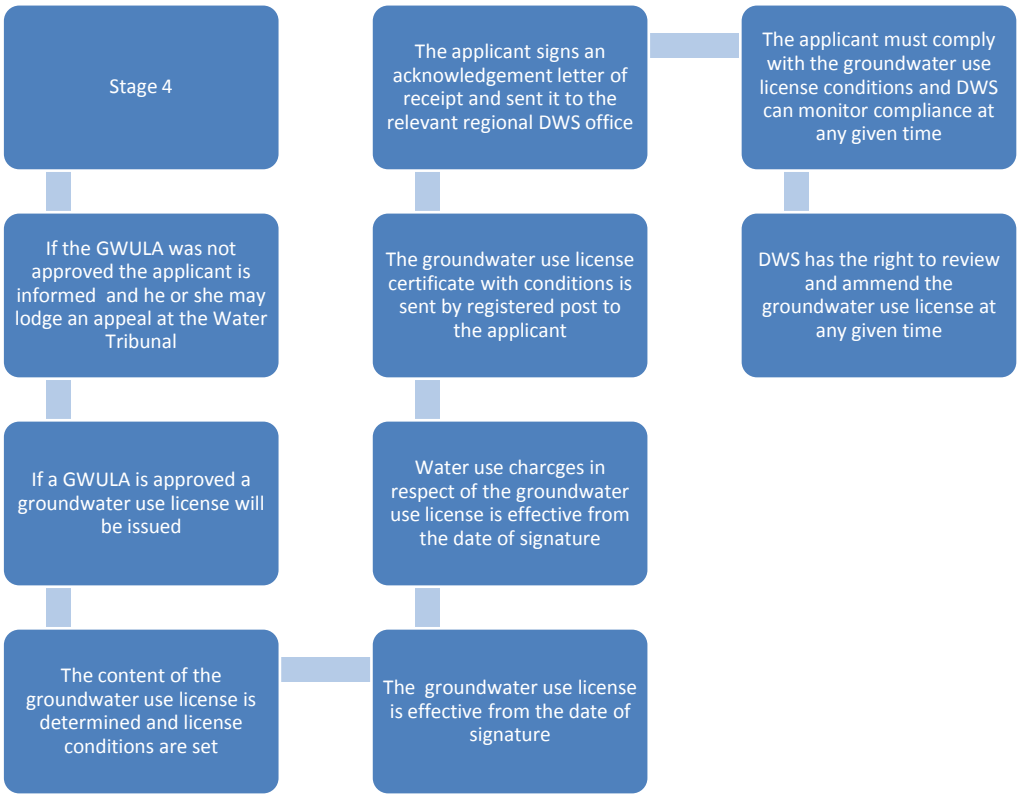


Figure 6.6: Stage 4 of the GWULA process

6.16 Overall Process Flow to be Followed by the Applicant and DWS Official Regarding the GWULA

Figure 6.7 summarises the overall process flow to be followed by the applicant and the DWS Official regarding the GWULA.

Figure 6.7: Overall process flow of GWULA

6.17 Conclusion

A framework for handling groundwater use authorisation applications for irrigation purposes in the agricultural sector was developed. The motivation for this framework, only being intended for irrigation purposes in the agricultural sector, is that there are far too many problems associated with the handling and processing of groundwater use authorisation applications for irrigation purposes in the agricultural sector.

Various principles, which are relevant to the consideration of water use authorisation applications were highlighted. The existing lawful groundwater use process was discussed. Groundwater use is recognised as an existing lawful water use when groundwater abstraction or groundwater resource development took place between the period of 1 October 1996 and 31 September 1998.

Schedule 1 use was discussed and it entitles a person to acquire water for reasonable domestic use, for small gardening that is not for commercial purposes, for watering livestock, or for fire-fighting. This schedule also permits the storing and using of run-off water from the roof (RSA DWAF, 2007b:3). No formal application process is required.

The general authorisation application procedure was discussed. According to Section 39 of the NWA and as published on 26 March 2004 in the Government Gazette 2004, users may use water without a license if the volume is within the provisions of the general authorisations (RSA DWA, 2004). In terms of the general authorisation, water users must register their use. A general authorisation will continue until compulsory licensing is enforced. This will result in the withdrawal of the general authorised use and the continuation of existing lawful groundwater use.

When a farm or smallholding was sold in the past, existing groundwater use authorisations could be transferred to the new owner. Unfortunately, with the New Water Policy Review document that came into effect on 31 January 2014, any existing water use authorisation expires when the farm or smallholding is sold.

The researcher foresees that the cancellation of transfer of ownership applications of existing registered groundwater use will have extremely negative effects in the agricultural sector. The farm or smallholding will be rendered as a non-economic unit and the groundwater use will immediately be regarded as illegal use. The new owner will have to apply for a new groundwater use authorisation that cannot be guaranteed. The economic value of agricultural land will also be negatively influenced.

The next chapter will elaborate on case studies to demonstrate the developed framework for groundwater use authorisations, as part of groundwater governance in water scarce areas in South Africa.

Chapter 7

Case Studies Demonstrating the Framework for Groundwater Use Authorisations as Part of Groundwater Governance within South Africa

7.1 Introduction

The main objective of Chapter 7 is to provide true case studies in order to demonstrate the developed framework for groundwater use authorisations as part of groundwater governance in South Africa.

Case study A is with regard to the farm namely "the remaining extent of Zamenloop 382" in the Edenburg district of the Free State Province. In the first phases of the research, the owner of the farm, Mr C.A. (Corrie Roux), sadly passed away. His son, Mr Ricus Roux, gave the researcher permission to make use of his father's groundwater and surface water use authorisation applications and specialist study as part of this case study. When Mr Roux is mentioned in this chapter, it will refer to the late Mr Corrie Roux.

Case study B is with regard to the farm namely "Portion 0 of Uitkoms 1033" in the Registration Division: IN, North West Province, as required in terms of the National Water Act, 1998 (Act 36 of 1998).

7.2 Background

The preceding chapters all built up to the development of a framework for groundwater use authorisations as part of groundwater governance within South Africa. It included the following: The introduction and overview of the proposed research study and the action research methodology in *Chapter 1.* This was followed by an overview and discussion on groundwater governance in South Africa in *Chapter 2*. *Chapter 3* provided an overview of food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations. *Chapter 4* provided a comparison and evaluation of the National Water Act (Act 36 of 1998) with international water laws, followed by a discussion on the groundwater reserve determination process of South Africa in *Chapter 5*. *Chapter 6* provided a framework for processing groundwater use authorisation in the agricultural sector. These all built up to this chapter for true case studies to test the developed framework for groundwater use authorisations as part of groundwater governance within South Africa.

7.3 Case Study A

After purchasing the farm, namely the remaining extent of Zamenloop 382 in the Edenburg District in the Free State Province, Mr Corrie Roux requested the researcher to assist him with the following on his farm:

- Geophysical investigation.
- Groundwater resource development.
- Transfer of ownership application of the existing registered water use.
- Surface water use licensing application.
- Groundwater general authorisation application.
- Preliminary geohydrological and hydrological report.
- For the aquifer pump testing Mr Roux selected and appointed a contractor.

Mr Roux was planning to plant pecan nut trees on his farm.

7.3.1 Preliminary geohydrological and hydrological situation on the remaining extent of Zamenloop 382

The preliminary geohydrological and hydrological report comprised of the following sections:

7.3.1.1 Objectives and scope of the preliminary geohydrological and hydrological study

The scope of the project was to determine the preliminary geohydrological and hydrological situation. It included the following:

- Desktop study.
- Fieldwork.
- Description of topography and drainage.
- Prepare a 1:50 000 topographical map using a geographic information system (GIS).
- Determine preliminary geology.
- Prepare a geological map.
- Hydrocensus with borehole data as, and if available.
- Prepare a map indicating the location of the boreholes.
- Groundwater and surface water sampling for chemical and microbiological quality analysis as and when applicable.
- Estimation of direction of groundwater flow.
- Aquifer classification.
- Prepare a geohydrological map.
- Determine groundwater and surface water use within the area.

- Reporting.

7.3.1.2 Background, location, topography and drainage of the study site

Important features of the farm included the following:

- The coordinates of the farm are S -29.551262° (latitude) and E 25.783575° (longitude).
- The approximate topographical height of the site is 1 280 m above sea level.
- Due to the elevation of the area of the site, the general local drainage is expected to be from a north-eastern to north-western direction.

The Department of Water and Sanitation requires a 1:50 000 topographical map of the farm and Edenburg area. Figure 7.1 indicates the location of the remaining extent of Zamenloop 382 on a 1:50 000 topographical map.

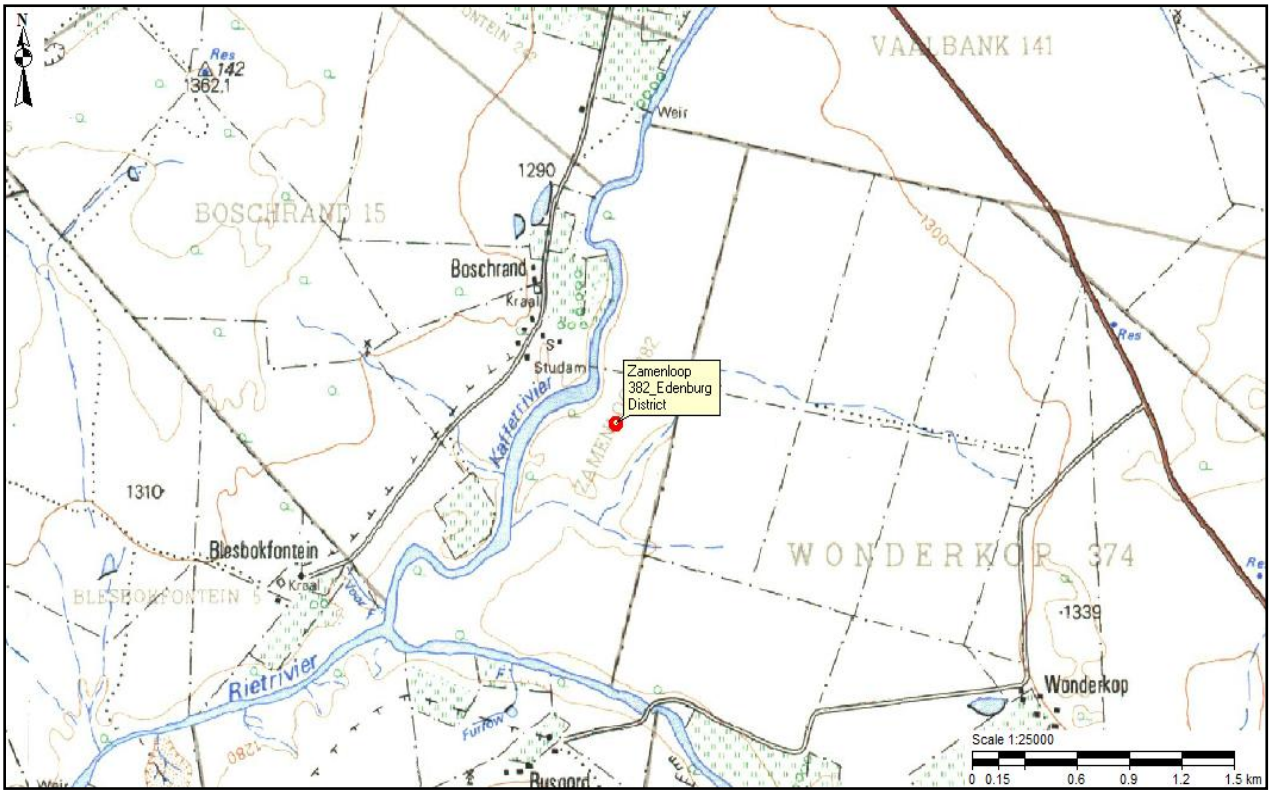


Figure 7.1: Topographical map number 2925DB of the remaining extent of Zamenloop 382 in the Edenburg district

7.3.1.3 Regional geological setting

The geology of the farm comprises of the Adelaide subgroup of the Beaufort group of the Karoo sequence, with the occurrence of blue-grey and purple mudstone interbedded with yellow sandstone and siltstone. Aeolian sand and alluvium are seen at the river areas.

The DWS requires a 1:250 000 geological map of the farm and Edenburg area, therefore Figure 7.2 indicates the location of the remaining extent of Zamenloop 382 and the Edenburg area on a geological map. For the purpose of this chapter, the 1:50 000 scale is used.

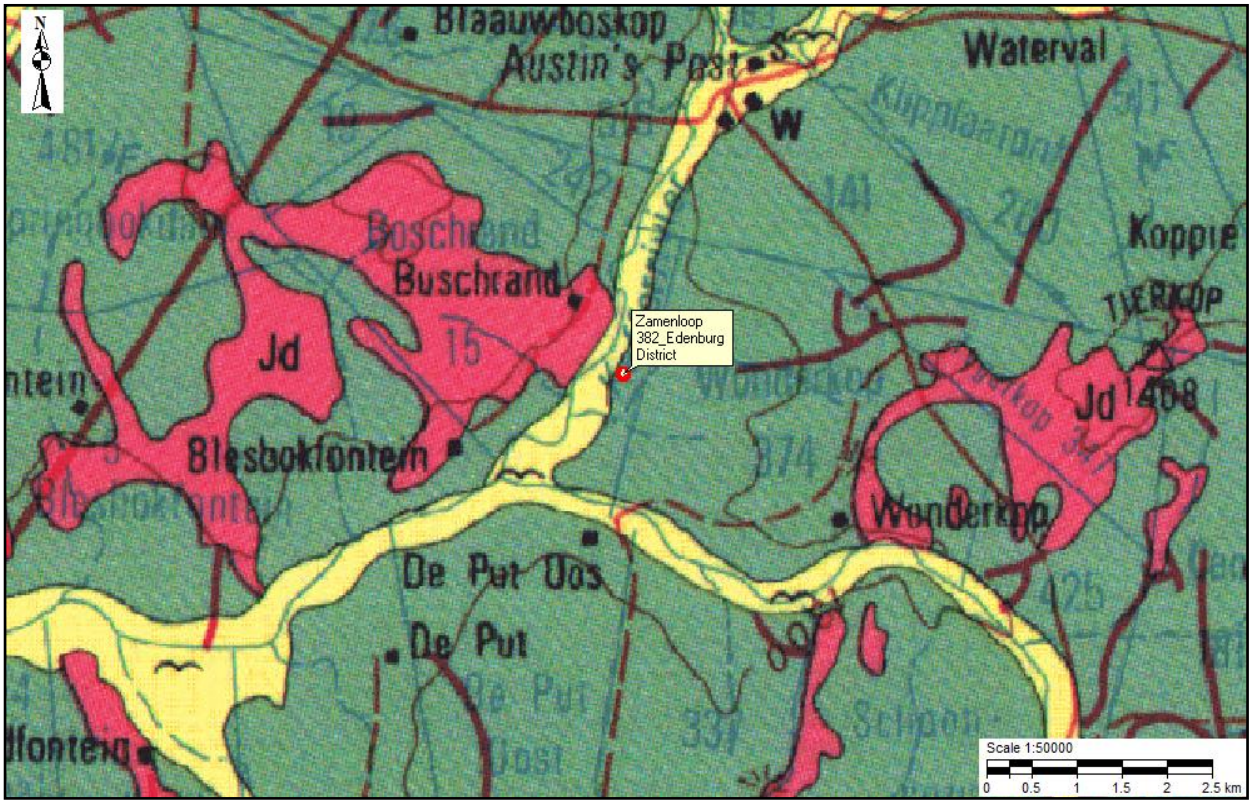


Figure 7.2: Geological map number 2924 Koffiefontein of the remaining extent of Zamenloop 382 in the Edenburg district

7.3.1.4 Geohydrology and hydrology setting

7.3.1.4.1 Hydrocensus

No boreholes were found within a one kilometer radius of the proposed groundwater abstraction area. The nearest borehole identified with the National Groundwater Archive was greater than 16 km from the farm. The farm is adjacent to the Riet River and the Tierpoort River.

7.3.1.4.2 National Groundwater Archive (NGA)

The NGA database provided more groundwater data with regard to the surrounding area of the proposed groundwater abstraction. Figure 7.3 indicates the location of the boreholes, as identified with the NGA and on the farm.

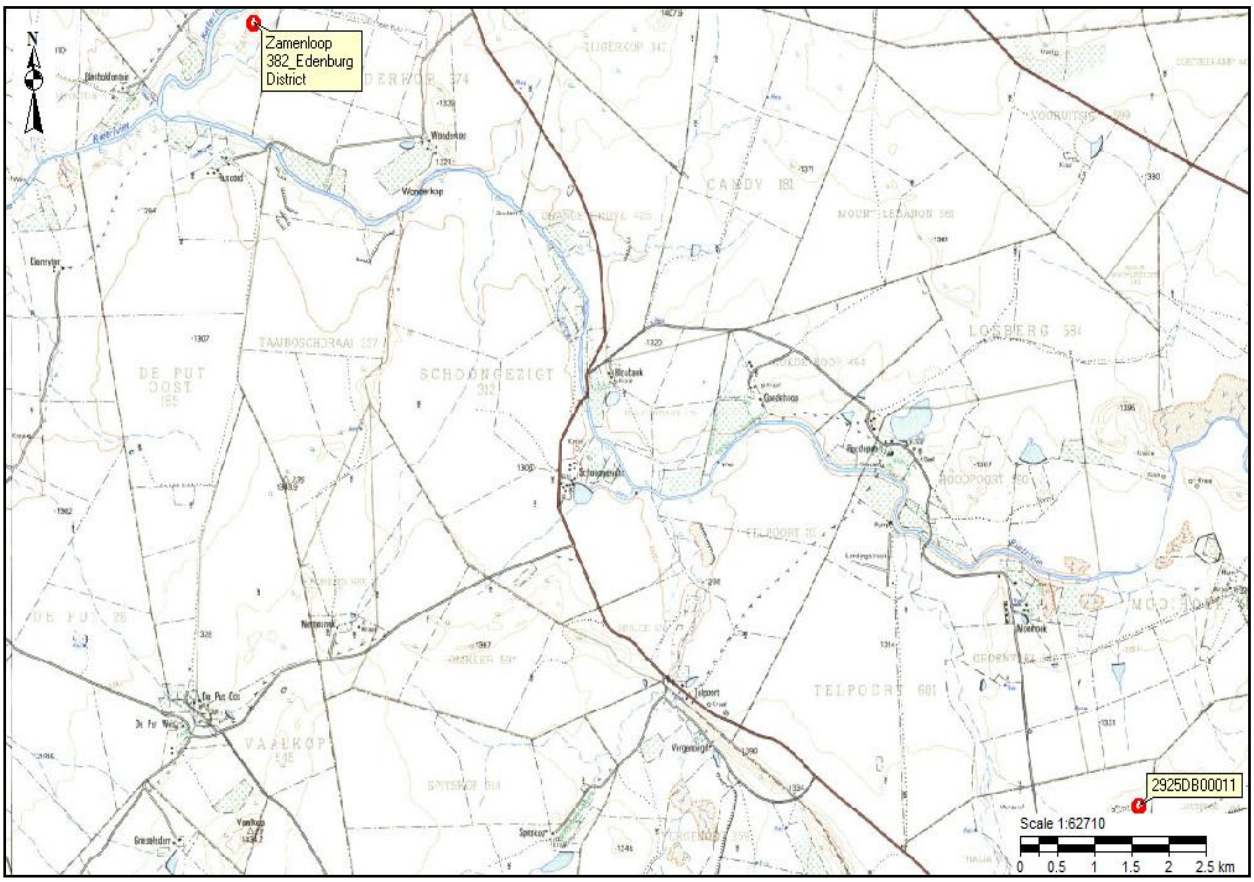


Figure 7.3: Locations of boreholes identified in the area of remaining extent of Zamenloop 382 in the Edenburg district

Boreholes that were identified with the NGA database are tabled in Table 7.1. They were identified according to location, groundwater levels, approximate distance from the nearest site and year of measurement.

Table 7.1: Boreholes identified on the remaining extent of Zamenloop 382 in the Edenburg district

Site Name	Location		Water level (mbgl)	Approximate Distance from nearest site (km)	Year of measurement
	S (Latitude)	E (Longitude)			
2925DB00007	-29.6501°	25.8868°	3	>16km	1974
2925DB00011	-29.6353°	25.9063°	15	>16km	1974
2925DB00019	-29.6474°	25.9902°	21	>16km	1974
2925DB00022	-29.6704°	25.8415°	1	>16km	1974
2925DB00023	-29.6606°	25.8643°	9	>16km	1974
2925DB00038	-29.6676°	25.8863°	12	>16km	1974
2925DB00044	-29.6617°	25.9025°	8	>16km	1974
2925DB00060	-29.6648°	25.9825°	9	>16km	1974
2925DB00084	-29.7399°	25.8444°	6	>16km	1974
2925DB00088	-29.7388°	25.8857°	9	>16km	1974
2925DB00113	-29.7497°	25.9031°	9	>16km	1974
2925DB00127	-29.5411°	25.9849°	9	>16km	1974
2925DB00133	-29.7467°	25.7650°	5	>16km	1983

Boreholes that were drilled on the remaining extent of Zamenloop 382, are tabled in Table 7.2 according to location, groundwater levels, approximate distance from the nearest site and year of measurement.

Table 7.2: Boreholes drilled on the remaining extent of Zamenloop 382 in the Edenburg district

Borehole number	Location		Water level (mbgl)	Approximate Distance from nearest site (km)	Year of measurement
	S (Latitude)	E (Longitude)			
(G3)	-29.542550°	25.787233°	5.82	On site	2012
(G4)	-29.546483°	25.785717°	6.70	On site	2012
(G5)	-29.547767°	25.784633°	7.28	On site	2012

Although the data from the NGA database as indicated in Table 7.1 are old and outdated, the groundwater level measurements for the boreholes between the year 1974 and 1984 are between 1 and 10 m below ground level (mbgl) and corresponds well with the current groundwater levels as seen in Table 7.2.

7.3.1.5 Groundwater and surface water quality

Groundwater samples were taken from the newly drilled boreholes on the remaining extent of Zamenloop 382 and surface water samples from the weirs of the farm from the Tierpoort River.

The groundwater and surface water samples were analysed for various chemical and microbiological parameters by the laboratory at the Institute for Groundwater Studies (IGS) at the University of the Free State (UFS).

The results indicated that all the chemical and microbiological parameters of the water from the river, except for Na (sodium) and *Feacal Coliforms,* are within the target water quality guideline range.

All the chemical parameters of the groundwater samples, except for Cl (chloride) at G3 and G5, Br (bromide) at G3, sodium at boreholes G3 and G5, and NO_3^- (nitrate) concentrations at borehole G4, are within drinking water quality limits, as specified by the South African National Standards 241:2006 & 2011 for drinking water purposes.

The Na (sodium concentration) of 101.3 mg/L river water and Na concentration of 282 mg/L groundwater at G5, exceeds the Target Water Quality Range of 70 mg/L for irrigation purposes.

Crops that are sensitive to foliar absorption accumulate toxic levels of sodium when crop foliage is wetted. They display foliar injury and yield decrease; however, pecan nut trees are not listed as a sensitive crop.

The *Feacal coliform* concentration of 46 cfu (*coliforms units*)/100 ml river water exceeds the Target Water Quality Range of 1 cfu/100 ml water. Crops and pastures that are not consumed raw can be irrigated, provided the crops and pastures are allowed to dry before harvesting and grazing.

The Cl concentration of 915 mg/L groundwater at G3 and 480 mg/L groundwater at borehole G5, exceeds the Target Water Quality Range of 100 mg/L water. At borehole G3, all moderately sensitive crops and moderately tolerant crops accumulate chloride to levels toxic to crops. This occurs when chloride uptake is through root absorption where water is applied to the soil surface, thereby excluding wetting of crop foliage.

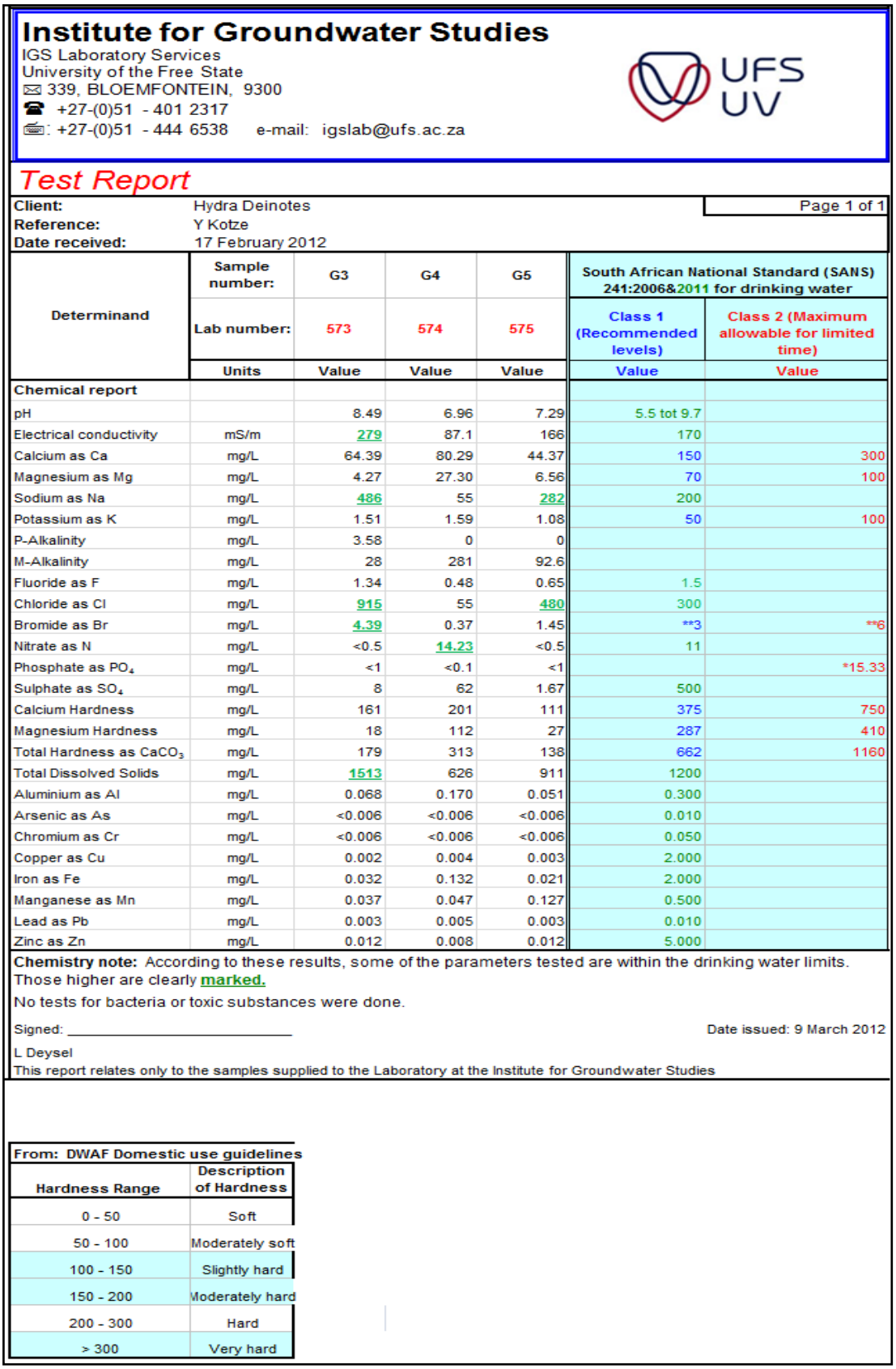
As stated previously, pecan nut trees are not listed as a sensitive crop. At borehole G5, increasing problems with the accumulation of chloride to levels that are toxic to crops can be expected when chloride uptake is through root absorption. This excludes wetting of crop foliage.

The nitrate concentration of 14.23 mg/L groundwater at borehole G4 exceeds the Target Water Quality Range of 5 mg/L water. Sensitive crops are increasingly likely to be affected, depending on the magnitude of irrigation application. Other crops remain largely unaffected in the lower concentration range, but are increasingly affected as concentration increases. Pecan nut trees are not listed as a sensitive crop.

For the high concentration of Total Dissolved Solids at borehole G3 a relative moderate salt-tolerant crop can be maintained by using a low-frequency application system.

Figure 7.4 provides more detailed data on the test report results by IGS regarding the groundwater quality of the samples taken from the boreholes.

Figure 7.5 provides more detailed data on the test report results by IGS regarding the surface water quality of the samples taken from the weirs situated within the Tierpoort River.



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UFS UV

Test Report

Client: Hydra Deinotes
Reference: Y Kotze
Date received: 17 February 2012

Page 1 of 1

Determinand	Sample number:	G3	G4	G5	South African National Standard (SANS) 241:2006&2011 for drinking water	
	Lab number:	573	574	575	Class 1 (Recommended levels)	Class 2 (Maximum allowable for limited time)
	Units	Value	Value	Value	Value	Value
Chemical report						
pH		8.49	6.96	7.29	5.5 tot 9.7	
Electrical conductivity	mS/m	279	87.1	166	170	
Calcium as Ca	mg/L	64.39	80.29	44.37	150	300
Magnesium as Mg	mg/L	4.27	27.30	6.56	70	100
Sodium as Na	mg/L	486	55	282	200	
Potassium as K	mg/L	1.51	1.59	1.08	50	100
P-Alkalinity	mg/L	3.58	0	0		
M-Alkalinity	mg/L	28	281	92.6		
Fluoride as F	mg/L	1.34	0.48	0.65	1.5	
Chloride as Cl	mg/L	915	55	480	300	
Bromide as Br	mg/L	4.39	0.37	1.45	**3	**6
Nitrate as N	mg/L	<0.5	14.23	<0.5	11	
Phosphate as PO_4	mg/L	<1	<0.1	<1		*15.33
Sulphate as SO_4	mg/L	8	62	1.67	500	
Calcium Hardness	mg/L	161	201	111	375	750
Magnesium Hardness	mg/L	18	112	27	287	410
Total Hardness as $CaCO_3$	mg/L	179	313	138	662	1160
Total Dissolved Solids	mg/L	1513	626	911	1200	
Aluminium as Al	mg/L	0.068	0.170	0.051	0.300	
Arsenic as As	mg/L	<0.006	<0.006	<0.006	0.010	
Chromium as Cr	mg/L	<0.006	<0.006	<0.006	0.050	
Copper as Cu	mg/L	0.002	0.004	0.003	2.000	
Iron as Fe	mg/L	0.032	0.132	0.021	2.000	
Manganese as Mn	mg/L	0.037	0.047	0.127	0.500	
Lead as Pb	mg/L	0.003	0.005	0.003	0.010	
Zinc as Zn	mg/L	0.012	0.008	0.012	5.000	

Chemistry note: According to these results, some of the parameters tested are within the drinking water limits. Those higher are clearly marked.

No tests for bacteria or toxic substances were done.

Signed: _____ Date issued: 9 March 2012

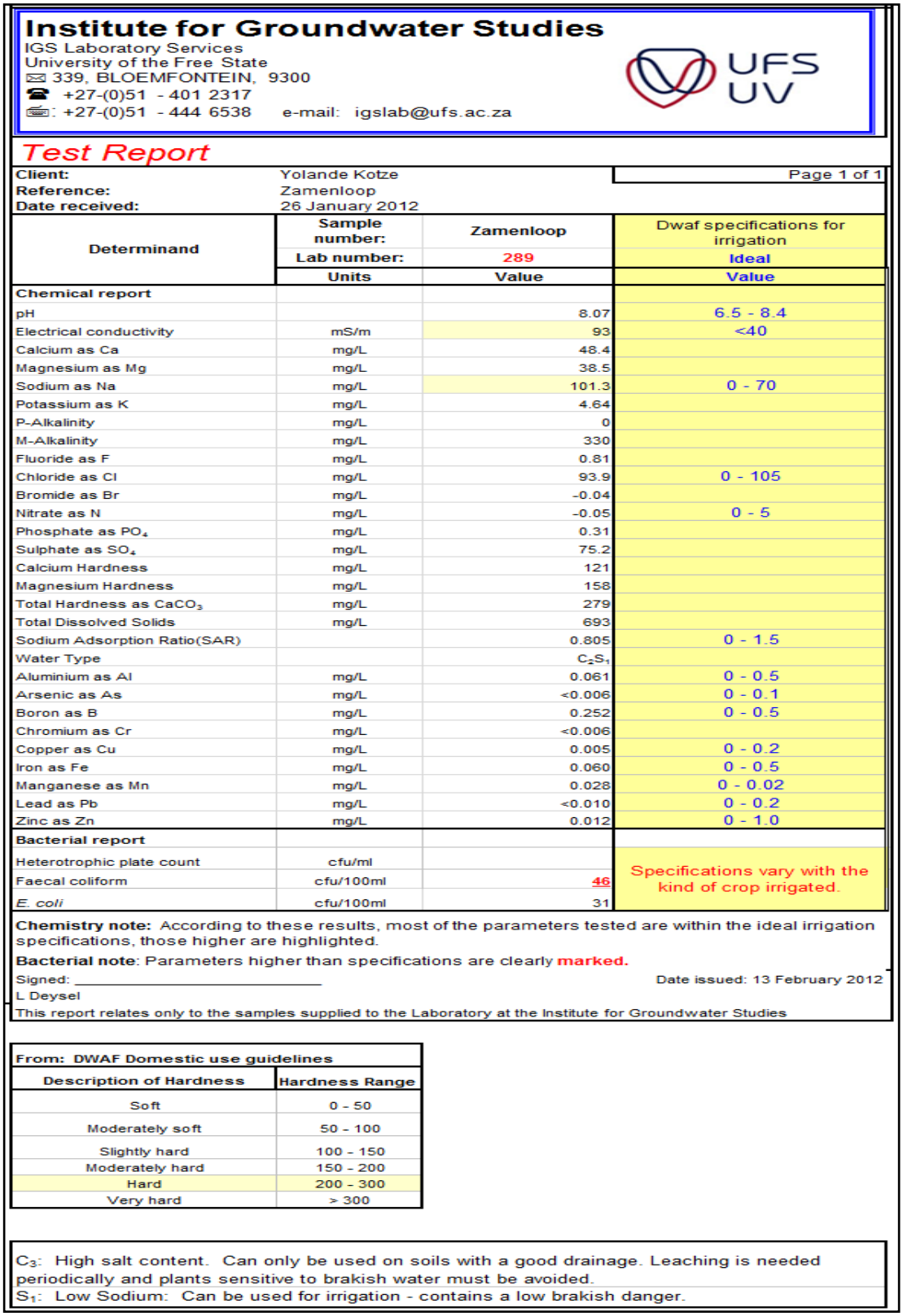
L Deysel

This report relates only to the samples supplied to the Laboratory at the Institute for Groundwater Studies

From: DWAF Domestic use guidelines

Hardness Range	Description of Hardness
0 - 50	Soft
50 - 100	Moderately soft
100 - 150	Slightly hard
150 - 200	Moderately hard
200 - 300	Hard
> 300	Very hard

Figure 7.4: Test report results from the Institute for Groundwater Studies regarding the groundwater quality of samples taken from the boreholes on the remaining extent of Zamenloop 382



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UFS UV

Test Report

Client: Yolande Kotze
Reference: Zamenloop
Date received: 26 January 2012

Page 1 of 1

Determinand	Sample number:	Zamenloop	Dwaf specifications for irrigation
	Lab number:	289	Ideal
	Units	Value	Value
Chemical report			
pH		8.07	6.5 - 8.4
Electrical conductivity	mS/m	93	<40
Calcium as Ca	mg/L	48.4	
Magnesium as Mg	mg/L	38.5	
Sodium as Na	mg/L	101.3	0 - 70
Potassium as K	mg/L	4.64	
P-Alkalinity	mg/L	0	
M-Alkalinity	mg/L	330	
Fluoride as F	mg/L	0.81	
Chloride as Cl	mg/L	93.9	0 - 105
Bromide as Br	mg/L	-0.04	
Nitrate as N	mg/L	-0.05	0 - 5
Phosphate as PO_4	mg/L	0.31	
Sulphate as SO_4	mg/L	75.2	
Calcium Hardness	mg/L	121	
Magnesium Hardness	mg/L	158	
Total Hardness as $CaCO_3$	mg/L	279	
Total Dissolved Solids	mg/L	693	
Sodium Adsorption Ratio(SAR)		0.805	0 - 1.5
Water Type		C_2S_1	
Aluminium as Al	mg/L	0.061	0 - 0.5
Arsenic as As	mg/L	<0.006	0 - 0.1
Boron as B	mg/L	0.252	0 - 0.5
Chromium as Cr	mg/L	<0.006	
Copper as Cu	mg/L	0.005	0 - 0.2
Iron as Fe	mg/L	0.060	0 - 0.5
Manganese as Mn	mg/L	0.028	0 - 0.02
Lead as Pb	mg/L	<0.010	0 - 0.2
Zinc as Zn	mg/L	0.012	0 - 1.0
Bacterial report			
Heterotrophic plate count	cfu/ml		Specifications vary with the kind of crop irrigated.
Faecal coliform	cfu/100ml	46	
E. coli	cfu/100ml	31	

Chemistry note: According to these results, most of the parameters tested are within the ideal irrigation specifications, those higher are highlighted.
Bacterial note: Parameters higher than specifications are clearly **marked.**

Signed: _____ Date issued: 13 February 2012
L Deysel
This report relates only to the samples supplied to the Laboratory at the Institute for Groundwater Studies

From: DWAF Domestic use guidelines

Description of Hardness	Hardness Range
Soft	0 - 50
Moderately soft	50 - 100
Slightly hard	100 - 150
Moderately hard	150 - 200
Hard	200 - 300
Very hard	> 300

C_3: High salt content. Can only be used on soils with a good drainage. Leaching is needed periodically and plants sensitive to brakish water must be avoided.
S_1: Low Sodium: Can be used for irrigation - contains a low brakish danger.

Figure 7.5: Test report results from the Institute for Groundwater Studies regarding the surface water quality of samples taken from the weirs situated within the Tierpoort River adjacent to the remaining extent of Zamenloop 382

7.3.1.6 Groundwater flow

Due to the elevation of the area of the site, the general local drainage is estimated to be from a north-eastern to north-western direction.

7.3.1.7 Aquifer classification

The aquifer is classified as a minor aquifer in accordance with The Aquifer Classification Map of South Africa (Parsons and Associates).

According to minimum requirements set by the Department of Water Affairs, the main parameters in the classification of the aquifer are the yield of the boreholes and the quality of the groundwater. Borehole yields and groundwater quality in the proximity of the site could not be obtained, and the aquifer area was therefore classified according to the map as a *minor aquifer*.

A minor aquifer can be typically fractured or potentially fractured rocks which do not have a high primary permeability or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying base flow for rivers. A minor aquifer is also expected to be a moderately yielding aquifer of acceptable quality or high yielding aquifer of poor quality water.

7.3.1.8 Hydrogeology, hydrology and water use in the area of the farm

7.3.1.8.1 Hydrogeology

The DWS requires a 1:500 000 hydrogeological map of the farm and Edenburg area, and Figure 7.6 therefore indicates the location of the remaining extent of Zamenloop 382 and the Edenburg area on a hydrogeological map. For the purpose of this chapter, the 1:50 000 scale is used.

According to the 1:500 000 hydrogeological map series of the Republic of South Africa (map number 2924 Bloemfontein), the site is situated on an intergranular and fractured aquifer type with median borehole yields in the regional area of between 0.1 and 0.5 litres per second. The geology is predominantly argillaceous rocks such as shale, mudstone and subordinate siltstone.

In general, the groundwater of the area is of good quality. Electrical Conductivity varies between zero and 70 mS/m. The mean annual precipitation that recharges the groundwater of the area varies between 400 mm and 600 mm.

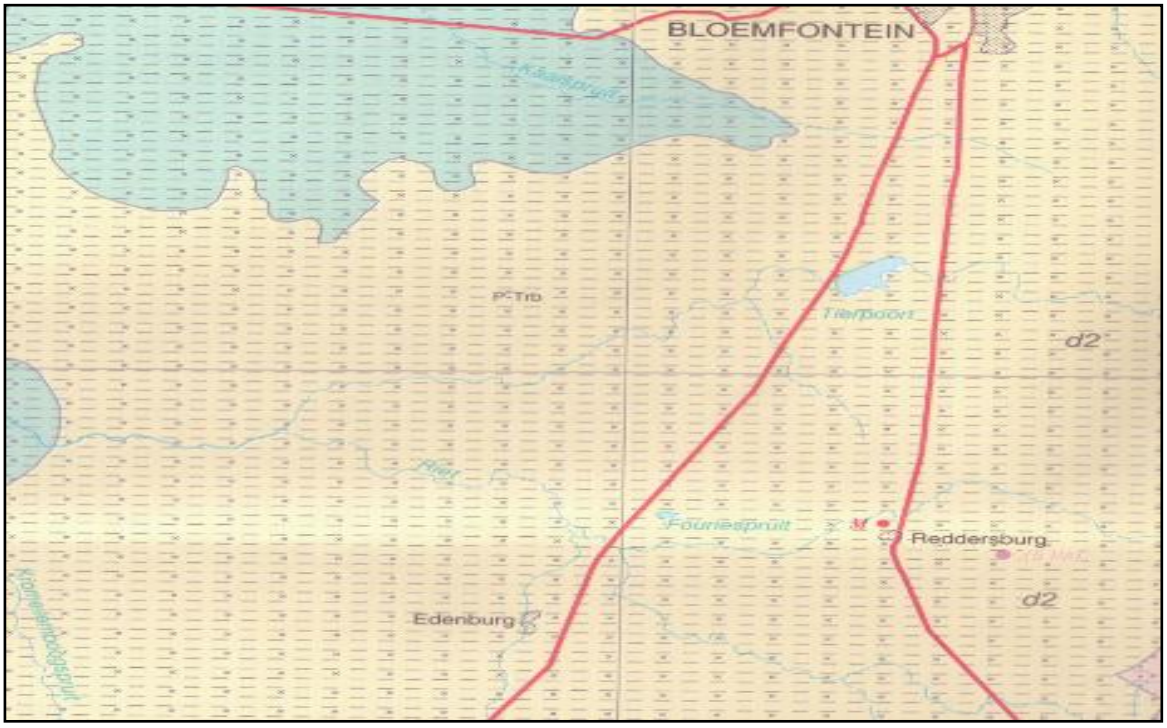

Figure 7.6: The hydrogeological map series number 2924 Bloemfontein of the Edenburg district

The approximate topographical height of the farm is 1 280 m above sea level.

7.3.1.8.2 Hydrology

The farm is adjacent to the Riet River and the Tierpoort River. The Riet River is a westward-flowing tributary of the Vaal River. The main tributary of the Riet River is the Modder River. After the confluence, the Riet River flows westwards to meet the Vaal River and the Tierpoort River is a tributary of the Riet River.

7.3.1.8.3 Groundwater and surface water use

The groundwater and surface water use in the area is mainly for domestic use, watering livestock and agricultural use.

7.3.1.9 Conclusions and recommendations made for the remaining extent of Zamenloop 382 in the Edenburg district within the Free State Province

The report was based on the information that was gathered during the site visit and the desk study completed for the proposed area. The report represented the basic geological and geohydrological background of the area during May 2012.

From the study the following conclusions were made:

- Due to the elevation of the area of the site, the general local drainage is estimated to be from a north-eastern to north-western direction.
- The site is situated on a minor aquifer system.
- The aquifer type is classified as intergranular and fractured.
- The geology of the farm comprises of the Adelaide subgroup of the Beaufort group of the Karoo sequence with the occurrence of blue-grey and purple mudstone interbedded with yellow sandstone and siltstone. Aeolian sand and alluvium are seen at the river areas.
- The groundwater levels on the remaining extent of Zamenloop 382, Edenburg District, Free State Province, varied between 5.82 and 7.28 m below ground level.
- In general, the groundwater was of good quality with Electrical Conductivity of between zero and 70 mS/m, with elevated fluoride concentrations.
- The mean annual precipitation that recharges the groundwater of the area was between 400mm and 600mm.
- The approximate topographical height of the farm is 1280 m above sea level.
- The groundwater and surface water use in the area is mainly for domestic use, watering livestock and agricultural use.
- The groundwater quality is suitable for the intended agricultural irrigation.

The following were recommended to the farmer:

- Monitor the groundwater level of every borehole on a monthly basis for a period of one hydrological year; thereafter, the groundwater levels should at least be monitored on a three-month basis. All monitoring records should be kept and be available on request.
- Monitor the groundwater quality every six months for the first year; thereafter, annually. All monitoring results and records should be kept and be available on request.
- In the event of the groundwater being consumed for drinking water purposes, it was recommended that at least a five-stage reverse osmosis water purifier is installed within the house to purify the water for drinking water purposes.

7.4 Implementation of the Framework for Groundwater Use Authorisations as Part of Groundwater Governance within South Africa within this Case Study A

7.4.1 Provision of governance made in this case study

Varady, van Weert, Megdal, Gerlak, Iskandar and House-Peters (2013:7) cited Saunier and Meganck's thought that was formulated in 1995 by the Commission on Global Governance, namely that "governance is the sum of the many ways individuals and institutions, public and private, manage their common affairs".

Mr Roux was given the opportunity through governance to plan his common agricultural affairs on the remaining extent of Zamenloop 382.

7.4.2 Food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations in this case study

The Organisation for Economic Co-operation and Development (OECD, 2001:5) classifies a farm or smallholding functioning as an economic unit when it:

- Engages in agricultural activities;
- Engages in non-agricultural activities;
- Aims to value the final production of all agricultural products; and provides agricultural services.

The remaining extent of Zamenloop 382 remains an economic unit as the ownership application of the existing registered surface water use was transferred to the new owner, Corico Trust. Mr Roux was a member of this trust and the groundwater general authorisation was also approved. In this case, food security, water security, the economic value of water and the farm as an economic unit remained intact.

If a groundwater use authorisation application is not authorised, a farm or smallholding may become a non-economic unit depending on the area of farming. If the farm or smallholding is, for example, in an area where rainfall is extremely low and groundwater is the sole reliant resource, it is inevitable that it will become a non-economic unit. In most cases, the farmer will then continue with groundwater abstraction in order to make a living, thus resulting in unlawful groundwater use.

It is not always possible to authorise an application if sufficient groundwater is not available and if the resource is under strain. However, the DWS may consider providing small equal amounts of groundwater in such areas without damaging the groundwater resource. This may lead to the decrease of unlawful groundwater use in those areas.

7.4.3 The National Water Act, groundwater reserve determinations and groundwater and surface water use authorisations in this case study

As member of Corico Trust, Mr Roux was given the opportunity under the NWA to apply for water use authorisations on the farm (see below), namely remaining extent of Zamenloop 382:

- Transfer of ownership application of the existing registered water use.
- Surface water use licensing application.
- Groundwater general authorisation application.

- Groundwater use license application.

7.4.3.1 Schedule 1 use

Mr Roux and his family members of three was automatically authorised to use small volumes of water for domestic use and animals as well as for the storing and using of rainwater from their roof. Applications for Schedule 1 use need not be submitted.

7.4.3.2 Transfer of ownership application

Mr Roux, on behalf of Corico Trust, applied for the transfer of the existing surface water registration into the name of the new owner, Corico Trust. The transfer of ownership application was processed by DWS within a period of three months and the transfer was done extremely quickly and efficiently.

7.4.3.2.1 Problems encountered

- DWS informed Mr Roux that the farm falls within the Riet River Government Control Area of the Kalkfontein Dam Catchment. The existing lawful water use of surface water is determined when the use of surface took place during 1963, and during the qualifying period between 1997 and 1999. The official stated that there was no surface water use during the mentioned qualifying periods. The official also explained to Mr Roux that when DWS will perform validation and verification of water use on his farm, his transferred surface water use will be deregistered. This was as a result of non-existing lawful water use on the farm. Mr Roux was then advised to apply for a surface water use license, groundwater general authorisation and a groundwater use license.

7.4.3.3 Surface water use licence application

On behalf of Corico Trust, Mr Roux then applied for a surface water use license. In July 2012, a full license application with all the required documentation and supporting documentation was submitted.

7.4.3.3.1 Problems encountered

- From the years 2012-2015, the surface water application was delegated to three officials from the DWS regional office.

7.4.3.4 Groundwater general authorisation application

On behalf of Corico Trust, Mr Roux applied for a groundwater general authorisation which was then submitted in July 2012.

7.4.3.4.1 Positive feedback

- The official handled this groundwater general authorisation application with great commitment and within a period of less than four weeks. As a result, the registration certificate of the groundwater general authorisation was issued. The appointed official set an example of what can be achieved if committed to render excellent and efficient services within DWS, as for most of the time general authorisations are processed within a period of months or even years.

7.4.3.5 Groundwater use licence application

On behalf of Corico Trust, Mr Roux applied for a groundwater use license. A full license application with all the required documentation and supporting documentation was submitted in July 2012. (Refer to Appendix C for an example of the groundwater use license application).

7.4.3.5.1 Problems encountered

- From 2012 to 2015, this specific groundwater application was delegated to many officials from the DWS regional office. All of the delegated officials left DWS to pursue their careers in the private sector. This application is now currently being handled by the same official who is also conducting the surface water license application. The official requested the reserve determination during the current year and it is foreseen that the application may still be in process for a few years to come. This again raises the same concern as with the surface water license application, in which the water use authorisation process and systems in place need urgent attention to be of an acceptable standard for efficient service delivery and to prevent backlogs of applications. The problem that occurred is not an isolated case, and many other applicants experience the difficulty.

7.5 Case Study B

Mr. A Boshoff of Beauhoff Farming applied for a groundwater use licence authorisation (WULA) for the proposed abstraction of groundwater from boreholes on the farm Portion 0 of Uitkoms 1033, Registration Division: IN, North West Province, as required in terms of the National Water Act, 1998 (Act 36 of 1998).

The farm falls within the jurisdiction of Ratlou Local Municipality and is located within the Lower Vaal Water Management Area, Dry Harts, and the Quaternary Drainage Region C32B.

The purpose of the groundwater use license application project was to achieve the following objectives:

- Comply with legal requirements to obtain authorisation from DWS prior groundwater abstraction.
- Achieve sustainable groundwater use and resource management on the farm.
- Perform a geohydrological study.
- Perform a hydrocensus, and to
- Perform aquifer pump testing consisting of step discharge tests and recovery tests.

7.5.1 Activity description and groundwater use

The proposed activity is the establishment of a pecan nut orchard under drip irrigation, rye grass under centre pivot irrigation, summer pastures under centre pivot irrigation, and lucerne under centre pivot irrigation.

The total irrigation requirement according to Sapwat for pecan nut trees in the Vryburg area, North West Province is 1324 mm. The total irrigation requirement according to Sapwat for rye grass in the Vryburg area, North West Province is 1023 mm. The total irrigation requirement according to Sapwat for summer-pastures in the Vryburg area, North West Province is 1173 mm.

The total irrigation requirement according to Sapwat for lucerne in the Vryburg area, North West Province is 1234 mm. Department of Water and Sanitation, Kimberley Office advised Mr. A Boshoff to apply for the groundwater volume of 436 100 m^3 per annum. Therefore 10 hectares of pecan nut trees, 11 hectares of rye grass, 11 hectares of summer pastures, and 5.04 hectares of lucerne may be planted if the groundwater use license application is successful.

The abstraction of groundwater is proposed from 9 boreholes located on the property. None of the boreholes are equipped and according to the safe sustainable yield calculations approximately 9.85 L/s can be abstracted from the proposed boreholes. This translates to 851 m^3/day or 25 885.8 m^3/month or 310 630 m^3/annum.

7.5.2 Requirements for the GWULA according to Section 21(a) of the NWA

The *Initial Regional* assessment is required to determine the amount of information necessary for each new Water Use License Application (WULA) for abstraction from groundwater, based on the amount of recharge that is used by the applicant in relation to the specified property. (Refer to Appendix B for an example of the information requirements according to categorisation A, B, and C.)

Categories A, B and C list the information requirements for the licence application, as should be provided by the applicant to the Department of Water Affairs.

Category A – Small scale abstraction (<60% of recharge on property)

Category B – Medium scale abstraction (60-100% of recharge on property)

Category C – Large scale abstraction (>100% of recharge on property)

7.5.2.1 Initial regional assessment

The calculations for the Regional Initial assessment are as follow:

$AREA_{PROP} * RE = RE_{AREA}$ (m^3/a)

$ABS_{EX} + ABS_{NEW} = ABS_{TOTAL}$ (m^3/a)

$ABS_{SCALE} = (ABS_{TOTAL} / RE_{AREA}) * 100$

Where

$AREA_{PROP}$	=	Size of property (m^2)
RE	=	Recharge (m)
ABS_{EX}	=	Existing use volume (m^3)
ABS_{NEW}	=	New use volume (m^3)
ABS_{SCALE}	=	Scale of abstraction (%)

In the determination of the Category the following input parameters were used:

$AREA_{PROP}$	=	5387171 (m^2)
RE	=	15 - 25mm/a (average 20mm/a)
ABS_{EX}	=	Existing use volume (m^3)
ABS_{NEW}	=	310630 New use volume (m^3)
ABS_{SCALE}	=	Scale of abstraction (%)

7.5.2.2 Determination of category

The intended abstraction over a 24hr period is 310630 m^3/a. The Category determination is as follow:

$AREA_{PROP} * RE = RE_{AREA}$ (m^3/a)

5387171 * 0.02 = 107743 m^3/a

$ABS_{SCALE} = (ABS_{TOTAL} / RE_{AREA}) * 100$,

(310630 / 107743) * 100 = 288.304%

The above calculation indicates the scale of ground water abstraction falls Category C – Large scale abstraction (>100% of recharge on property). The following information should be submitted for support.

7.5.2.2.1 Requirements for Category A

- A geo-hydrological report compiled by an acceptable and qualified geohydrological consultant. Report should include appropriate maps, tables and figures to support the conclusions and recommendations.
- Detail geology of the area, including structures, maps and so forth.
- Detail borehole census within at least 1km width zone around the area of recharge as well on the area itself. Information to be collected for each borehole should at least include pump installation depth, borehole depth, depth of water level, yield of the borehole, depth of water strike(s), volume abstracted (daily, weekly, monthly) and water quality (one macro analysis per property in the zone).
- Aquifer description and characteristics including extent of the aquifer and hydraulic properties (storativity and transmissivity). This would require pump testing. Drilling might or might not be required. Groundwater piezometric contour map showing flow direction and depth to water level contour map.
- Effective annual recharge on this property and the safe yield of the aquifer.
- Volume and purpose of the water required and the available for abstraction. A water balance that at least cover the aquifer unit in which the property is located should, in other words, is done that includes all gains and losses.
- Contact details of the relevant parties in the hydro census area.
- Impact the abstraction will have on existing users surrounding properties. This should be short and long term impact. This might be supported by numerical model.
- Proximity to and potential impact of the abstraction on surface water discharges and groundwater dependant terrestrial ecosystems.
- Potential impact of potential use on groundwater and surface water quality.
- Geo-referenced map of the property in question, with boreholes, surface water features, geological features, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol / diesel tanks, irrigation areas) depicted.
- Monitoring programme – weekly water levels, weekly rainfall, 3 monthly macro analysis and surface water discharges and 6 monthly qualities in the 1km width zone.
- The Department of Water and Sanitation recommends that the following measures be taken when testing boreholes for sustainable yields and to provide the following information.
- Refer to test procedure in the South African National Standards Code No.: SANS 10299.
- Perform a tree (3) hour stepped drawdown test to determine the discharge rate of the intended constant rate test or;

- The constant discharge test should be done at approximately 2/3 of the blow yield of the borehole.
- For HOUSEHOLD use it is recommended that an 8 hour constant rate test be performed whilst the drawdown and recovery is measured.
- For IRRIGATION it is recommended that a 24 hour constant rate test should be performed whilst the drawdown and recovery is measured. This test could also be performed for intended BULK WATER SUPPLY for a volume of up to 150 000 m^3 per annum.
- For BULK WATER SUPPLY in excess of 150 000 m^3 per annum it is recommended that an 72 hour constant rate test should be performed whilst the drawdown and recovery is measured.
- All the data obtained should be attached to the relevant WULA forms, together with an analysis of the data (including draw down curves) and recommendation for the sustainable yield of the borehole by a qualified Geohydrologist.
- If the 8-hour pumping schedule per day is followed which allows for the abstraction of approximately 180386 m^3/a or (5.72 L/s) then the category is determined as follow:

AREAPROP * RE = REAREA (m^3/a)
5387171 * 0.02 = 107743 m^3/a
ABSSCALE = (ABSTOTAL / REAREA) * 100
(180386 / 107743) * 100 = 59.73%

The above calculation indicates the scale of groundwater abstraction falls in Category A – Small scale abstraction (<60% of recharge on property). The following information should be submitted for support:

- Volume and purpose of the water required.
- Detail borehole census within at least 1km width zone around the area of recharge as well on the area itself. Information to be collected for each borehole should at least include pump installation depth, borehole depth, depth of water level, yield of the borehole, depth of water strike(s), volume abstracted (daily, weekly, monthly) and water quality (one macro analysis per property in the zone).
- Proximity to and potential impact of the abstraction on surface water discharges and groundwater dependant terrestrial ecosystems.
- Potential impact of potential use on groundwater and surface water quality.

- Geo-referenced map of the property in question, with boreholes, surface water features, geological features, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol / diesel tanks, irrigation areas) depicted.
- Monitoring programme – weekly water levels, weekly rainfall, 3 monthly macro analysis and surface water discharges and 6 monthly qualities in the 1km width zone.

7.5.2.2.2 Requirements for Category B

- Geology of the area / borehole.
- Volume and purpose of the water required.
- Detail borehole census within at least 1km width zone around the area of recharge as well on the area itself. Information to be collected for each borehole should at least include pump installation depth, borehole depth, depth of water level, yield of the borehole, depth of water strike(s), volume abstracted (daily, weekly, monthly) and water quality (one macro analysis per property in the zone).
- Proximity to and potential impact of the abstraction on surface water discharges and groundwater dependant terrestrial ecosystems.
- Geo-referenced map of the property in question, with boreholes, surface water features, geological features, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol / diesel tanks, irrigation areas) depicted.
- Contact details of the relevant parties in the hydro census area.
- Potential impact of potential use on groundwater and surface water quality.
- Monitoring programme – weekly water levels, weekly rainfall, 3 monthly macro analysis and surface water discharges and 6 monthly qualities in the 1km width zone.

7.5.3 Legal Assessment of GWULA According to the NWA

The National Water Act 36 of 1998 (NWA) identifies eleven (11) consumptive and non-consumptive water uses, which must be authorised under a tiered authorisation system. This authorisation system includes scheduled uses, general authorisations (GA) and water use licences. It allows for the “Reserve”, as defined in the NWA as the quantity and quality of water required to protect aquatic ecosystems in order to secure ecological sustainable use of the water resource. Furthermore, the NWA provides for the public consultation processes in the establishment of strategies and decision making and guarantees the right to appeal against such decisions.

Section 27 of the NWA specifies that the following factors regarding a water use authorisation must be taken into consideration:

- Existing lawful water uses.
- Need to redress past racial and gender discrimination.
- The efficient and beneficial use of water in the public interest.
- The socio-economic impact of the proposed water use.
- Alignment with the catchment management strategy.
- The class and resource quality objectives of the water resource.
- Investments made by the applicant in respect of the water use in question.
- The strategic importance of the water use to be authorised.
- Quality of water in the water resource required for the reserve and meeting international obligations.
- Duration of proposed development to be authorised.

The Section 27 motivation for the farm Portion 0 of Uitkoms 1033 is as follows:

7.5.3.1 Existing lawful water use

Communications with Department Water and Sanitation has indicated that there are no existing lawful uses currently authorised for the property Portion 0 of Uitkoms 1033, Portion O, Registration Division: IN, North West Province. The proposed abstraction of water for irrigation purposes will require a water use license and as such needs to be licensed in accordance with the requirements of the National Water Act (Act 36 of 1998).

7.5.3.2 Need to redress past racial and gender discrimination

Section 27(1b) of the NWA requires information on the contribution that will be made to rectify the results of past racial and gender discrimination.

The applicant, Mr Andre Boshoff is the sole owner of the proposed irrigation scheme. It is expected that the proposed development will initially provide 5 to 8 new job opportunities within the area during construction and operational phases.

During the operational phase of the irrigation scheme approximately 6 new employment opportunities will be created (of which 50% will be filled by women).

The proposed groundwater use will positively contribute to the uplifting and improvement of previously disadvantaged individuals through alleviation of poverty and provision of basic human needs, as well as electricity at the houses. Other farm workers which reside in the town due to their children attending school are provided financially in order to enable them to travel to the farm and back to their residence. Transportation and financial aid is provided for the workers children attending school as well.

The groundwater will be mainly used for the irrigation of pecan nut trees, rye grass, summer pastures, and lucerne. With harvesting the workers will also form part of the cooperative through being owner drivers to transport the harvest to the markets which will be supplied. This is dependent on the groundwater use authorisation.

7.5.3.3 The efficient and beneficial use of water in the public interest

The 10 hectares of pecan nut trees, 11 hectares of rye grass, 11 hectares of summer pastures, and 5.04 hectares of lucerne are essential for the food production market.

The water use authorisation will allow the farm to remain an economic unit and to function in order to continue to contribute to job creation and food security. In the event of approving the groundwater use license the groundwater will be used sustainably according to the sustainable yields of the boreholes as determined during the aquifer pump testing.

7.5.3.4 The socio-economic impact of the proposed water use

If the groundwater use license is approved the authorisation will have a positive impact on the socio-economic sector. Local people will be employed and the produce will meet local market demands and generate income resulting in alleviating poverty of the workers families and households. The development of small businesses in the Vryburg farming area is also foreseen and will result in localised growth and development of the economic sector.

There is a need for workers and farmers to acquire certain skills regarding to the business of agriculture. Training and mentorship will focus on marketing for harvest. Awareness will be created on the importance of farming in an economic sustainable manner and growth therefore contributing to the national poverty alleviation programme. Record keeping will assist and enable farmers to assess the progress of the project and identify the skills needed for managing irrigation farming properly.

In the event that the groundwater use license is not authorised the result will be job loss, loss of food security in the specific sector, and other essential basic human needs. It will adversely affect the local economy of the area and lead to the loss of revenue as employment opportunities are scares. It would also not be feasible to proceed without the groundwater use license in order to address government mandate of alleviating poverty and hunger through uplifting projects.

7.5.3.5 Alignment with the catchment management strategy

There is not a catchment management strategy currently applicable to this relevant water resource. All the requirements of the relevant authority will be taken into consideration and a precautionary approached will be followed. The strategy of the applicant will be aimed at

integrated water resource management that will consider and include the protection, use, development, conservation, and management of the groundwater resource. Guidelines will be adopted as determined by the relevant authority on water conservation and demand catchment management.

7.5.3.6 The class and resource quality objectives of the water resource

The class of the water resources within the quaternary drainage region C32B of the Lower Vaal Water Management Area is yet to be determined by DWS, as are the Resource Water Quality Objectives, however this proposed development is foreseen to have minimal to none impact on the quality of the water resource.

7.5.3.7 Investments made by the applicant in respect of the water use in question

Significant investments have already been made:

- Purchased Portion 0 of Uitkoms 1033 for R8 080 765.00
- Office equipment to the value of R16 000.00
- Irrigation equipment to the value of R371 973.96
- Packing store-STORE at R700 000.00
- Planter at R158 914.41
- T6070 Dt tractor at R900 000.00
- One plough at R849.82
- Two bulk trailers at R200 000.00
- Forklift at R180 000.00
- Power generator at R5000.00
- One Freightliner truck at R1 500 000.00
- Geohydrological study at R79 004.06
- Aquifer pump testing at R 295 968.96
- Drilling of an additional four boreholes in future at R290 301.00
- The main total of the overall investments already made is R12 778 777.00

7.5.3.8 The strategic importance of the water use to be authorised

The proposed development is important for developing and contributing to the local economy of the Vryburg area in the North West Province. It will also serve as an opportunity for uplifting and job creation as workers are directly dependant on income and social relief contributing to a sustainable economic viable life.

7.5.3.9 Quality of water in the water resource required for the reserve and meeting international obligations

The water quality is suitable for the irrigation of the pecan nut trees, rye grass, summer pastures, and lucerne.

7.5.3.10 Duration of proposed development to be authorised

It is anticipated that the business might be viable for more than 20 years and therefore the water use needs to be authorised for greater than 20 years, subjected to annual review by the delegated authority.

The proposed taking of groundwater for irrigation purposes requires licensing in accordance with Section 21(a) of the NWA.

The following WULA forms have been completed and submitted together with all supporting documentation to DWS Northern Cape Regional Office:

- DW756: Registration / Licensing Part 1 - Individual
- DW760: Registration / Licensing Part 2 – Section 21(a) of the National Water Act: Taking water from a water resource.
- DW901: Supplementary water use information – Property where water use occurs.
- DW902: Supplementary water use information – Details of property owner.
- DW784: Supplementary water use information – Pump technical data.
- DWA787: Taking water from a water resources – Irrigation field and crop information.
- Supplementary form DW784: Pump technical data has not been completed in it's entirely as pumps for the boreholes need to be purchased and installed.

7.5.4 Environmental related aspects

The following section deals with environmental related aspects.

7.5.4.1 Climate

The Vryburg area being situated within a semi-arid area has a typical continental climate with very cold winters and extremely hot summers. The mean maximum and minimum temperatures for January, the warmest month are 33^{o}C and 17^{o}C respectively. For July, the coldest month, the mean maximum and minimum temperatures are 19^{o}C and -0.6^{o}C respectively. The mean daily temperatures vary between 27^{o}C and 9^{o}C for summer and winter respectively.

Prevailing winds blow from the west and north-west; the former which traverses the Kalahari Desert and which is a hot, dry wind often carrying dust and sometimes even sand.

The area is characterised as a summer rainfall region with local short-duration thunderstorms with occasional hail. The mean annual precipitation for the Vryburg Area amounts to 460 mm.

7.5.4.2 Topography

The study area and surrounding area is characterised by a slightly undulating flat plain. The only prominent landmark for several kilometres in the surrounding area is Massouwskop (1358 mamsl) towards the north western area. There is no relationship between topography and geological formations from which it was developed.

The most striking features in the area is the presences of dolerite dykes, which forms narrow ridges and rise slightly above the general ground-level, which extend in straight lines for several kilometres.

7.5.4.3 Surface drainage

The property is located within the Lower Vaal Water Management Area, Dry Harts, which falls within the quaternary drainage region C32B.

A Tributary of the Leeuwspruit drains through the property and run-off is in south-eastern direction. The Leeuwspruit and its tributaries drain a catchment area of 530 km^2 at an average gradient of 0.65 metres per kilometre over its entire channel length.

7.5.4.4 Vegetation

The grass-veld is the predominating form of vegetation on the property.

7.5.5 Geology

The following section deals with geology of the farm.

7.5.5.1 Ventersdorp Supergroup

The Venterdorp Supergroup consists of the Allanridge Lava and Bothaville Quartzite Formations. Large outcrop areas of Allanridge Lava are present in the property area. The Ventersdorp Supergroup rocks are classified into four major zones, namely:

- The upper lava zone, in places scoriaceous, and flow-breccia.
- A volcanic zone: breccia and agglomerate.
- A sedimentary zone: quartzite, grit and conglomerate.
- The lower tuff zone: tuff and tuffaceous sediments, cherty or calcareous in places.

One of the most distinctive features of the Ventersdorp succession is the considerable variation in depth and thickness, causing individual formations to attenuate and thicken so that it seems as if they are irregularly distributed.

7.5.5.1.1 Allanridge Lava

The texture of the andesitic lava is fine grained. It is usually grey-green to dark blue-grey in colour with occasionally dark black spots, which weather to a reddish-brown colour on surface. The block configuration of weathering is mainly due to well-developed joint system in the lava. The lava normally contains amygdales of quartz, jasper, chalcedony, calcite, agate, and epidote, varying from 1mm to more than 100 mm in diameter.

7.5.5.1.2 Bothaville Quartzite

The clastic sediments are composed of quartzite, grit and conglomerate. The quartzite is fine to coarse grained and often finely laminated with prominent cross bedding. Alternating bands of different colour may be present. Some may be light to dark grey, with a greenish tinge, while others are bright green, white or pale green spotted ones and milky white bands are also found. Outcrops of these sediments are evident on farms situated approximately 25 km south east of the study area.

7.5.5.1.3 Griqualand West Sequence

Discordantly and directly overlying the uneven floor of the Ventersdorp Lava is the Griqualand West Sequence, of which only the Vryburg and Schimdtsdrif Formations are present. The two formations are entire conformable and without any sharp diving horizon between them.

7.5.5.1.4 Vryburg Formation

The Vryburg Formation consist of the following:

- Upper andesitic and amygdaloidal lava, including flow-breccia, as overlain locally by flagstone, gritty in places and with dolomitic lenses – Waterloo Member.
- Upper sediments consisting of quartzite and flagstone, locally with dolomitic lenses – Koboya Member I.
- Lower andesitic and amygdaloidal lava – Rosendal Member.Basal sediments, quartzite, grit, conglomerate and flagstone – Koboya Member I.

7.5.5.1.5 Schimdtsdrift Formation

The Schimdtsdrif Formation consists of the following:

- Lower transitional stage that can be divided into three layers.

- The upper stromatolitic limestone, calcite dolomite, chert and interbedded shale and siltstone with a quarzitic layer at the top – Monteville Member.
- The middle zone consisting mainly of khaki shale and siltstone with thin interbedded dolomite and chert – Clearwater Member.
- Lower oolitic, stromatolitic and mat algal limestone and slightly calcitic dolomite with interbedded shale and flagstone – Boomplaas Member.Upper non-clastic carbonaceous stage.

7.5.5.1.6 Tertiary to recent deposits

Late Tertiary to Recent deposits, consisting of sand and surface drift, alluvium, surface-limestone and calcrete are exposed in the study area.

7.5.5.1.7 Igneous intrusions

Dolerite dykes are prominent in the investigation area that intersects rocks of the pre-Karoo age. These dykes are highly weathered and outcrop as calcrete ridges with a thick covering vegetation. Displacements on either side of the dykes are present.

7.5.6 Geohydrology

The following section deals with hydrological and geohydrological aspects of the property of concern.

7.5.6.1 Surface water

A non-perennial tributary of the Leeuwspruit drains through the property and run-off is in south-eastern direction. No rivers, wetlands, streams or other natural surface water bodies were identified on the study area or within 1km of the farm boundaries.

7.5.6.2 Groundwater

7.5.6.2.1 Groundwater occurrences

The following section describes an overview of groundwater occurrences associated with different lithological units as adopted by Van Der Westhuizen and Hodgson (1981).

7.5.6.2.2 Groundwater in the Allanridge Lava

Groundwater occurrences within the Allanridge Lava are associated with the following geohydrological conditions:

- Weathered lava in shallow basins and troughs of decomposition.
- Jointed and fractured zones in fresh un-weathered rock, and Suitable structures such as weathered dyke contacts.

Groundwater abstraction varies from 20 m^3/d up to 1000 m^3/d, depending on the specific demand for domestic, irrigation and stock farming purposes. The presence of high yielding boreholes and abstraction in the order of 1000 m^3/d or 11.5 L/s that are present on farms nearby (10km south west of study area) are associated with dyke intrusions.

Van Der Westhuizen and Hodgson (1981) concluded that significant groundwater quantities can be abstracted from the Allanridge Lava.

7.5.6.2.3 Groundwater in the Vryburg Formation

The Vryburg Quartzite Formation is the most important groundwater source in the surrounding area (Municipal water supply). Groundwater is encountered in the following geohydrological conditions: Joints in quartzite and cracks and or fractures in quartzite. Groundwater occurrences of yields of excess of 2000 m^3/day were encountered at depths greater than 150 m.

7.5.6.2.4 Groundwater in the Schimdtsdrift Formation

The Schimdtsdrif Formation is characterised by dolomitic flats with surface depression in the low lying areas with low infiltration rates. Boreholes drilled in these formations can have yield up to 650 m^3/d or 7 L/s. There is not enough information available to determine the geohydrological properties of this formation.

7.5.6.2.5 Groundwater associated with dykes

Potential yields of boreholes drilled in and along these linear intrusive dykes range from 200 up to 1200 m^3/day (3 to 14 L/s) making this also a good groundwater resource. The dykes may either be semi-permeable or impermeable to groundwater movement.

7.5.7 Aquifer classification

7.5.7.1 Aquifer classification

The aquifer(s) of the area under investigation is classified as a minor aquifer according to the map of Aquifer Classification of South Africa (2012). The map indicates the aquifer classification system of South Africa.

7.5.7.2 Aquifer susceptibility

The aquifer susceptibility index is classed as low to moderate vulnerability. The map indicates the qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities and includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification.

7.5.7.3 Aquifer vulnerability

The aquifer vulnerability for the property indicates the least tendency for contamination if pollutants are discharge or leeched over the long term.

7.5.8 Aquifer testing

Extensive aquifer testing has been performed by AB Pumps at various stages during the course of this investigation. Aquifer tests were performed for the following purposes:

- To determine the hydraulic parameters.
- To calculate the safe sustainable yield.
- To determine the sphere of influence of each of boreholes tested and hydraulic connectivity.
- To determine main fracture depths.
- To determine optimal pump installation depths.

The aquifer(s) that underlies the property of the farm Portion 0 of Uitkoms 1033, consists of the Allanridge Lava and contact weathered zones of the intrusive dolerite dykes. None of the boreholes aquifer tested were drilled into the contact zones of the dolerite dykes with the surrounding Allanridge Lava's.

The following hydraulic aquifer test pumping methods were performed:

- Calibration test.
- Stepped discharge test.
- Constant discharge test.
- Recovery test.

7.5.8.1 Calibration test

This type of test involves the determination of the actual rate of inflow into the borehole from the surrounding geological formations. It is achieved by abstracting all the water that flows into the borehole. Eventually, when the borehole is empty, it is only the water that flows into the borehole that is abstracted. If this rate of abstraction is measured, it represents the rate at which the water enters the borehole from the aquifer such as the actual yield of the aquifer.

The calibration tests were conducted over a 60 minute period.

7.5.8.2 Stepped discharged test

The step drawdown test is a single-well test and it is performed to evaluate the productivity of a borehole. It also gives an indication of the optimum yield at which the borehole can be subjected to constant discharge testing, if required. The results of a step drawdown test will indicate

whether further pump testing in the form of a constant discharge test is warranted or whether the borehole is judged to be sufficiently weak (potential yield less than 0.5 L/s) to make a utilisation recommendation without further testing. If the result of the stepped discharge test is positive, then a constant rate-pumping test must be performed.

In performing a step discharge test, the borehole is subjected to three or more sequentially higher pumping rates, which is maintained for an equal length of time. The test is done by pumping the borehole at a low constant discharge rate until the drawdown stabilises. The constant discharge rate is then increased and the borehole is pumped until the drawdown stabilises again. The pumping rate is then increased again and the process is repeated. The time per pumping rate should be between 60 and 120 min. (Hobbs and Marais, 1997).

A step length of 60 min was recommended for the tests. The drawdown in the borehole in response to each of the pumping rates must be measured and recorded in accordance with a prescribed time schedule.

The hydrocensus information on boreholes tested together with test results on calibration and stepped discharged tests performed. The following conclusion and recommendations on the results were made:

- Borehole E-006: Water level reached pump inlet with 20 min in calibration test yielding 0,48 L/s. Not recommended for further testing. Poor recovery.
- Borehole F-007: Water level reached pump inlet with 32 min in calibration test yielding 0,48 L/s. Not recommended for further testing. Poor recovery.
- Borehole G-008: Borehole shows moderate development on borehole efficiency and has a moderate recovery rate. Recommended constant discharge test – 6.0 L/s at 24hr.
- Borehole H-009: This borehole is situated approximately 20m from borehole I-010 which has higher geohydrological properties. No further tests required.
- Borehole I-010: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 3.70 L/s at 24hr.
- Borehole J-011: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 3.6 L/s at 24hr.
- Borehole K-013: Borehole shows poor to moderate development on borehole efficiency and has a poor recovery rate. Recommended constant discharge test – 4.0 L/s at 24hr.
- Borehole L-014: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 6.5 L/s at 24hr.
- Borehole M-015: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 4.0 L/s at 24hr.

- Borehole N-016: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 3.2 L/s at 24hr.
- Borehole R-020: Borehole shows good development on borehole efficiency and has an excellent recovery rate. Recommended constant discharge test – 3.4 L/s at 24hr.
- Borehole S-012: Borehole shows moderate development on borehole efficiency and has a poor to moderate recovery rate. Recommended constant discharge test – 9.0 L/s at 24hr.

7.5.8.3 Constant rate discharge test

The constant discharge test is used to determine an aquifer's hydraulic parameters like transmissivity, storativity (if an observation well exists) and a conceptual model of the aquifer's hydraulic scenario, for example the presence of impermeable or recharge boundaries. The test involves monitoring the drawdown in the borehole while the discharge is kept constant. A description of the various methods used to analyse the data obtained from constant discharge tests is given in Kruseman and De Ridder (1991). The duration of the constant rate test may be determined by the information and level of reliability required (Weaver, 1993). It is common practice to run the test for about eight hours for boreholes to be equipped with hand, solar or wind driven pumps, and for forty-eight to seventy-two hours for boreholes to be equipped with electricity or diesel driven pumps, which are to be operated on a daily basis.

7.5.8.4 Recovery test

The recovery test can be used to calculate an aquifer's hydraulic parameters, to establish whether recharge has taken place during or shortly after the constant discharge test and whether the storativity values vary throughout the aquifer (Driscoll, 1986). It can also give an indication of the extent of the aquifer, or the extent and connectiveness of fractures. The Geological Society of South Africa recommends this test to be continued until the water level in the borehole recovers to its pre-pumping level; the water level recovers to less than 5% of the total drawdown experienced during the constant rate test; three readings in succession are identical; or the test is carried out for half the length of time of the constant discharge test (Weaver, 1993). In order to establish whether the aquifer has been significantly dewatered during the constant discharge test, and in order to accurately apply the recovery test data for estimating sustainable borehole yields, it may be preferable to monitor recovery water levels for at least the same duration as the constant discharge test.

The following results where obtain by means of the constant rate discharge tests and the recovery tests:

- Borehole G-008: The test was conducted over a 24-hour period with an abstraction rate of 6.0 L/s during which a relative drawdown of 68.47 m was achieved. The pump inlet was installed

at a depth of 99.60 mbgl. The available drawdown for the aquifer test was calculated at 85.03 m. After 24-hour period of recovery the water level recovered approximately to 60% of its static water level. The recovery rate is moderate to poor.

- Borehole I-010: The test was conducted over a 24-hour period with an abstraction rate of 3.75 L/s during which a relative drawdown of 83.71 m was achieved. The pump inlet was installed at a depth of 99.60 mbgl. The available drawdown for the aquifer test was calculated at 90.74m. At time t=1200min in the CD test a sudden drop in water level was observed. Thus sudden drop is the result of dewatering of the main fracture that is located at depth 54m. After 16-hour period of recovery the water level recovered approximately to 99.22% of its static water level. The recovery rate is excellent.
- Borehole J-011. The test was conducted over a 24-hour period with an abstraction rate of 3.60 L/s during which a relative drawdown of 52.01 m was achieved. The pump inlet was installed at a depth of 127.40 mbgl. The available drawdown for the aquifer test was calculated at 115.43 m. At pump time 18 hour, revealed a sudden drop in water level which is the result of dewatering of the main fracture at depth 48 mbgl. After a 3-hour period of recovery the water level recovered approximately to 97% of its static water level. The recovery rate is excellent.
- Borehole K-013: The test was conducted over a 24-hour period with an abstraction rate of 4.0 L/s during which a relative drawdown of 64.57 m was achieved. The pump inlet was installed at a depth of 99.60 mbgl. The available drawdown for the aquifer test was calculated at 85.03 m. After 24-hour period of recovery the water level recovered approximately to 10% of its static water level. The recovery rate is poor.
- Borehole L-014: The test was conducted over a 24-hour period with an abstraction rate of 6.52 L/s during which a relative drawdown of 13.43 m was achieved. The pump inlet was installed at a depth of 58.94 mbgl. The available drawdown for the aquifer test was calculated at 50.54m. After an 18-hour period of recovery the water level recovered approximately to 93% of its static water level. The recovery rate is excellent.
- Borehole M-015: The test was conducted over a 24-hour period with an abstraction rate of 4.0 L/s during which a relative drawdown of 12.46 m was achieved. The pump inlet was installed at a depth of 78.50 mbgl. The available drawdown for the aquifer test was calculated at 72 m. After a 5-hour period of recovery the water level recovered approximately to 97% of its static water level. The recovery rate is excellent.
- Borehole N-016: The test was conducted over a 24-hour period with an abstraction rate of 3.24 L/s during which a relative drawdown of 12.55 m was achieved. The pump inlet was installed at a depth of 96.500 mbgl. The available drawdown for the aquifer test was calculated at 92.85m. After 20 min of recovery the water level recovered approximately to 99% of its static water level. The recovery rate is excellent.

- Borehole R-020: The test was conducted over a 24-hour period with an abstraction rate of 3.42 L/s during which a relative drawdown of 7.17 m was achieved. The pump inlet was installed at a depth of 45.30 mbgl. The available drawdown for the aquifer test was calculated at 39.10 m. After 2-hour period of recovery the water level recovered approximately to 99% of its static water level. The recovery rate is excellent.
- Borehole S-012: This borehole was earmarked to be pump tested for at least 72-hours due to its high yield in excess of 19 L/s. The pump inlet was installed at depth 149 m. The available drawdown for the aquifer test was calculated at 134.75 m. The abstraction for first constant test was at 9 L/s. The water level reached pump inlet within 4 hours of pumping. The test was abandoned and restarted with a 5 L/s abstraction rate for the remainder of 68-hours. A relative drawdown of 84.90 m was obtained. After 72-hour period of recovery the water level recovered approximately to 95% of its static water level. The recovery rate is moderate to poor.

The data obtained from the various pump tests were analysed with the FC-Method developed by Prof. Gerrit van Tonder from the Institute for Groundwater Studies (IGS) at the University of the Free State.

7.5.8.5 Sphere of influence between boreholes

The sphere of influence between boreholes was measured by utilising two observation boreholes per constant rate test. The drawdown characteristics was observed and recorded for each of the observation boreholes.

The drawdown data was analysed by means of the Cooper-Jacob equation to determine the transmissivity (T) and storativity values (S). Note that storativity values cannot be accurately calculated by utilising aquifer test pumping data and should only be regarded rough estimations. However the transmissivity values can be accurately determined.

The geometric mean of the transmissivity value calculated by means of the observation borehole data is 16.2 m^2/d. The geometric mean of the late time transmissivity values calculated by means of the aquifer pump tested borehole data is in the order of 12.52m^2/d and the geometric mean of the storativity value is calculated at 0.0000039.

In general the higher the transmissivity value the steeper the gradient measured regarding the drawdown over time. In other words the quicker the water level was lowered over time will result in a higher T-value or gradient and the other way round. The higher the T-value the greater the measure of influence will be between production boreholes. The other parameter in influencing the T-value is the distance between the tested borehole and the observation borehole.

Although there was no drawdown observed in some observation boreholes it is mostly a function of low transmissivity values of the sedimentary rocks. Over long durations of pumping even boreholes that indicated no influence between each other will begin to influence each other and will be observed in terms of drawdown.

Based on the geological map, pump test results and geohydrological properties of the boreholes pump tested, the farm area was delineated in three areas of aquifers with same geohydrological properties. Apart from the similar geohydrological properties they are divided into the same aquifer compartments separated by dolerite dyke intrusions.

Therefore the analyses of the aquifer test pumping was performed as a rule that the two closes boreholes to the tested borehole was used as borehole of influence that have to be taken into account in the calculation of the sustainable yield of the borehole. The maximum available drawdown utilised to calculate the sustainable yields of each borehole was not the highest yielding water strike or fracture, but usually a shallower good yielding fracture that corresponds to the geometric mean of maximum available drawdown calculated for the borehole field as a whole. The reason being to ensure that production boreholes with deeper laying fractures and pump installations do not dewater the fractures of production boreholes in the vicinity with shallower main water strikes or fractures, which may cause decreases in sustainable yields in these boreholes due to dewatering and fracture collapse.

The geometric means for the different aquifers calculated for the maximum available drawdown added to the static water levels depths are to be seen as the critical water level of the borehole fields and a water level depth that is not to be exceeded as a whole. Exceeding this water level depth may cause certain of the main water strikes or fractures of boreholes to dewatered, which in turn may lead to permanent sustainable yield decreases over extended periods of dewatering.

The critical water level for aquifer 1 is calculated at 61.00 mbgl, for aquifer 2 at 21.66 mbgl and for aquifer 3 at 20 mbgl. If the farm area is to be taken as homogeneous unit without any dolerite dyke contributing to different aquifers and compartments then the critical water level is calculated as 43 mbgl.

7.5.8.6 Sustainable yield recommendations

The following sustainable yield is recommended for the aquifer test pumped boreholes:

- The recommended sustainable abstraction rate for borehole G-008 is calculated at 1.00 L/s for a 24-hour pump cycle per day. At this recommended abstraction rate, approximately, 86.4 m^3/d can be abstracted.

- The recommended sustainable abstraction rate for borehole I-010 is calculated at 0.54 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 46.66 m^3/d can be abstracted.
- The recommended sustainable abstraction rate for borehole J-011 is calculated at 0.48 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 41.47 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole K-013 is calculated at 0.63 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 54.43 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole L-014 is calculated at 2.95 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 254.88 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole M-015 is calculated at 1.22 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 105.88 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole N-016 is calculated at 0.88 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 76.03 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole R-020 is calculated at 1.28 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 110.59 m^3/d can be abstracted.
    - The recommended sustainable abstraction rate for borehole S-012 is calculated at 0.87 L/s for 24-hour pump cycle. At the recommended abstraction rate, approximately, 75.17 m^3/d can be abstracted.

Groundwater monitoring must be implemented to manage the groundwater resources of the borehole field in a sustainable and responsible manner. The groundwater resource monitoring for the tested boreholes are as follows:

- The rest or static water levels, the pump water levels and the abstraction volumes of the production boreholes are to be measured on a frequent basis. The decline in groundwater levels are not necessarily due to abstraction but could also be a function of seasonal change such extended drought or dry periods. Therefore should drastic declines in static or pump water levels occur, the abstraction rates will have to be decreased to ensure sustainable utilisation.
- The recommended abstraction boreholes must be equipped with conduit pipes to ensure that groundwater level measurements can be taken even when the boreholes are equipped. It

further recommended that the abstraction boreholes be equipped with flow meters to measure and record the abstracted flow volumes.

- Groundwater quality is generally fairly stable and chances occur slowly (dictated by groundwater flow paths and velocities) except for bacteriological constituents. For this reason samples are normally taken as grab samples and typically at a reduced frequency compared to surface water samples.
- Groundwater sampling should at least be undertaken bi-annually to account for seasonality (DWAF, Water Monitoring Systems, Best Practice Guidelines G3, 2007). The inorganic constituents to be analysed for includes: pH, EC, PAlk., MAlk., Na, K, Ca, Mg, Cl, B, F, Fe, Mn, As, PO_4, NO_2 as N, NO_3 as N, NH_4 as N and SO_4. The bacteriological constituents to be analysed for includes heterotrophic plate count, total coliforms and *Escherichia coliforms*. Bacteriological sampling is to be performed at least quarterly.

7.6 Implementation of the Framework for Groundwater Use Authorisations as Part of Groundwater Governance within South Africa within this Case Study B

7.6.1 Provision of governance made in this case study

Varady, van Weert, Megdal, Gerlak, Iskandar and House-Peters (2013:7) cited Saunier and Meganck's thought that was formulated in 1995 by the Commission on Global Governance, namely that "governance is the sum of the many ways individuals and institutions, public and private, manage their common affairs".

Mr Boshoff was given the opportunity through governance to plan his common agricultural affairs on Portion 0 of Uitkoms 1033.

7.6.2 Food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations in this case study

The Organisation for Economic Co-operation and Development (OECD, 2001:5) classifies a farm or smallholding functioning as an economic unit when it:

- Engages in agricultural activities;
- Engages in non-agricultural activities;
- Aims to value the final production of all agricultural products; and provides agricultural services.

The Portion 0 of Uitkoms 1033 remains an economic unit as the groundwater use license application was recommended for approval by DWS, therefor food security, water security, the economic value of water and the farm as an economic unit remained intact.

7.6.3 The National Water Act and groundwater reserve determination in this case study

Mr Boshoff was given the opportunity under the NWA to apply for a groundwater use authorisation on the farm (see below), namely Portion 0 of Uitkoms 1033:

- Groundwater use license application.

7.6.3.1 Schedule 1 use

Mr Boshoff and his family members of three was automatically authorised to use small volumes of water for domestic use and animals as well as for the storing and using of rainwater from their roof. Applications for Schedule 1 use need not be submitted.

7.6.3.2 Groundwater use licence application

Mr Boshoff applied for a groundwater use license. A full license application with all the required documentation and supporting documentation was submitted on 21 September 2015.

Problems encountered

- DWS informed Mr Boshoff that the farm, which he purchased with an existing registered groundwater use, does not have an existing lawful water use. DWS made a mistake when they approved the existing lawful water use application of the previous owner. The satellite imaging was wrongly interpreted during the processing of the application. DWS then advised Mr Boshoff to apply for a groundwater use license application. Mr Boshoff had to spend hundreds of thousands of rand for specialist studies, which he did not foresee when he purchased the farm from the previous owner.

7.7 Conclusions

The main objective of Chapter 7 was to provide true case studies in order to demonstrate the framework for groundwater use authorisations as part of groundwater governance within South Africa.

After purchasing the farm, Mr Roux (Case study A) requested the researcher to assist him with a geophysical investigation, groundwater resource development, transfer of ownership application of the existing registered water use, surface water use licensing application, groundwater general authorisation application, preliminary geohydrological and a hydrological report.

After purchasing the farm, Mr. Boshoff (Case study B) of Beauhoff Farming requested the researcher and her colleague Mr Dirk Rudolf to assist him with a geophysical investigation, a geohydrological study, a hydrocensus, aquifer pump testing, groundwater resource management programme, and a groundwater use license application.

In the chapter, various problems encountered with the applications were briefly discussed.

The following chapter will conclude the research study by summarising the main findings of the thesis and highlighting the contribution of this research to new knowledge.

Chapter 8
Summary and Conclusions

8.1 Introduction

South Africa has adopted a law and policy framework for water that is based on the constitutional recognition of the right of access to water (Gowlland-Gualtieri, 2007:1). The National Water Act, Act 36 of 1998 (NWA) (RSA, 1998) was promulgated "to provide for fundamental reform of the law relating to water resources, to repeal certain laws and to provide for matters connected therewith". The National Government of South Africa is recognised as the custodian of all water resources in South Africa and is obligated to ensure that all water resources are protected, utilised, developed, conserved and managed in a sustainable and equitable manner.

The NWA is currently recognised internationally as one of very few acts that recognise basic human needs on which South Africa as a country can be proud of, although proper implementation of the act is lacking. The act is in line with the Constitution of the Republic of South Africa, Act 108 of 1996 (RSA, 1996) which embraces human rights such as the right to access water, a healthy environment, health care, housing, food and social security, culture and education. All basic human needs are recognised within the Constitution.

The NWA requires the National Department of Water and Sanitation (DWS) to give the highest priority to basic human needs and ecological sustainability, or in other words, the reserve above those of agriculture and other industries (Nieuwoudt, Backeberg and Du Plessis, 2004). The NWA should be read in conjunction with the Water Services Act, Act 108 of 1997 (RSA, 1997), as the act regulates the accessibility of water and sanitation by domestic users.

The NWA does not directly distinguish, nor differentiate between surface water and groundwater resources, but subsumes all water resources. The general authorisations, however, very briefly distinguish between surface water and groundwater.

The following sections will summarise how the necessary information was obtained to assist the Department of Water and Sanitation (DWS) in dealing with groundwater use authorisations for irrigation purposes, as part of groundwater governance in water scarce areas within South Africa.

8.2 Aim and Objective

Groundwater in many parts of South Africa provides the sole and/or partial water supply for meeting basic human needs. With an increase in the dependency on groundwater usage, the need to properly and effectively protect, use, develop, conserve, manage and control groundwater resources has become a national priority of the custodian of all water resources, the DWS.

Groundwater resources are lacking proper management and effective groundwater governance within South Africa and are mostly due to a lack of knowledge and skills, especially with regard to the development, sustainable use, protection and principles of groundwater resource management and groundwater governance. Proper and effective management of groundwater resources and groundwater governance principles may contribute to the alleviation of poverty in many areas of South Africa. The greatest groundwater challenge is to ensure efficient groundwater governance and proper effective groundwater resource management in order to manage groundwater resources in a hydrological sustainable water balance/hydrogeological manner.

The over-abstraction of groundwater within certain areas of South Africa is of great concern and may have many negative consequences. The depletion of groundwater resources and the deterioration of groundwater quality have a negative health impact on large sections of rural communities that solely and/or partially rely on groundwater to meet their basic human needs. Water quantity- and quality-related problems are directly linked to many other crises such as poor school attendance, food insecurity, poor nutritional status among both children and HIV/Aids affected people and decreased productivity (Oluoko-Odingo, 2009).

A lack of access to water directly affects the quality of life of most vulnerable populations as the simplest of domestic tasks become more burdensome. Competing demands for water between households, communities, agriculture and industries will increase over time. This is as a result of population growth and tension and conflict. At the heart of the threat to future water supplies is the destruction of natural ecosystems, deforestation, groundwater depletion, land degradation and pollution. Environmental damage contributes to an increase in natural disasters, climate change and water attenuation.

Proper groundwater governance and groundwater resource management will significantly contribute to the reduction of over-abstraction, increase in sustainable groundwater abstraction and better groundwater quality.

This research study focused on challenges and solutions to positively contribute to the improvement of groundwater governance, groundwater resource management and the handling

of groundwater use authorisations for irrigation purposes with special reference to the agricultural sector in South Africa.

The main objective of this study was to develop a framework for groundwater use authorisations as part of groundwater governance within South Africa and was reached by means of a stages approach as discussed in Chapter 1.

8.3 Research Design

The research methodology used in this study was action research and the *researcher* and *practitioner* was the author of this thesis. The study repeated the action research methodology over five stages:

Stage 1 provided an overview and discussion on groundwater governance in South Africa.

Stage 2 provided an overview of food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.

Stage 3 provided a comparison and evaluation of the National Water Act (Act 36 of 1998) with international water laws.

Stage 4 provided a discussion on the groundwater reserve determination process of South Africa.

Stage 5 provided a framework for processing groundwater use authorisation applications in the agricultural sector.

8.3.1 Action Research – Stage 1

Stage 1 of the action research commenced in Chapter 2 with a *problem diagnoses* stage. The current water governance framework of South Africa was discussed. It was highlighted that the current water governance framework is not fully implemented, mainly due to the lack of understanding of the implementation principles, the urgency thereof, support and human resources. Chapter 2 concluded that a fully functional, reliable and appropriate groundwater governance framework will significantly contribute towards sustainable groundwater resource development and use. It will also protect groundwater supply for current and future use, and maintain ecological and environmental integrity.

8.3.2 Action Research – Stage 2

Chapter 3 expanded on the problem diagnosis stage that was initiated in Chapter 2. Chapter 3 focused on groundwater use in agriculture, groundwater pollution sources, groundwater

resource management problems, food security, water security, economic value of water, groundwater use authorisations and potential problems arising if a groundwater use is not authorised in the agricultural sector of South Africa.

Groundwater irrigation that is effectively managed can make a substantial contribution to agriculture and food security and can lift many households out of poverty. Smallholder farming can be stabilised by intensified cropping, buffering droughts and allowing farmers to diversify and access markets for high-value crops that require continuous on-farm groundwater management. Properly trained and mentored emerging farmers can substantially increase their income from the sale of milk, eggs, livestock and chickens which is also dependent on the area or district of farming.

It was concluded that the agricultural sector makes use of the highest percentage of groundwater, followed by urban industrial use, bulk water supply schemes, commercial use, mining, non-urban industrial use, Schedule 1 use and power generation. Agricultural activities may produce a wide range of impacts on soils, surface water and groundwater. The most important groundwater resource management problem occurring in the agricultural sector is an increasing demand for crop irrigation, which leads to over-abstraction of groundwater resources.

If a groundwater use authorisation application is not authorised, a farm or smallholding may become a non-economic unit depending on the area of farming. If the farm or smallholding is, for example, in an area where rainfall is extremely low and groundwater is the sole reliant resource, it is inevitable that it will become a non-economic unit. In most cases the farmer will then continue with groundwater abstraction to make a living, thus resulting in unlawful groundwater use.

It is not always possible to authorise an application if there is not sufficient groundwater available and if the resource is under stress. However, the DWS may consider providing small equal amounts of groundwater in such areas, without damaging the groundwater resource. This may lead to a decrease of unlawful groundwater use in those areas.

8.3.3 Action Research – Stage 3

Chapter 4 focused on the process of law and policy development, identified criteria for comparison and compared and evaluated the NWA with international water laws. An understanding was gained regarding the advantages, disadvantages and implementation of the compared water laws. The comparison and evaluation of the NWA with international water laws also assisted with the determination whether or not the NWA needs to be updated and improved.

The researcher highlighted the paramount importance of a groundwater legislation framework for effective groundwater governance. The groundwater legislation framework forms the basis for the development of policies and decision-making principles. An efficient legal framework will significantly contribute to regulating access to groundwater resources, set criteria for groundwater allocation, protection of groundwater resources, the establishment of groundwater management tools and groundwater monitoring programmes.

It was concluded that South Africa's National Water Policy and its supporting legislation, the NWA, are recognised internationally as being amongst the most progressive initiatives in the area of water resource management. It can also provide a model for many countries in the world to shift and adapt to newer realities of managing scarce natural water resources in an environment that is uncertain and continually changing, and is influenced by processes such as climate change as well as regional and localised processes (Pietersen, Beekman and Holland, 2011:15-16).

The NWA provides a powerful set of regulatory tools for groundwater assessment, planning and management. The National Water Resource Strategy (RSA DWAF, 2004b) provides an implementation framework for the NWA, but is incomplete regarding groundwater governance provisions. The National Groundwater Strategy 2010 (RSA DWA, 2010) addresses these groundwater management related deficiencies in the National Water Resources Strategy of 2011.

It was also concluded that although the NWA of South Africa is recognised internationally as being amongst the most progressive initiatives in the area of water resource management, that various amendments to the NWA are required with special reference to groundwater governance and groundwater resource management.

8.3.4 Action Research – Stage 4

Chapter 5 focused on groundwater resource directed measures; assumptions on which the groundwater resource directed measures are based; groundwater reserve determination assessment steps; post-groundwater reserve determination activities; levels of the groundwater reserve determination measures; classification of groundwater-dependent ecosystems and the degree of dependency; groundwater reserve determination measures: methods, tools, and data; and layout for reporting the outcomes of the groundwater reserve determination measures assessments.

It was concluded that the use of groundwater resource directed measures assessments by international countries, differs extensively from country to country, and that information on the use thereof is extremely limited. Many geohydrologists question the effectiveness, reliability and

validity of the reserve determination; however, the protection of current and future groundwater requirements for the ecological component and basic human needs component cannot be ignored and should not be neglected.

8.3.5 Action Research – Stage 5

Chapter 6 provided a framework for understanding and processing groundwater use authorisation applications in specifically the agricultural sector. The framework provides guidance for understanding and processing of groundwater use authorisations such as existing lawful water use as late registrations; Schedule 1 use, general authorisations; and groundwater use licenses. The limitations of the framework are that it is only intended for groundwater use authorisation applications for irrigation purposes, and that integrated groundwater use license applications are not included in this framework. The main motivation for using the framework only for groundwater use authorisation applications for irrigation purposes in the agricultural sector, is that there are far too many problems associated with the handling of groundwater use authorisation applications for irrigation purposes in the agricultural sector.

Various principles that are relevant to the consideration of water use authorisation applications were highlighted. The existing lawful groundwater use process was discussed. Groundwater use is recognised as an existing lawful water use when groundwater abstraction or groundwater resource development took place between the period of 1 October 1996 and 31 September 1998.

Schedule 1 use was discussed and it entitles a person to acquire water for reasonable domestic use, for small gardening that is not for commercial purposes, for watering livestock, or for fire-fighting. This schedule also permits the storing and using of run-off water from the roof (DWAF, 2007:3). No formal application process is required.

The general authorisation application procedure was discussed. According to Section 39 of the NWA and as published on 26 March 2004 in the Government Gazette 2004, users may use water without a license if the volume is within the provisions of the general authorisations (RSA DWA, 2004). In terms of the general authorisation, water users must register their use. A general authorisation will continue until compulsory licensing is enforced. This will result in the withdrawal of the general authorised use and the continuation of existing lawful groundwater use.

When a farm or smallholding was sold in the past, existing groundwater use authorisations could be transferred to the new owner. Unfortunately, with the New Water Policy Review document that came into effect on 31 January 2014, any existing water use authorisation expires when the farm or smallholding is sold. The selling of a property with a registered groundwater use falls

within the same category of water trading as the registered surface water use. Water trading is no longer permitted (RSA DWS, 2014a:8).

The researcher foresees that the cancellation of transfer of ownership applications of existing registered groundwater use will have extremely negative effects on the agricultural sector. The farm or smallholding will be rendered as a non-economic unit and the groundwater use will immediately be seen as illegal. The new owner will have to apply for a new groundwater use authorisation that cannot be guaranteed. The economic value of agricultural land will also be negatively influenced.

Chapter 7 provided true case studies to demonstrate the developed framework for groundwater use authorisations as part of groundwater governance within South Africa.

8.4 Problems Identified During the Research Study and Possible Solutions

8.4.1 Stage 1

Stage 1 provided an overview and discussion on groundwater governance in South Africa.

8.4.1.1 Problems identified

The proper knowledge and skills do exist for most groundwater governance problems, but a major problem is the lack of human resource capacity and funding to implement the groundwater governance framework. An evaluation of the effectiveness of existing governance provisions and capacity to implement effective groundwater governance was performed by Pietersen et al. (2011:18). They had the following conclusions:

- Hydrogeological maps and aquifer delineation with limited classified typology are in place.
- Groundwater governance is overall weak or non-existing.
- Groundwater monitoring and assessment of groundwater resource quantity and quality is poor.
- Provisions for groundwater resource development and groundwater use authorisations are fair.
- Compliance monitoring for groundwater abstraction and pollution is poor.
- Provisions for the establishment of an aquifer management committee or organisation are non-existent.
- Cross-sector coordination is weak or non-existent.

The current water governance framework of South Africa is not fully implemented. This is mainly due to a lack of understanding of the implementation principles, the urgency thereof, support and human resources.

The development and future application of groundwater management tools are adversely affected by the insufficient appreciation of the resource, shortcomings in knowledge and information, centralised system structures and an inadequate recognition of the significance of aquifer-dependent ecosystems and services.

8.4.1.2 Possible solutions

Groundwater governance will positively benefit if the principles developed for institutional arrangements for management of groundwater resources are applied (Foster and Garduño, 2013). The principles for effective groundwater governance, but not limited to, are as follows:

- Accessible, rapid and inexpensive mechanisms for conflict resolution.
- Groundwater use entitlement sanctions for unlawful groundwater users and groundwater polluters.
- Effective compliance monitoring by the DWS.
- Effective independent groundwater quantity and quality monitoring by groundwater users with groundwater use authorisations.
- Nested stakeholder groups such as groundwater user associations in areas with geographically large groundwater resource systems.
- Arrangements for the participation of stakeholders in decision-making.
- Congruence between groundwater resource allocation and environmental constraints.
- Clearly defined boundaries for groundwater resource evaluation and allocation.
- Ecological, economical, socio-cultural, political and institutional aspects as part of the groundwater governance framework of South Africa should be taken into consideration.

A fully functional, reliable and appropriate groundwater governance framework will significantly contribute towards sustainable groundwater resource development and use. This is done in order to protect groundwater supply for current and future use, and maintaining ecological and environmental integrity.

The most important tool and measure that was identified is the implementation of existing water legislation and groundwater regulations. Effective implementation measures for the implementation of the NWA and regulations are of utmost importance in order to achieve proper and effective implementation of the act and regulations.

The strengthening of policies, legislation, institutional reform and proper recognition of groundwater resource management and groundwater governance accountability will significantly contribute in effective implementation of water legislation and groundwater regulations in South Africa.

8.4.2 Stage 2

Stage 2 provided an overview of food security, water security and the economic value of water in the agricultural sector versus the allocation of groundwater use authorisations.

8.4.2.1 Problems identified

An ever-increasing population growth can place groundwater supply schemes for drinking water purposes under increased pressure. Agricultural activities may produce a wide range of impacts on soils, surface water and groundwater. The environment is negatively affected by deterioration of natural resources.

Harmful effects are listed, but not limited to, the following:

- Deterioration of drainage water and irrigation return flows through salinisation.
- Soil salinisation due to water logging in areas with insufficient drainage.
- Soil losses and sedimentation due to erosion from poor water resource management.
- Movement of toxic elements through the soil.
- Point and non-point pollution from agricultural chemicals.
- Changes in the groundwater systems.

The harmful effects contribute to increased conflict between rural development and the environment in developing countries where crop production is not always seen as a first priority.

The most important groundwater resource management problem occurring in the agricultural sector is an increasing demand for crop irrigation which may lead to over-abstraction of groundwater resources. Long-term over-abstraction usually leads to depletion of groundwater resources and negative adverse effects on the environment.

Shah (2012:4) emphasises that “groundwater is also prone to the tragedy of the commons as individual short-term interests prevailing over long-term communal concerns and its effective management requires collective action”.

The above-mentioned situation leads to:

- Counterproductive competition between groundwater irrigation users.
- Conflicts in rural areas.

- Negative impacts on natural aquifer discharge such as spring-flows and riverbed flows which results in negative impacts on downstream surface water-flows.
- Degradation of important groundwater dependent ecosystems (Shah, 2012:5).

Although provision is made for food and water security in various legislations of South Africa, there is still a perception that crop production and agricultural water use is not always seen as an immediate priority. In the current political situation in South Africa the agricultural sector is perceived to be a threat due to the Apartheid regime of the past.

In South Africa, political issues regarding land reform is often higher on the priority list. The researcher agrees that provision should be made for land reform in this country, but not at the cost of food and water security. If land reform is not properly managed and poorly implemented, all citizens and non-citizens in rural communities, towns and cities will adversely be affected on the long-term by malnutrition, hunger and increased poverty.

Groundwater and surface water security in South Africa is volatile and uncertain, mainly due to political issues and poor water governance and water management. Water security in the agricultural sector secure food security, thus without water security, the production of crops and meat in agriculture will be limited and not secured.

If a groundwater use authorisation application is not authorised, a farm or smallholding may become a non-economic unit depending on the area of farming. If the farm or smallholding is, for example, in an area where rainfall is extremely low and groundwater is the sole reliant resource, it is inevitable that it will become a non-economic unit. In most cases the farmer will then continue with groundwater abstraction in order to make a living, thus resulting in unlawful groundwater use.

8.4.2.2 Possible solutions

The sustainable use of groundwater resources can significantly contribute in decreasing the negative effects of over-abstraction in the agricultural sector. In managing the over-abstraction of groundwater resources in agriculture – as the main groundwater resource management problem – the following interventions, but not limited to, are proposed for the purpose of this study:

- Sanctions against groundwater users with groundwater use authorisations which over-abstract and are acting unlawful.
- Include groundwater resource management principles within groundwater use authorisations as part of the conditions.
- Introduce stringent penalties if the conditions of the groundwater use authorisation are not adhered to.

- Monitor and record groundwater levels by the groundwater user.
- Monitor and record the abstraction volume by the groundwater user.
- Monitor and record the groundwater quality by the groundwater user.
- Monitor rainfall by the groundwater user.
- In order to ensure that the sustainable yield is still valid according to previous aquifer pump testing, perform aquifer pump testing at five-year intervals at the least. If the sustainable yield differs from the original sustainable yield, the new sustainable yield should be used for groundwater abstraction for irrigation purposes.
- Determine the likelihood of surface water–groundwater interaction in alluvial aquifers.
- Determine whether recharge of groundwater resources within specific quaternary drainage regions are taking place in a relatively short period of time or over long periods of time. This is very important for the issuing of groundwater use authorisations in identified “red areas”, or in other words, high priority water-scarce areas of the DWS.

Water security occurs when all people, at all times, have physical and economic access to sufficient, safe and clean water that will meet all their basic human needs (Lal, 2015:1530).

According to Lal (2015:1530), the most important principles of water security are the following:

- *Water availability:* The availability of an adequate quantity of good quality water.
- *Water access:* Access by individuals and communities to sufficient water through legal, political, economic and social arrangements at local, regional, national and international levels.
- *Utilisation and retention:* Utilisation of water for domestic use, healthcare, food production and processing and recreational use.
- *Stability:* Ensuring that water is always available through sustainable use and good water governance and water management.

It is not always possible to authorise an application if there is not sufficient groundwater available and if the resource is under strain. However, without damaging the groundwater resource, the DWS may consider providing small equal amounts of groundwater in such areas. This may lead to a decrease of unlawful groundwater use in those areas.

8.4.3 Stage 3

Stage 3 provided a comparison and evaluation of the National Water Act (Act 36 of 1998) with international water laws.

8.4.3.1 Problems identified

Groundwater resources and associated goods and functions are undervalued. The implementation of groundwater legislation, regulations and guidelines is insufficiently enforced and is mostly lacking on ground level. In general, South African water legislation and groundwater regulations and guidelines are mostly difficult to understand, to take into account and to implement. This situation is often related to social and cultural constraints which are related to stakeholders' attitudes and traditional ways of thinking. Uncoordinated and fragmented groundwater governance also contributes to poor groundwater governance and groundwater resource management.

8.4.3.2 Possible solutions

A comparison and evaluation of the NWA with international water laws identified the need that the NWA must be updated and improved. The updates and improvements of the NWA is especially aimed at elaborating more on groundwater governance, groundwater resource management and sustainable allocation of groundwater resources.

Education, raising awareness, cooperation networks and stakeholder involvement must be greatly encouraged and improved in order to significantly contribute to the achievement of successful sustainable groundwater resource regulation and management.

8.4.4 Stage 4

Stage 4 provided a discussion on the groundwater reserve determination process of South Africa.

8.4.4.1 Problems identified

The use of groundwater resource directed measure assessments by international countries differs extensively from country to country, and information of the use thereof is extremely limited.

Many geohydrologists question the effectiveness, reliability and validity of the reserve determination; however, the protection of current and future groundwater requirements for the ecological component and basic human needs component cannot be ignored and should not be neglected.

It was also highlighted that "*In essence, a combination of groundwater contribution to baseflow and basic human needs met from groundwater is the volume of groundwater required to sustain the reserve. However, because the reserve bucket analogy is inappropriate for groundwater, and the groundwater component of the reserve is best represented by a groundwater level rather*

than a volume, the concept of recording the groundwater component as a reserve is problematic. It is preferable and practical to determine the volume of groundwater that can be abstracted from a resource unit without impacting the ability of groundwater to sustain the reserve. This is referred to as groundwater allocation" (RSA DWAF, 1999:10).

8.4.4.2 Possible solutions

New, innovated research regarding the determination of the volume of groundwater that can be abstracted from a groundwater resource unit without impacting the ability of groundwater to sustain the reserve, should be encouraged and considered. Procedures and methods to address sustainable groundwater allocation should be reconsidered and improved.

8.4.5 Stage 5

Stage 5 provided a framework for understanding and processing groundwater use authorisation applications in the agricultural sector.

8.4.5.1 Problems identified

Existing guidelines for water use authorisation applications are too diverse and broad which contribute to the confusion among DWS officials on how to handle and process the applications. Time management of handling and processing water use authorisations is extremely poor. A shortage of personnel dedicated to handling water use authorisation applications is a problem, as is the high turnover of staff. Most newly appointed officials are not, or poorly orientated in performing their job requirements. Instead of truly managing South Africa's most precious resource, water, personal and political agendas are unfortunately very high on the list. Water is life, and without water life is not sustainable.

8.4.5.2 Possible solutions

A possible solution is to revise all the existing water use authorisation application guidelines to make it specific, to the point and to prevent confusion among DWS officials. The water use authorisation process should be taken seriously, handled with care as well as great urgency. Another solution is to properly educate and orientate DWS officials in the water use authorisation process and according to their job requirements. Systems that are in place should be approved to retain competent qualified officials. The sustainable allocation and management of all water resources should be placed before personal and political agendas; if not, South Africa will in the distant future experience water- and food-related conflicts for survival. This foreseen situation should be prevented at all costs and can be achieved with proper and efficient water resource governance and management.

8.5 Research Conclusions

The main objective of this study was to develop a framework for groundwater use authorisations as part of groundwater governance within South Africa.

The main objective was reached by means of a stages approach:

Stage 1 provided an overview and discussion on groundwater governance in South Africa.

Stage 2 provided an overview of food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.

Stage 3 provided a comparison and evaluation of the NWA with international water laws.

Stage 4 provided a discussion on the groundwater reserve determination process of South Africa.

Stage 5 provided a framework for understanding and processing groundwater use authorisation applications in the agricultural sector.

This study concludes that even though the South African water related legislation is too diverse, broad and with contradicted regulations and policies, it was extremely difficult, but not impossible to develop a framework for groundwater use authorisations as part of groundwater governance within South Africa. As stated in Chapter 1, the research hypothesis can, therefore, be accepted. The researcher, however, recommends that this framework should be used as a basis to improve groundwater use authorisation understanding, groundwater use authorisation processing, groundwater governance and the NWA of South Africa.

8.6 Contributions to the Body of Scientific Knowledge

In the past, research has been done with regard to water use authorisation application processes. Limited work has, however, been done on groundwater use authorisations and groundwater governance within South Africa.

This study intended to provide a platform to initiate debate regarding the effectiveness of groundwater governance, sustainable groundwater resource allocation, the validity of the groundwater reserve and the current water legislation in South Africa and the implementation thereof.

The most important research contributions this study made in this endeavour are highlighted below:

- A framework for groundwater use authorisations as part of groundwater governance in water scares areas within South Africa was developed.

- During the research project, it was also identified that the South African water related legislation is too diverse, broad and comprises of contradicted regulations and policies. These finding strengthens the fact that DWS officials are confused and mostly uncertain on how to handle groundwater use authorisation applications and other matters related to water legislation. Poor training, education and orientation, or none at all, also significantly contribute to more confusion.
- A comparison and evaluation of the NWA with international water laws was performed. The NWA of South Africa is internationally recognised as being amongst the most progressive initiatives in the area of water resource management. This initiative may provide a model for many countries in the world to shift and adapt to newer realities of managing scarce natural water resources in an environment which is uncertain and continually changing. However, amendments to the NWA are required to make regulation more specific, non-contradictable and with special reference to groundwater governance and groundwater resource management.
- The agricultural sector is the sector making use of the largest quantity of groundwater resources in South Africa. A framework for understanding and processing groundwater use authorisations for irrigation purposes in the agricultural sector was therefore developed.
- It was identified during this study that the effectiveness and reliability and validity of the reserve determination are questionable and that the use of groundwater resource directed measure assessments by international countries differ extensively from country to country, and information of the use thereof is extremely limited.
- It is not always possible to authorise an application if there is not sufficient groundwater available and if the resource is under stress. However, the DWS may consider providing small equal amounts of groundwater in such areas, without damaging the groundwater resource. This may lead to a decrease of unlawful groundwater use in those areas. Food, water and economic value of water will then also remain secure.

8.7 Further Research

Further research is proposed and is as follows:

- A comprehensive review of the National Water Act and related policies and legislation.
- Research of the impacts of climate change on water resources, the existing and predictive vulnerability and necessary legal and policy responses thereto in South Africa.

- Research on groundwater governance in South Africa. This should be conducted in order to develop and establish an efficient comprehensive groundwater governance framework and implementation thereof.
- Research on renewable and non-renewable groundwater resources for sustainable resource development and use.
- Research on artificial recharge to supply non-renewable groundwater resources with water and sustain sustainable use of the non-renewable groundwater resources.
- Research on groundwater–surface water interaction in the allocation of groundwater use authorisations on farms or smallholdings where interaction is probable.
- Development of guidelines on handling groundwater use authorisation applications where groundwater–surface water interaction is occurring.
- Development of transboundary aquifer management framework and tools, taking into consideration international water law.
- Research on groundwater dependent ecosystems in South Africa.
- Research on strategy and implementation of South African water law based on transparency, participation and accountability.
- Research on fracking and the prevention and management of groundwater pollution with special reference to fractured rock aquifers in South Africa.
- Research on the effective and sustainable development of groundwater use authorisation software, the training of DWS officials and the successful use of the software. This can particularly positively contribute to more effective groundwater allocation and the decrease of processing time of groundwater use authorisation applications. There is currently a general water use license application programme in place at DWS, but the internet based system is non-functional. An investigation why the system is non-functional should be launched and appropriate and effective mitigation measures should be considered and implemented.
- New innovative research regarding the determination of the volume of groundwater that can be abstracted from a groundwater resource unit without impacting the ability of groundwater to sustain the reserve should be encouraged and considered. Procedures and methods to address sustainable groundwater allocation should be reconsidered and improved.
- Development of education, raising awareness, cooperation networks and stakeholder involvement guidelines in the groundwater sector will greatly encourage and improve sustainable groundwater management and regulation.

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Appendix A
Examples of Reserve Determinations by the Department of Water and Sanitation and the Description thereof

"It is hereby greatly acknowledged that the reserve determinations used as examples were provided by the Department of Water and Sanitation, Free State Regional Office, as part of their contribution to this research project."

An example of a reserve determination report

DW 1

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CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

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Attention: Q Bruwer

APPROVED RESERVE & RECOMMENDED CONDITIONS FOR THE PROTECTION OF GROUNDWATER IN QUATERNARY CATCHMENT C24F: H.J SWART FAMILY TRUST

1. BACKGROUND

A preliminary determination of the groundwater Reserve has been determined for quaternary catchment C24F, to assist in the evaluation of the licence applications made by H J Swart Family Trust to abstract 63 072 m³ of groundwater per annum for domestic water supply purposes in the Upper Orange WMA, Free State Province.

A summary of the application received from the Free State Regional Office is tabled below. An indication of where and for which purpose a Reserve was conducted is provided.

Table1. Summary of water use licence application for which a Reserve determination was requested.

Applicant	Quaternary	Water Resource	Water use (S21of National Water Act, Act 36 of 1998)	Licence/ General authorisation	Reserve	Reserve Location
Swart Familie Trust	C24F	Groundwater	S21 (a) S21 (e) S21 (g) S21 (j)	Licence	Yes	Entire quaternary catchment C24F

2. STUDY AREA

The study area is located in the North West within quaternary catchment C24F of the Middle Vaal Water Management Area. The catchment is drained by the Taaibosspruit River and its tributaries. The regional geology comprise of Chert and Dolomite of the Malmani Sub-group towards the north,

towards the western region the area is underlain by andesites of the Ventersdorp Supergroup. The average borehole yields in this region is 4.0l/s.

3. RESERVE DETERMINATION

3.1 Groundwater Quantity Component

Quaternary catchment C24F receives an estimated average annual groundwater recharge of 54.46million m^3 (Mm^3), of which 4.5 Mm^3 per annum or 8.3 % is required for the Reserve. Please note that this Reserve consists mostly of the ecological component (95%), under circumstances where a very small population depends on groundwater in the catchment. The groundwater contribution to the ecology (maintenance low flow in-stream flow requirement) was based on a Present Ecological Status Category of C, consistent with surface water recommendations. The applicant wishes to abstract 63 072 m^3 per annum, which together with the Reserve represent 8.9% of the available groundwater resources in the catchment. A summary of the Reserve determination is given in Table 1.

Table 1: Summary of the Reserve

Catchment	Area (km^2)	Recharge[1] (Mm^3/a)	Population[2]	Groundwater component of baseflow[3] (Mm^3/a)	Baseflow required by IFR[4] (Mm^3/a)	BHN reserve[5] (Mm^3/a)	Reserve as % of Recharge
C24F	2019	54.46	25150	5.0*	4.273	0.23	8.3

* Recharge based on the GRA II dataset.
* Herold Baseflow Separation Model.

3.2 Groundwater Quality component

The groundwater quality Reserve was determined from the statistical analysis of 2 data sets from the catchment. The ambient groundwater quality in quaternary catchment C24F falls in Class 0 of DWAF water quality classification. Class 0 represents the allowable limited for long term domestic use.

It should be pointed out that occasionally water quality at specific sites may exceed the broader and generic groundwater quality Reserve determined for the catchment, due to the natural spatial water quality variations dictated by the geology in which the water occurs. Under these circumstances, site-specific data should be obtained and used to determine more representative local ambient groundwater quality conditions at the site. This Directorate should be notified of such incidence, so as to revise the Reserve accordingly.

An example of a reserve determination report continue

4. RECOMMENDATIONS

The following recommendations are made:

i) No groundwater abstraction may take place within 100m of river, spring or wetland. This distance may be increased by the Regional Office if deemed necessary.

ii) Due to the low confidence of this Reserve determination, the results should not be used to evaluate medium to high impact water use activities.

iii) Future licence applications in this area should be referred to the Chief Director: Resource Directed Measures to verify the applicability of the level of Reserve determination in relation to the specific licence application and if necessary to stipulate recommendations and conditions related to protection of the ecology of the water resource.

Please do not hesitate to contact the Deputy Director: Groundwater Reserve Requirement, Ms N S Motebe at the above telephone number or email, should you have any queries in this regard.

DIRECTOR GENERAL

DATE: 26/11/9.

cc. CHIEF DIRECTOR: WATER USE

An example of a motivation of approval of a GWULA reserve

water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

Tel: (012) 336 8073 Fax: (012) 336 7575

INTERNAL MEMO

Date: December 9, 2008	File No: 26/8/3/3/506
To: Deputy Director: Groundwater Reserve Requirements	From: NY Mvimbi

PRELIMINARY RESERVE DETERMINATION UNDERTAKEN FOR THE GROUNDWATER COMPONENT, QUATERNARY CATCHMENT C24F TO SUPPORT THE EVALUATION OF WATER USE LICENCE APPLICATION BY H.J SWART FAMILIE TRUST.

MOTIVATION FOR APPROVAL

1. PURPOSE OF SUBMISSION

The purpose of this submission is to present the results of the preliminary determination of the groundwater component of the Reserve undertaken for quaternary catchment C24F. This low confidence Reserve determination was undertaken to enable the evaluation of a water use licence application by H J Swart Family Trust for the following activities:

- Abstraction of 63 072 m^3 of groundwater per annum for domestic water supply purposes to a new development.

You are requested to approve the Preliminary Groundwater Reserve for quaternary catchment C24F for the following water uses:

- Section 21(a) – taking water from a water resource;
- Section 21(e) – engaging in controlled activity identified as such in section 37(1) or declared under section 38(1)
- Section 21(g) – disposing waste in a manner which may detrimentally impact on a water resource
- Section 21(j) – removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

Though the current application is specifically for Section 21 (a), sections 21 (e), (g) and (j) have also been included in anticipation of future applications in the same catchment.

This submission includes recommendations and conditions (in a separate letter, addressed to the Central Regional DWAF Office) that should form part of the water use licence that may be issued to the Applicant.

water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

2. STUDY AREA

The study area is located in the North West within quaternary catchment C24F of the Middle Vaal Water Management Area. The catchment is drained by the Taaibosspruit River and its tributaries. The regional geology comprise of Chert and Dolomite of the Malmani Super-group towards the north, towards the western region there are andesites of the Ventersburg Super-group and the study area is dominated by gneiss and granite. The average borehole yield in this region is 4.0l/s.

3. RESERVE DETERMINATION

3.1. Groundwater Quantity Component

Quaternary catchment C24F receives an estimated average annual groundwater recharge of 54.46million m^3 (Mm^3), of which 4.5 Mm^3 per annum or 8.3 % is required for the Reserve. Please note that this Reserve consists mostly of the ecological component (95%), under circumstances where a very small population depends on groundwater in the catchment. The groundwater contribution to the ecology (maintenance low flow in-stream flow requirement) was based on a Present Ecological Status Category of C, consistent with surface water recommendations. The applicant wishes to abstract 63 072 m^3 per annum, which together with the Reserve represent 8.9% of the available groundwater resources in the catchment. A summary of the Reserve determination is given in Table 1.

Table 1: Summary of the Reserve

Catchment	Area (km^2)	Recharge (Mm^3/a)	Population[a]	Baseflow[a] (Mm^3/a)	IFR[a] (Mm^3/a)	BHN reserve[a] (Mm^3/a)	Reserve as % of Recharge
C24F	2019	*54.46	25 150	5.0*	4.273	0.23	8.3

* Recharge based on the GRA II dataset.
[a] Herold Baseflow Separation Model.

3.2. Groundwater Quality component

The groundwater quality Reserve was determined from the statistical analysis of 295 data sets from the catchment. The ambient groundwater quality in quaternary catchment C24F falls in Class 0 of DWAF water quality classification. Class 0 represents the allowable limited for long term domestic use.

It should be pointed out that occasionally water quality at specific sites may exceed the broader and generic groundwater quality Reserve determined for the catchment, due to the natural spatial water quality variations dictated by the geology in which the water occurs. Under these circumstances, site-specific data should be obtained and used to determine more representative local ambient groundwater quality conditions at the site. This Directorate should be notified of such incidence, so as to revise the Reserve accordingly.

An example of a motivation of approval of a GWULA reserve continue

water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

4. RECOMMENDATIONS

The following recommendations are made:

i) No groundwater abstraction may take place within 100m of river, spring or wetland. This distance may be increased by the Regional Office if deemed necessary.

ii) Future licence applications in this area should be referred to the Chief Director: Resource Directed Measures to verify the applicability of the level of Reserve determination in relation to the specific licence application and if necessary to stipulate recommendations and conditions related to protection of the ecology of the water resource.

iii) Local assessment of groundwater data.

ASSISTANT DIRECTOR: GROUNDWATER RESERVE REQUIREMENTS

DATE: 17/12/2008

RECOMMENDED / ~~NOT RECOMMENDED~~

DEPUTY DIRECTOR: GROUNDWATER RESERVE REQUIREMENTS

DATE:

An example of a motivation of approval of a GWULA reserve continue

PRELIMINARY DETERMINATION OF THE RESERVE AND RESOURCE CLASS IN TERMS OF SECTION 14(1)(b) AND 17(1) OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

I, **HARRISON HURSINEY PIENAAR**, in my capacity as Chief Director of the Resource Directed Measures Directorate, and duly authorised in terms of section 63 of the National Water Act, 1998 (Act No. 36 of 1998), do hereby declare the preliminary determination of the Reserve as contained below.

CHIEF DIRECTOR: RESOURCE DIRECTED MEASURES

DATE: 26/11/9.

1. **Location of Groundwater Resource**

Drainage Region	:	C24F
Water Management Area	:	Middle Vaal

2. **Preliminary determination of the Groundwater component of the Reserve for Water Quantity in terms of section 17(1)**

C24F → 8.3% of the Recharge of **54.46** million cubic metres per annum.

NOTE:
C24F - This amount accounts for the ecological Reserve **(95%)**. The basic reserve is set at 0.14 million cubic metres per annum **(5%)**.

3. **Preliminary determination of the Reserve for Water Quality in terms of section 17(1)**

GENERAL CHEMISTRY

Parameter	Ambient Ground Water Quality[1]	Basic Human Needs Reserve[2]	Ground Water Quality Reserve[3]
Electrical Conductivity (mS/m)	52.00	<150	57.2
Sodium (mg/l)	6.90	<200	7.6
Magnesium (mg/l)	30.00	<70	33.0
Calcium (mg/l)	50.15	<150	55.2
Chloride (mg/l)	18.80	<200	20.7
Sulphate (mg/l)	3.00	<400	3.3
Nitrate (mg/l)	7.13	<10	7.8
Fluoride (mg/l)	0.10	<1.5	0.1

[1] Based on data obtained from the National Groundwater Database (refer Annexure B). Values reported are the statistical median of each parameter.
[2] Ref: *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.* 1998. Water Research Commission Report No: TT 101/98. Pretoria, South Africa (Set for a Class 1).

Page 1 of 2

[3] Ref. Where a difference in the water quality values for the ambient groundwater quality and basic human needs was found, the lesser or more protective value was selected for the groundwater quality Reserve. Where the ambient groundwater quality was selected as the groundwater quality Reserve, the value was scaled up by 10 per cent.

PHYSICAL WATER QUALITY

Parameter	Ambient Ground Water Quality[1]	Basic Human Needs Reserve[2]	Ground Water Quality Reserve[3]
pH	8.0	5.0 – 9.5	6 – 9.5

[1] Based on data obtained from the National Groundwater Database (refer Annexure B). The value reported is the statistical median of the parameter .
[2] Ref: *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.* 1998. Water Research Commission Report No: TT 101/98. Pretoria, South Africa

TOXIC SUBSTANCES AND COMPLEX MIXTURES

Parameter	Ambient Ground Water Quality	Basic Human Needs Reserve[1]	Water Quality Reserve
Toxics	Not Provided	< TWQR	

TWQR denotes Target Water Quality Range

[1] Ref: South African Water Quality Guidelines, Volume 1: Domestic Water Use, 2nd Ed. 1996. Department of Water Affairs and Forestry. Pretoria, South Africa.

4. Applicability

This preliminary determination (Desktop Level) of the Reserve, in terms of section 17(1)(b), is applicable to the authorising of the following water uses:

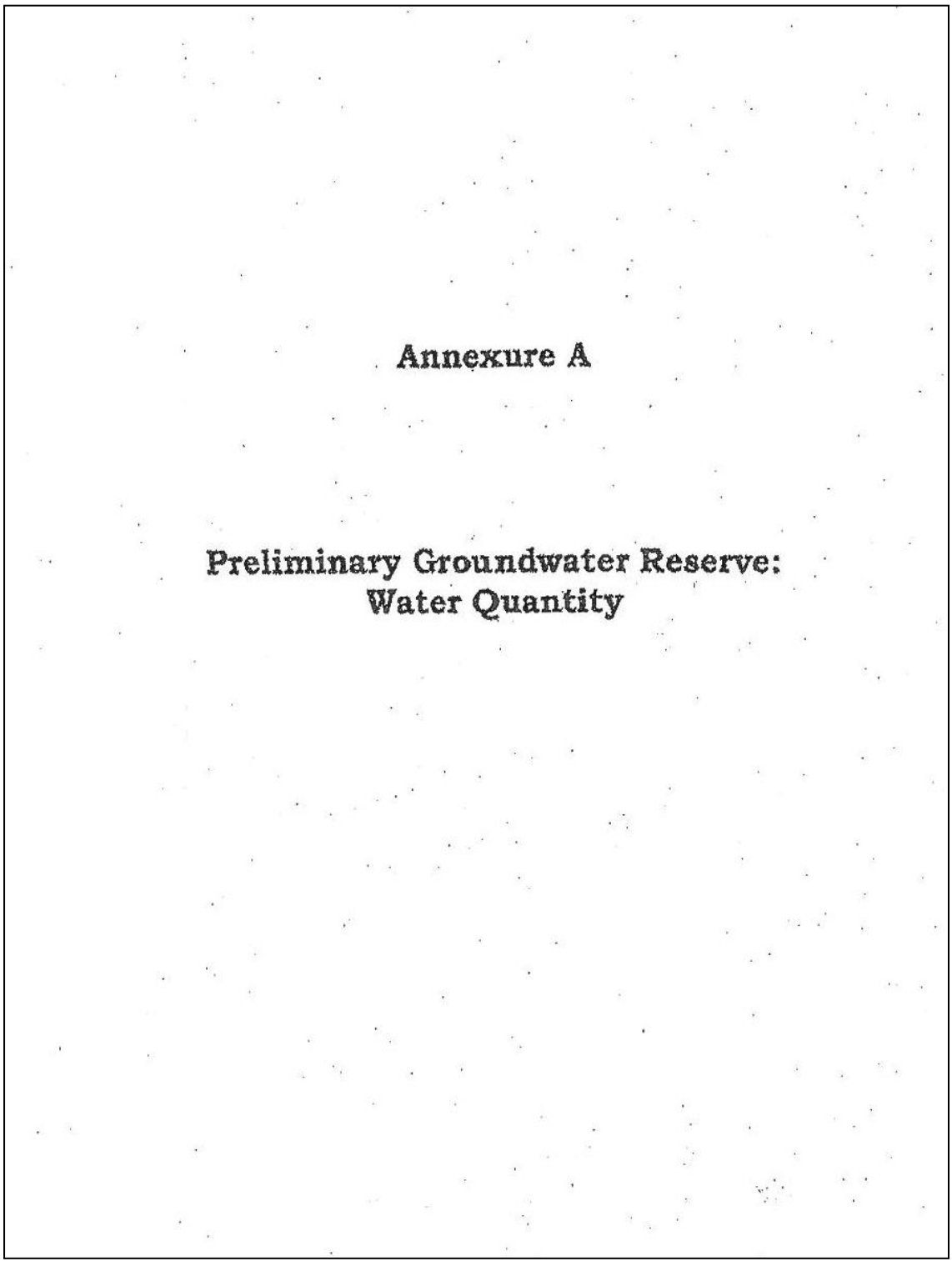
- Section 21(a) – taking water from a resource.
- Section 21 (e) – engaging in controlled activity identified as such in section 37(1) or declared under section 38(1)
- Section 21(g) – disposing waste in a manner which may detrimentally impact on a water resource
- Section 21(j) – removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

Though the current application is specifically for Sections 21 (a), sections 21(e), (g) and (j) have also been included in anticipation of future applications in the same catchment.

5 Additional supporting documentation is provided in the following Annexures

Annexure A: Preliminary Groundwater Reserve – Water Quantity ☒
Annexure B: Preliminary Groundwater Reserve – Water Quality ☒
Annexure C: Resource Quality Objectives (Preliminary) ☒
Annexure D: Background and Record of Decision ☒
Annexure E: Methodology ☒
Annexure F: Specialist Reports ☐
Annexure G: Map of Study Area ☐

An example of a motivation of approval of a GWULA reserve continue



Annexure A

Preliminary Groundwater Reserve:
Water Quantity

An example of a motivation of approval of a GWULA reserve continue

GROUNDWATER RESERVE DETERMINATION — QUANTITY COMPONENT

Catchment	Area (km²)	Recharge[1] (Mm³/a)	Population[2]	Baseflow[3] (Mm³/a)	IFR[4] (Mm³/a)	BHN reserve[5] (Mm³/a)	Reserve as % of Recharge
C24F	2019	54.46*	25 150	5.0'	4.273	0.23	8.3

* Recharge based on the GRA II dataset.
' Herold Baseflow Separation Model.

Notes

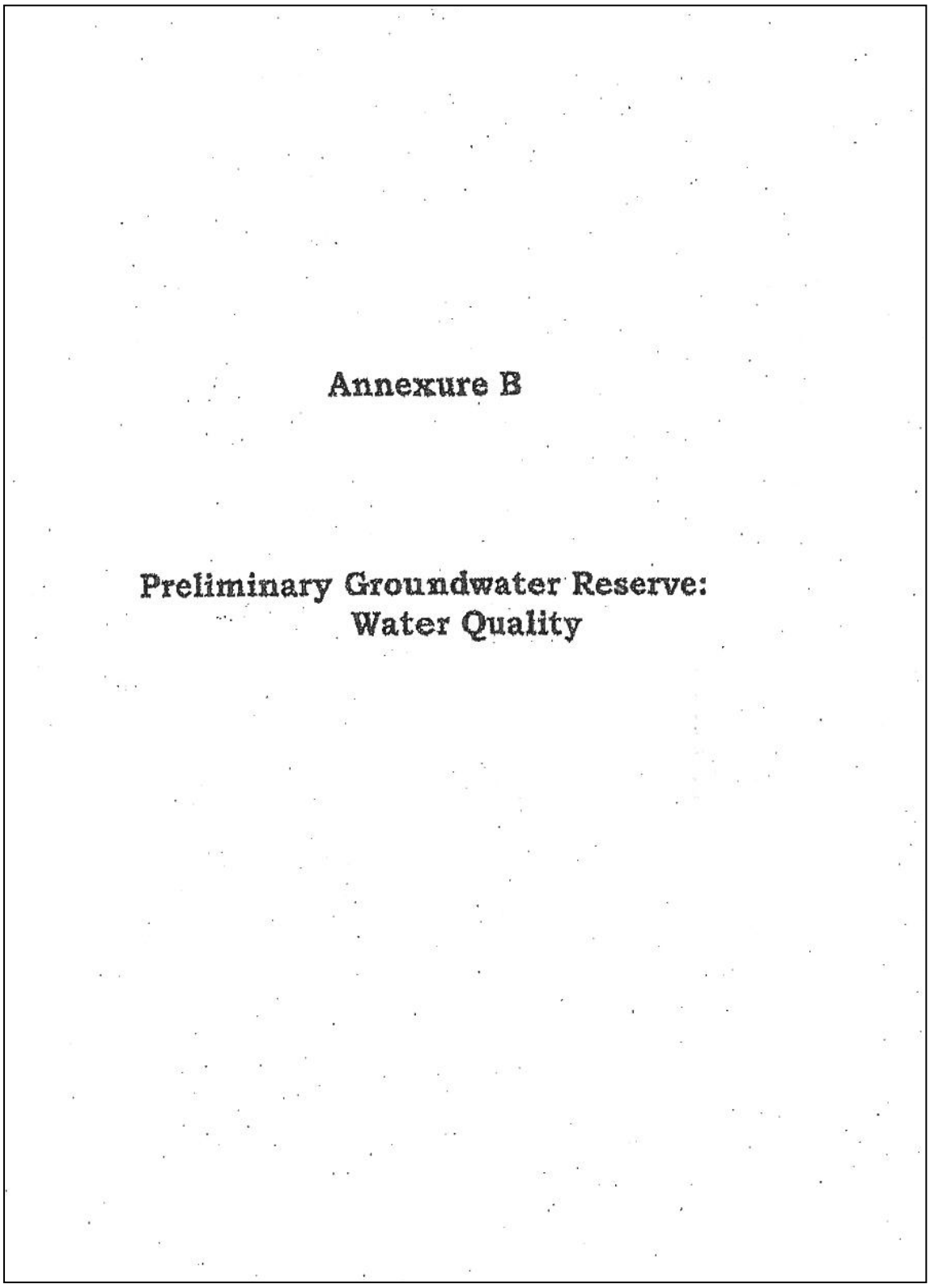
- Recharge is calculated as **4.7%** of MAP of **577 mm.**
- The IFR required from baseflow is based on the Maintenance Low Flow (MLF) for Class C (summary spreadsheet, Kleynhans, November 2000).
- An MLF of 0.13m³/s, (RESDSS Version 2; Hughes, January 2002) was used.

Definitions

- **Recharge:** Water reaching the aquifer directly from precipitation and the infiltration of surface water. [1]
- **Baseflow:** Baseflow is that part of stream flow that derives from groundwater and shallow subsurface storage. During the dry season, the stream flow is typically composed entirely of baseflow. [3]
- **Groundwater component of baseflow:** This is the component of Baseflow that derives from the aquifer adjacent to a surface water body, and excludes interflow in the vadose zone or short-term storm events which saturate the subsurface soil and discharge to a surface water body before reaching the aquifer. The Herold Baseflow Separation Model is used. [3]
- **Baseflow required by IFR:** The volume of baseflow required by the instream flow requirements set for the surface water component of the Reserve. [4]
- **The Reserve** constitutes the sum of the baseflow required by IFR plus the BHN reserve expressed as a percentage of the Recharge.

1] Bredenkamp, D.B., Botha L.J., van Tonder, G.J. and Van Rensburg, H.J. (1995). Manual on quantitative estimation of groundwater recharge and aquifer storativity. WRC Report TT 73/95
2] Assume that entire population of catchment is served with groundwater.
3] Herold, C.E. (1980). A model to compute on a monthly basis diffuse salts associated with runoff. HRU report no 1/80.
4] Hughes, D. A., January 2002. RESDSS Software, Version 2.
5] Based on a consumption of 25 litres per person per day.

An example of a motivation of approval of a GWULA reserve continue



Annexure B

Preliminary Groundwater Reserve:
Water Quality

An example of a motivation of approval of a GWULA reserve continue

GROUNDWATER RESERVE DETERMINATION — QUALITY COMPONENT

The water quality component of this preliminary Reserve determination is based on data obtained from the National Groundwater Data Base of the Department of Water Affairs and Forestry. 285 samples were analyzed requested from the National Groundwater Database / Achieves (NGDB /NGA).

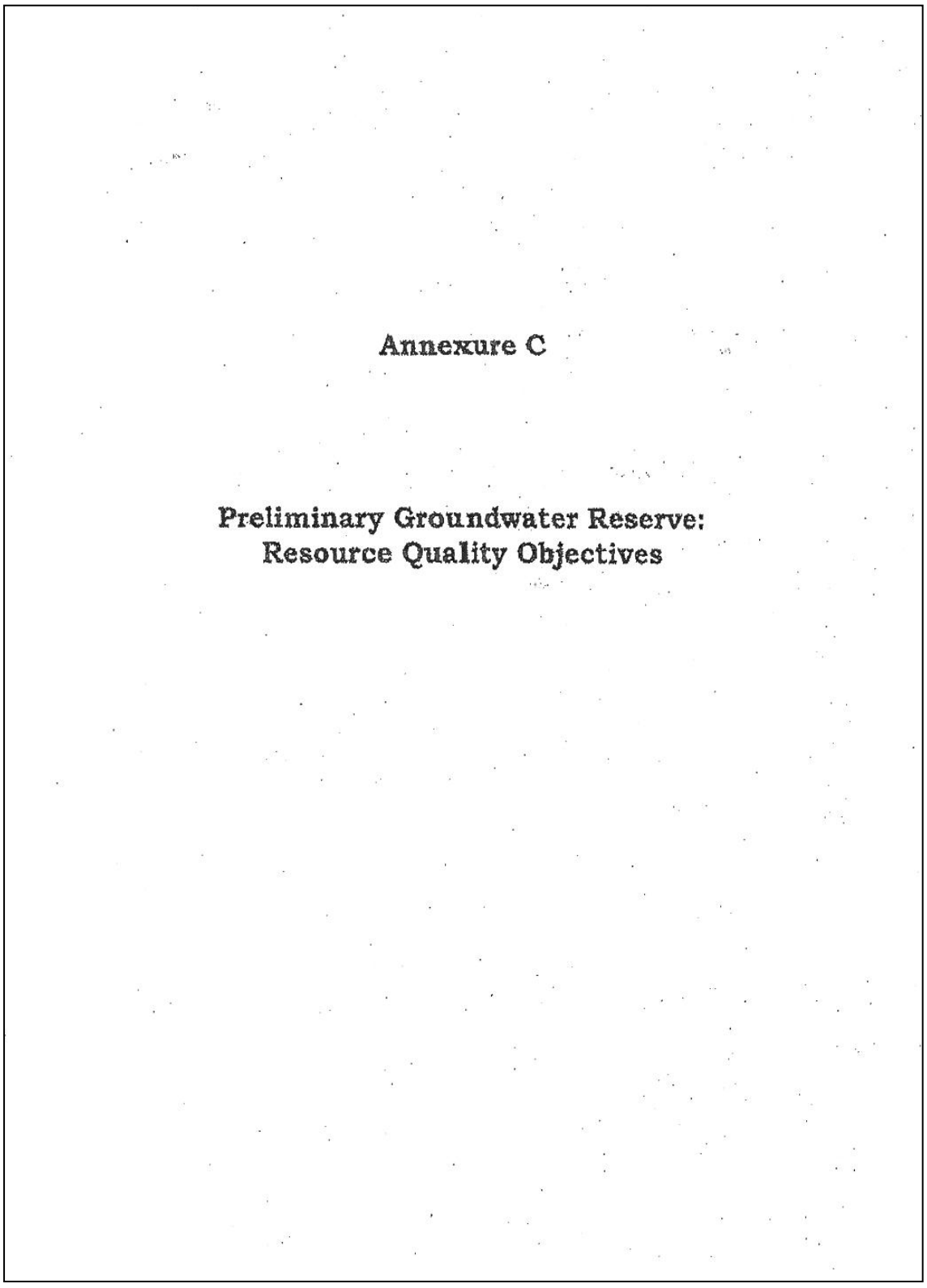
Groundwater quality

Chemical Parameter	Unit	Quaternary Catchment C24F			
		No of Samples	5 percentile	Median	95 percentile
Ph		285	6.72	7.99	8.36
Electrical Conductivity	mS/m	285	15.18	52.00	83.52
Calcium as Ca	mg/l	285	7.13	50.15	97.15
Magnesium as Mg	mg/l	285	5.68	30.00	53.36
Sodium as Na	mg/l	285	2.82	6.90	24.78
Total Alkalinity as $CaCO_3$	mg/l	285	15.31	179.17	307.17
Chloride as Cl	mg/l	285	3.16	18.80	111.80
Sulphate as SO_4	mg/l	285	2.00	3.00	49.31
Nitrate as NO_x-N	mg/l	285	0.56	7.13	21.34
Fluoride as F	Mg/l	285	0.05	0.10	0.27

Chemical Parameter	Target Water Quality Ranges[2]		
	Class 0	Class I	Class II
pH	6 - 9	5 - 6 & 9 - 9.5	4 - 5 & > 9.5 - 10
Electrical Conductivity	< 70	70 - 150	150 - 370
Calcium as Ca	< 80	80 - 150	150 - 300
Magnesium as Mg	< 70	70 - 100	100 - 200
Sodium as Na	< 100	100 - 200	200 - 400
Chloride as Cl	< 100	100 - 200	200 - 600
Sulphate as SO_4	< 200	200 - 400	400 - 600
Nitrate as NO_3-N	< 6	6 - 10	10 - 20
Fluoride as F	<0.7	0.7 - 1.0	1.0 - 1.5

[2] Ref: *Quality of Domestic Water Supplies, Volume 1: Assessment Guide, 2nd Ed.*1998. Water Research Commission Report No: TT 101/98. Pretoria, South Africa.

An example of a motivation of approval of a GWULA reserve continue



Annexure C

Preliminary Groundwater Reserve:
Resource Quality Objectives

An example of a motivation of approval of a GWULA reserve continue

GROUNDWATER RESERVE DETERMINATION – RESOURCE QUALITY OBJECTIVES (RQO's)

The following resource quality objectives are proposed based on the level of understanding of the aquifer system(s):

- Develop the aquifer system(s) at a sustainable rate as determined by the optimal yield of the borehole and the sustainable yield of the aquifer system through aquifer tests (pumping tests).

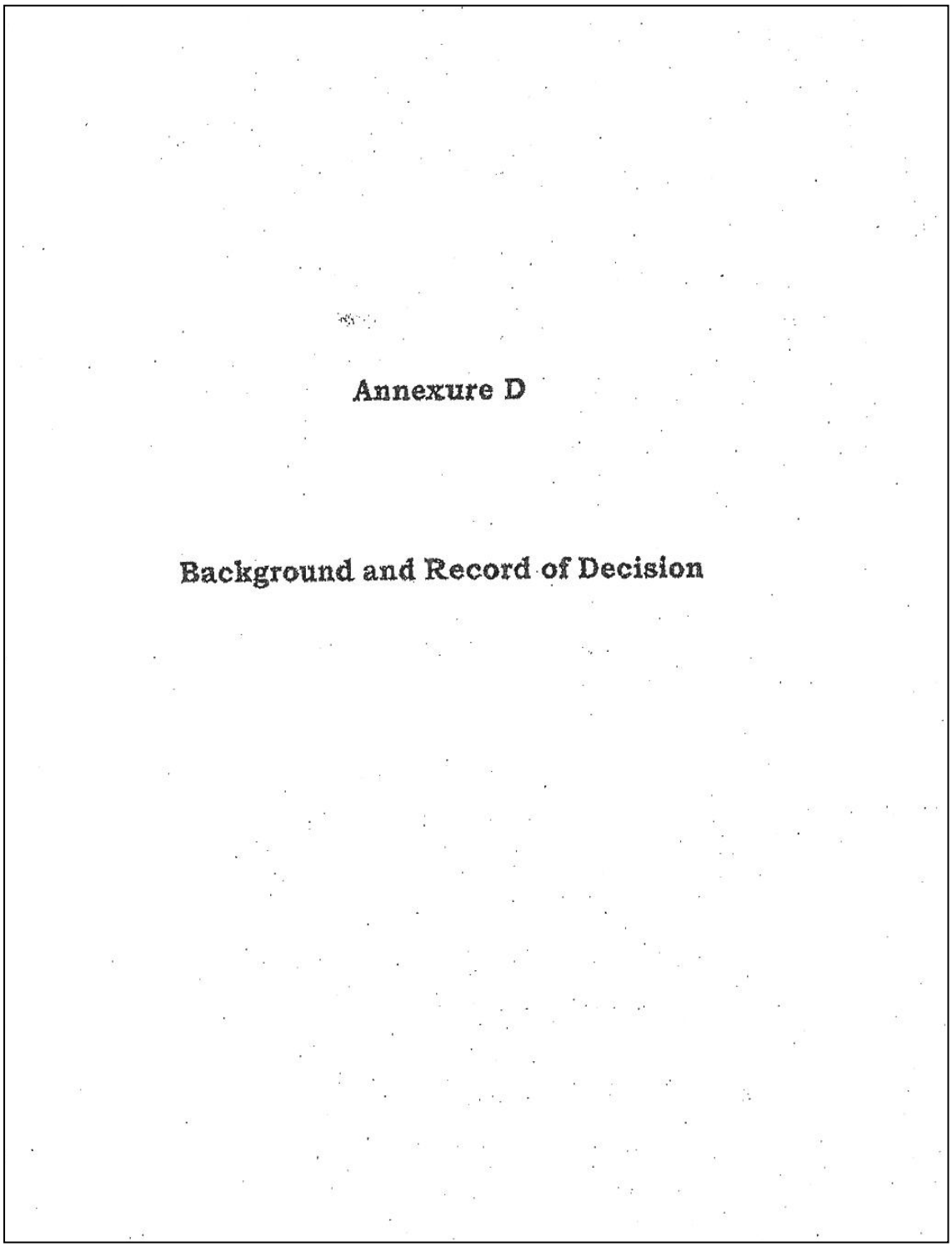
- Maintain groundwater levels and groundwater gradients with specific reference to maintaining the groundwater contribution to baseflow. Implement a groundwater level monitoring programme and specifically monitor the quantity and quality of groundwater.

- Continuously assess the potential impacts of the development activities, and associated land-use activities, on the quality of the groundwater resources. Implement a periodic groundwater quality sampling programme prior to and during development operations.

Implement the above activities to generally prevent the following:

- To prevent and/or manage decreasing groundwater level trends.
- To prevent the deterioration of the groundwater quality.
- To prevent stress on groundwater dependent ecosystems and to maintain the groundwater component of baseflow.
- To manage groundwater optimally within the catchment taking into account:
    - Increasing groundwater use in the catchment
    - Increasing disputes around groundwater use
    - The increasing numbers of boreholes completed and/or failing
    - The increasing number of potential groundwater pollution sources
    - Increasing groundwater pollution from existing sources

An example of a motivation of approval of a GWULA reserve continue



Annexure D

Background and Record of Decision

An example of a motivation of approval of a GWULA reserve continue

BACKGROUND AND RECORD OF DECISION

1. STUDY TEAM

DWAF team:	N. S. Motebe	RDM Office
	R. Titus	RDM Office (Author)
	Q. Bruwer	DWAF Regional Office

2. MOTIVATION FOR RESERVE DETERMINATION:

This Reserve determination (Desktop Level) was undertaken in support of a water use licence application by H.J Swart Family Trust, North West Province. The application relates to the following:

- Total amount of 63 072 m^3/annum of groundwater will be abstracted for domestic supply.

The following water use is recognised as applicable to this Reserve determination:

- Section 21(a) – taking water from a resource.
- Section 21 (c) – engaging in controlled activity identified as such in section 37(1) or declared under section 38(1)
- Section 21(g) – disposing waste in a manner which may detrimentally impact on a water resource
- Section 21(j) – removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

Though the current application is for Sections 21 (a), sections 21(c), (g) and (j) have been included in anticipation of future applications in the same catchment.

3. NATURE OF PROPOSED WATER USE APPLICATION

The applicant wishes to abstract 63 072 m^3/annum of groundwater from a borehole for domestic and/or urban supply.

4. SCOPE OF STUDY

A desktop (i.e. low confidence) level preliminary Reserve determination of the groundwater quantity component of the ecological Reserve and the basic human needs Reserve was undertaken.

General interpretation of a GWULA reserve as described by NY Mvimbi (2009)

The groundwater reserve mainly consists of two components, which is the groundwater quality and groundwater quantity components. The groundwater reserve together with the current allocation of groundwater for irrigation purposes is currently used in South Africa to ensure sustainable groundwater allocation.

Groundwater quality component

The groundwater quality component makes provision for basic human needs and the ecological water quality. The basic human needs are set according to prescribed standards for domestic water supply.

Ecological water quality component

The ecological water quality is defined by the ambient groundwater quality of a resource unit. The ambient groundwater quality is derived from the statistical analysis of data, derived from the National Groundwater Archive and from groundwater specialist studies performed in a specific quaternary drainage region. The water quality reserve cannot be better than the ambient water quality, as the latter originates from the geological environment of the groundwater resource.

Groundwater quantity reserve

The quantity and quality of groundwater are required to protect basic human needs, aquatic ecosystems, and to ensure sustainable development and use of groundwater and ecological systems.

Therefor the $Reserve_q$ = (MLF_IFR + BHN)/Recharge %

MLF = Maintenance low flow (Mm^3/a)

IFR = Instream flow requirements (Mm^3/a) for example high flow, low flow, and drought

BHN = Basic human needs (Mm^3/a)

All groundwater reserves are determined for a groundwater resource unit and not for individual boreholes. The resource unit is the particular quaternary drainage region. The area is expressed in the unit (km^2), recharge in the unit (Mm^3/a), and baseflow in the unit (Mm^3/a). The population is considered as well. The reserve is expressed as the percentage of recharge.

The above-mentioned components are inserted into the GWULA evaluation template in order to determine whether or not the applied volume of groundwater can be approved or not.

Appendix B
Examples of a Letter of Verification, Registration Certificate, Requirements and Letter of Request for a Reserve Determination, GWULA Evaluation Template, Determination of Requirements for GWULA, and Record of Recommendation

An example of a Section 35 letter: Request water user to apply for verification

Address and logo of relevant authority

Water User Address

Dear ……., [please include the name of the person or company]

WESTERN CAPE REGION: OLIFANTS DOORN WATER MANAGEMENT AREA: APPLICATION FOR THE VERIFICATION OF EXITING LAWFUL WATER USE IN THE JAN DISSELS RIVER CATCHMENT IN TERMS OF SECTION 35 OF THE NATIONAL WATER ACT

PROPERTY DESCRIPTION: [as per table]

OWNER: [as per table]

The Cluster Manager: Southern Region acting as the responsible authority of the Department of Water Affairs and Forestry has, in terms of section 35(3)*(b)* of the National Water Act, 1936 (Act No. 36 of 1998), has conducted an investigation into the veracity and lawfulness of all water use falling within the Jan Dissels River catchment.

The Jan Dissels River catchment is defined as the Jan Dissels River, including all the tributaries of the Jan Dissels River, upstream of its confluence with the Olifants River. This investigation included all surface water, underground water, as well as any water received via the Olifants River Government Water Control [check the name] area directly from the Clanwilliam Dam.

In terms of the NWA an existing lawful water use is one that had taken place at any time during a period of two years immediately before the commencement of the NWA and was authorised by or any law in force at that time. For all water resources, except surface water outside the area of a government water control area, the two year period is 1 October 1996 to 31 September 1998 (the qualifying period).

The property outlined above falls within the ambit of this investigation. The proposed extent of the existing lawful water use on this property was discussed at a meeting in Clanwilliam on 25 July 2006, to which all water users were invited. The methodology used to calculate

the proposed extent of existing lawful water use for your property was outlined at this meeting, and stakeholders were invited to provide any additional pertinent information in writing to the Department (DWAF, 2006:22).

The final proposed extent of existing lawful water for your property incorporating any approved changes is outlined as follows:

		Abstraction	Storage
Description	Hectares	Volume cubic metres/annum	
Use in qualifying period			
Use in 2005			
Proposed extent of existing lawful water use			

You are kindly requested to complete the attached application form in order for the responsible authority to make the final determinations.

An application form must be completed irrespective of whether you concur with the above-proposed determinations. Should you disagree with the above-proposed determination, you may make representation on any aspect to the responsible authority in writing for his or her consideration.

Any person has an interest in any determination may make similar representations. Additional information on all water use in the Jan Dissels River catchment is available from the Department's offices in Clanwilliam.

The final determination will limit the extent of your lawful water use in terms of section 32(1) of the NWA. Existing water use registration information will be modified were necessary.

You attention is respectfully drawn to the fact that once the final determination has been made by the responsible authority, all water use over and above the determined volumes will be regarded as a contravention of the NWA. Detailed reports on the methodology followed are available from the Regional offices (DWAF, 2006:22).

Yours sincerely

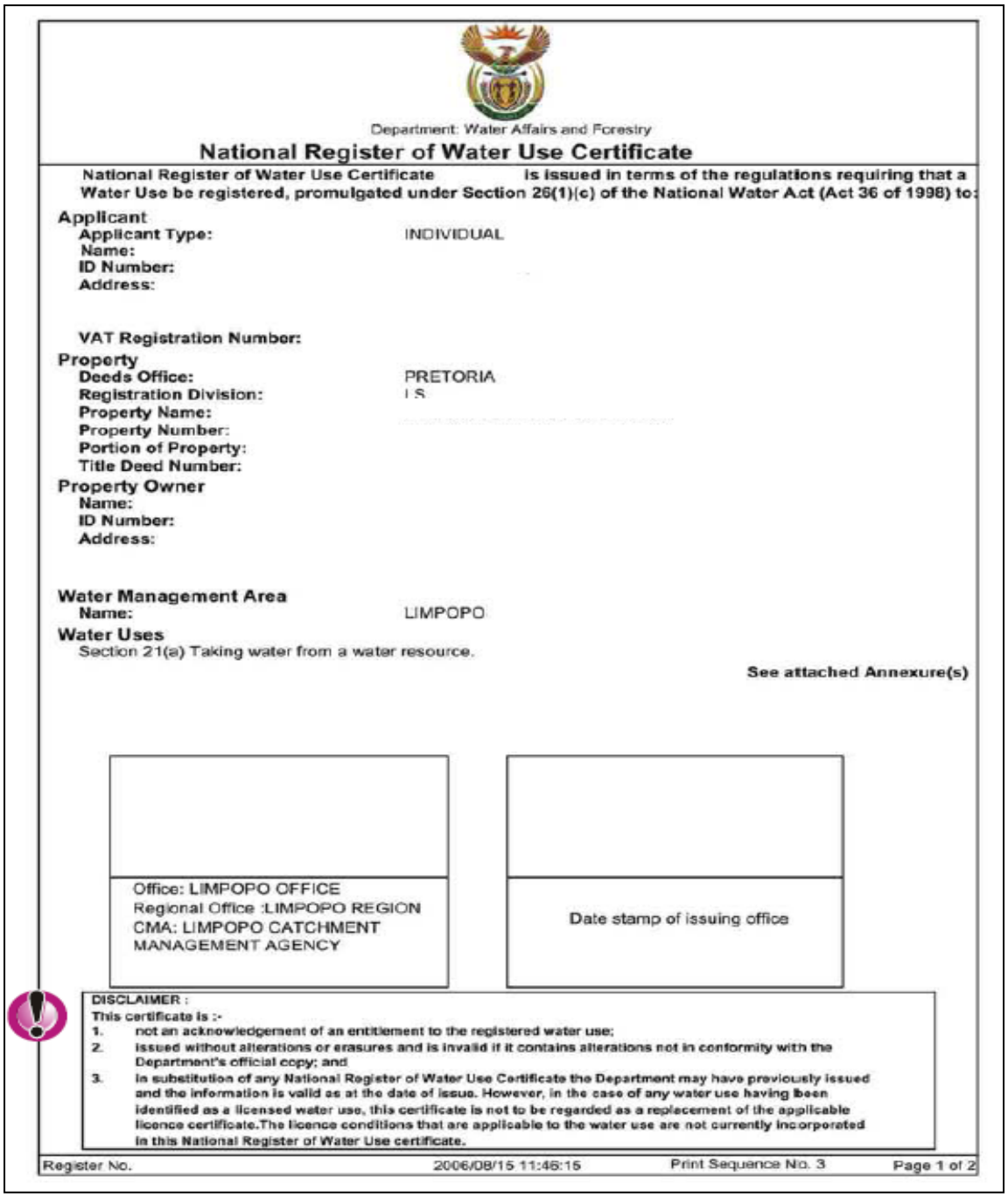
Signature

Title, initials, and surname

Designation

Date

An example of a registration certificate (DWAF, 2006:24)



Department: Water Affairs and Forestry

National Register of Water Use Certificate

National Register of Water Use Certificate is issued in terms of the regulations requiring that a Water Use be registered, promulgated under Section 26(1)(c) of the National Water Act (Act 36 of 1998) to:

Applicant
- **Applicant Type:** INDIVIDUAL
- **Name:**
- **ID Number:**
- **Address:**
- **VAT Registration Number:**

Property
- **Deeds Office:** PRETORIA
- **Registration Division:** LS
- **Property Name:**
- **Property Number:**
- **Portion of Property:**
- **Title Deed Number:**

Property Owner
- **Name:**
- **ID Number:**
- **Address:**

Water Management Area
- **Name:** LIMPOPO

Water Uses

Section 21(a) Taking water from a water resource.

See attached Annexure(s)

Office: LIMPOPO OFFICE Regional Office :LIMPOPO REGION CMA: LIMPOPO CATCHMENT MANAGEMENT AGENCY	Date stamp of issuing office

DISCLAIMER :

This certificate is :-

1. not an acknowledgement of an entitlement to the registered water use;
2. issued without alterations or erasures and is invalid if it contains alterations not in conformity with the Department's official copy; and
3. in substitution of any National Register of Water Use Certificate the Department may have previously issued and the information is valid as at the date of issue. However, in the case of any water use having been identified as a licensed water use, this certificate is not to be regarded as a replacement of the applicable licence certificate.The licence conditions that are applicable to the water use are not currently incorporated in this National Register of Water Use certificate.

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Department: Water Affairs and Forestry

National Register of Water Use Certificate

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	
Water Use Number:	3
Water Use Start Date:	1981/01/01
Water Use Status:	REGISTERED

Lawfulness Authentication

Finding	PARTIALLY LAWFUL
Finding Date	2006/08/07
Finding Reason	OFFICE DECISION
Finding Confirmed	NO

Water Use Details

Water Use Sector (i.e. Purpose of Water Use):	SCHEDULE 1	
Source Type:	BOREHOLE	
Water Resource Name:	BOORGATE	
Point of Abstraction:	**Latitude**	**Longitude**
Datum Type:	CAPE (MODIFIED CLARKE 1880)	
Quaternary Drainage Region:	A72A	

Registered Volumes

Start Date	Registered Volume (m³)	Time Interval
1981/01/01	600	PER YEAR

Comment

DISCLAIMER :

This certificate is :-

1. not an acknowledgement of an entitlement to the registered water use;
2. issued without alterations or erasures and is invalid if it contains alterations not in conformity with the Department's official copy; and
3. in substitution of any National Register of Water Use Certificate the Department may have previously issued and the information is valid as at the date of issue. However, in the case of the water use having been identified as a licensed water use, this certificate is not to be regarded as a replacement of the applicable licence certificate.The licence conditions that are applicable to the water use are not currently incorporated in this National Register of Water Use certificate.

An example of a certificate of verification (DWAF, 2006:25)

OFFICE OF THE **CHIEF DIRECTOR: CENTRAL CLUSTER**
Sanlam Plaza East, 285 Schoeman Street, Pretoria

Fax No: (012) 392-1438
P/Bag X995
PRETORIA
0001
M L J Botha
(012) 392-1308
082-808-9560
e-mail: bother@dwaf.gov.za
27/2/1/A21C/7

RB04059a.DOC

Clidet No 69 (Pty) Ltd
P.O. Box 70406
BRYANSTON
2021

Sirs

GAUTENG REGION: CROCODILE(WEST)-MARICO WATER MANAGEMENT AREA

APPLICATION FOR THE VERIFICATION OF EXISTING LAWFUL WATER USE IN TERMS OF THE NATIONAL WATER ACT, 1998 (ACT 36 OF 1998) – *CONFIRMATION OF EXISTING LAWFUL WATER USE IN TERMS OF SECTION 35(4)*

PROPERTY DESCRIPTION :
OWNER DETAILS :

In terms of section 35(4) of the National Water Act (Act 36 of 1998), the Department wishes to inform you that it has been determined that the extent and lawfulness of the water use on the above-mentioned property are as follows:

Description	*Taking of Water: Agriculture*				*Total Storing (m^3)*
	Source	*Irrigation*		*Watering Livestock*	
		Extent (ha)	*Volume (m^3/a)*	*Volume (m^3/a)*	
Permit Restrictions	Jukskei River		N/A		N/A
Other Restrictions	"	146.2	2 349 434		114 000
Recent Field Survey - April 2004	"	49.7	798 679	5 432	158 667
1998 Satellite Image	"	49.7	798 679	5 432	158 667
2001 Colour Aerial Photograph	"	49.7	798 679	5 432	158 667
Registered Water Uses	"	49.7	798 679	5 432	158 667
Possible existing lawful water uses	"	49.7	798 679	5 432	114 000
Possible unlawful water uses	"		0	0	44 667
Present day water use according to DWAF*2	"	49.7	798 679	5 432	158 667

*1 *As prescribed by the National Raw Water Pricing Strategy. Calculated by SAPWAT V.2.6.1 of April 2003 (Computer Model for the calculation of crop irrigation requirements). This model is based on a specific climatic zone (precipitation and evaporation) and irrigation system.*

An example of a certificate of verification continue (DWAF, 2006:26)

[2] *Please find attached hereto partly completed registration forms for the storing of water, considered to be correct by the Department. Please initial at the bottom of each page and return to this office in the stamped/addressed envelope included herewith.*

This implies that the extent and lawfulness of the water use on your property is:

(a) The water use for Taking of Water: Agriculture as registered by you, of 798 679 m^3/a for irrigation of pastures and 5 432 m^3/a for livestock watering, is correct.

(b) The water use for Storing Water not Containing Waste as registered by you, of 158 667 m^3, was not registered correctly. Please complete the attached registration application forms necessary to amend the existing registration.

Yours faithfully

CHIEF DIRECTOR: CENTRAL CLUSTER

Date: _____

An example of a standard request letter for a reserve determination (DWAF, 2007:60)

 email@dwaf.gov.za Tel (012) 336 7500 <insert name>

Fax (012) 323 4472 *<6/8/3/3/021>*

Chief Directorate: Resource Directed Measures

Department of Water Affairs and Forestry

Private Bag X313

PRETORIA

0001

ATTENTION: MS BARBARA WESTON

PRELIMINARY DETERMINATION OF THE RESERVE AND RESOURCE CLASS IN TERMS OF SECTION 14(1)(B) AND 17(1) OF THE NATIONAL WATER ACT, 1998: <PROVIDE NAME OF RESOURCE>: <PROVIDE QUARTENARY CATCHMENT AREA>

1. INTRODUCTION

The <*name*> Regional Office of the Department of Water Affairs and Forestry received water use licence applications for <*name water use activity*> in the <*name water resource and Water Management Area*>. In order to proceed with the water use licence application the Resource Directed Measure Office (RDM) is hereby requested to conduct a preliminary Reserve determination for the affected resource.

2. LOCALITY OF THE PROPOSED WATER USE ACTIVITY

<*Provide a brief description by addressing the following criteria :*>

- Quaternary catchment number.

- Name of water resource affected/impacted by the water use identified. For example name of the river, wetland, dam, or estuary. Indicate if it is a tributary and provide the name of the tributary and mainstream river.
- Geographic co-ordinates: latitude and longitude in degrees, minutes and seconds.
- Provide the 1:50 000 map reference and farm name or attached a copy of the relevant part of the 1: 50 000 map with the location of the water use marked on it.
- Proximity to other users, such as dams, weirs, abstraction points, or in-stream or riparian disturbance. Provide information in kilometres from the proposed activity.
- If there is more than one water use activity proposed, provide the above-mentioned details for each activity.

3. PURPOSE AND DESCRIPTION OF WATER USE

A preliminary determination of the Reserve needs to be undertaken in support of the water use licence application and in order to consider the following section 21 water use licence applications:

<select the relevant water uses and delete the rest as and when applicable>

Section 21(a): Taking water from a resource

Section 21(b): Storing water

- Describe the proposed development's life cycle to determine the potential water uses as defined in the Act, for example storage, discharge, abstraction.
- Provide a brief description of the applicant for example "Is the applicant an emerging or established user?"
- Provide a brief description of the objectives of the project for which the water is required.
- Provide details on the extent of water use
- Provide details on the water use activity itself, for example:
  - If abstraction – is it from groundwater? State the frequency or pattern of water use.
  - If storage – is it in-stream or off-channel? Will the in-channel storage affect moderate to high flows?
  - Will the proposed water use activity reduce the yield by more than 20%?
  - Are any International Obligations likely to be affected by the proposed water use activity?
  - Will a national/international environmental resource be affected?

4. MOTIVATION FOR A RESERVE DETERMINATION

<The request for a Reserve determination should be motivated in terms of the following

attributes>

- The proposed water use activity will contribute towards satisfying basic livelihoods.
- The proposed water use activity would contribute towards developing small-scale local level employment and income generation.
- The water use activity is geared towards satisfying priority regional objectives as identified in Regional Planning Initiatives as contained in the Integrated Development Plan and Interim Strategic Perspective
- The water use activity would satisfy the National Strategic Objectives;
- The water use activity will result in significant employment creation in line with priority planning objectives;
- The water use activity will assist in addressing past economic inequities through BBBEE and the water use activity would redress gender imbalances.

5. SUPPORTING DOCUMENTATION

<Provide the following documentation in support of the Reserve determination>

List and supply details and where possible copies of all studies related to the water use application and the receiving water resource for example basin studies, feasibility studies, groundwater studies.

Should the Resource Directed Measures Office requires any further assistance or clarification of information submitted, the Regional Office may be contacted at the number provided above.

REGIONAL DIRECTOR

DATE:

An example of a list of requirements that the DWS Regional Offices should meet before submitting a letter of request for a reserve determination to the Resource Directed Measures Directorate of DWS Head Office (DWAF, 2008)

The following documents must be submitted together with the letter of request for a reserve determination:

- Copy of fully completed license application together with all supporting documentation received.
- Background information gathered by the regional DWS geohydrologist during a site visit to the farm or smallholding.
- The required background information is administrative, scientific and technical information:
  Administrative information
  - Contact person and details of applicant.
  - Any available DWS or consultant groundwater reports for the area.
  - Description of the application or activities.
  - Coordinates of impacted points.
  - Quaternary draining region.

  Scientific and technical information
  - Potential impact on groundwater resources.
  - If there are negative impacts, the period of impact is required.
  - Land use activities on site that may have an impact on the groundwater resources.
  - Groundwater quality data and results.
  - Groundwater levels.
  - Distance between groundwater resources onsite and a river.
  - Basic human needs requirement from the groundwater resource as either a sole source or supplementary source.
  - Springs within the area.
  - Terrestrial vegetation dependent on groundwater resources in the area.
  - Other groundwater users in the area.
  - Size of the farm or smallholding.

An example of the groundwater use licensing application evaluation template by Dr E van Wyk and his DWAF team

Water Use License Application Evaluation Template

This is a typical example of the groundwater balance assessment used during a Water Use License Application and focus strictly on the groundwater recharge potential of the property on which the water use is to be developed and used.

Software will calculate the components for the assessment				Only insert data in THESE coloured boxes
A21F	Kaalfontein 44 IQ (sub- Quaternary Catchment)			Quaternary Catchment and Farm Name/Number/Portion
Size (ha) of Property (Deed)	3816	38.160	km² [Area in Km²]	Area (ha) of Property as per Transport Deeds Registrar
General Authorisation on Quaternary (m³/ha/a)	60	228 960	m³/ha/a on Area	First General Authorisation (DWAF)
General Authorisation on Quaternary (m3/ha/a)	0	0		Total volume as per General Authorisation (#2) on Area
License (Water Use required)	1500 000	1500 000	m³/a	Water use requested by licensee for Area
Harvest Potential MAP - Min	10 000		m³/km²/a	Harvest Potential as per Vegter's Map (Including lateral Recharge) -Minimum
Harvest Potential MAP - Max	15 000		m³/km²/a	Harvest Potential as per Vegter's Map (Including lateral Recharge) - Maximum
Available Volume/a: Lower Harvest Potential value		381 600	m³/a	Volume of groundwater that can be authorised with Harvest Potential evaluation. (Maximum - Minimum)
Available Volume/a: Highest Harvest Potential Value		572 400	m³/a	
Average Harvest Potential volume		477 000	m³/a	
Average Harvest Potential ratio		2.9	: 1	Ratio: This allocation VS Harvest Potential.
Exploitation Potential (Haupt) for Quaternary Catchment		8 781	m³/km²/a	This is: Harvest Potential corrected for abstraction, recharge and hydraulic characteristics of aquifer(s) in Quaternary Catchment
Exploitation Potential (Haupt) for Area		335 070	m³/a	
Exploitation Potential ratio		4.5	: 1	Ratio: This allocation VS Exploitation Potential (by WSM-Haupt)
GRA II Information	A21F		m³ on Area	
Volume water Stored in Aquifer	585.980		18 618 648	Total volume (m³) of groundwater stored in aquifer systems within QC (i.e. WZ + FZ) [Repeat from Project 1].
Harvest Potential (as in GRA II)	15.336		487 266	Annual volume (m³) of groundwater per km² available for exploitation according to Harvest Potential (Baron, Seward & Seymour, 1998)
Baseflow (MACBf)	8.159		259 231	Mean annual volume (m³) of groundwater discharge (baseflow) to rivers in Quaternary Catchment [output Project 3].
Average Annual Potential Recharge (Dry)	34.695		1 102 376	Mean annual volume (m³) of groundwater recharge from rainfall per Quaternary Catchment under 'drought' conditions, i.e. rainfall < MAP x %CV.
Groundwater Resource Pot (AGRP - Dry)	154.818	Mm³/a	4 919 113	Mean annual Groundwater Resource Potential (AGRP in m³) per Quaternary Catchment under 'drought' recharge conditions (Re Dry).
Average Groundwater Exploitation Potential (AGEP - Dry)	68.380		2 172 677	Mean annual Groundwater Exploitation Potential (AGRP in m3) per Quaternary Catchment under 'drought' recharge conditions (AGEPDry = AGRPDry x Ef). INCLUDING SOME STORAGE!
Potential Groundwater Exploitation Potential (PGEP - Dry)	66.999		2 128 788	Mean annual Potable Groundwater Exploitation Potential (PGEP in m³) per Quaternary Catchment under 'drought' recharge conditions ($PGEP_{Dry}$ = $AGEP_{Dry}$ x Pf).
Utilisable Groundwater Resource Potential(UGRP - Dry)	18.713		594 591	Mean annual Utilisable Groundwater Resource Potential (UGRP in m³) per Quaternary Catchment under 'drought' recharge conditions ($UGRP_{Dry}$ = $AGRP_{Dry}$ using max. allowable drawdown [Project 4]).
Annual Recharge required >>>>>>>		39.3	mm	Recharge required to sustain THIS water use on Area
Annual Recharge from av. Harvest Potential		12.5	mm	Recharge available On Area to sustain Harvest Potential
Annual Recharge from Exploitation Potential		8.8	mm	Recharge available On Area to sustain Max Utilisable Groundwater
Annual Recharge from GRA II Estimation.		28.9	mm	Recharge available On Area to sustain AGEP (GRA II)
Average Recharge Sub-QC (Mm³/a)	1.46	38.2	mm/a on s-QC	
Sub-Quaternary Catchment Area	38.16	<Km² / m²>	38 160 000	
Base flow	0.1031		Mm³/a	Source: From Reserve determination by Groundwater Consulting Services (March 2007).
Instream Flow Requirements	0.0000		Mm³/a	
Basic Human Needs	0.0037		Mm³/a	
Amount of Recharge available for allocation		38	mm/a	
Recharge in reserve on this Area		(1)	mm/a	Difference between Recharge in Reserve and Required for water use (deficit if printed in red!!!)
➔ Land area required to sustain thus Use		8970	ha	Based on mean recharge of: 17 mm/a
THIS ALLOCATION	1.5000		Mm³/a	
Already allocated in Quaternary Catchment	1.051		Mm³/a	Updated from WARMS data base on:
TOTAL ALLOCATION	2.5547		Mm³/a	Total allocation for Quaternary Catchment, this water use included
Summary: Reserve volume in Quaternary Catchment	-1.1	Mm³	175%	<< ALREADY allocated in A21F - Quaternary Catchment

An example of the groundwater use licensing application evaluation template by Dr E van Wyk and his DWAF team

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Catch	**Volume water in Aquifer System**	**Volume in 5m D-down**	**Storati-vity**	**Specific Yield**	**Harvest Potent**	**Exploi-tability Factor**	**Pota-bility Factor**	**Drought Index**	**Mean Annual Base Flow**	**Annual Abstract**	**Annual Potential Recharge**		**Groundwater Resource Potential**		**Groundwater Exploitation Potential**		**Potable Groundwater Exploitation Potential**		**Utilisable Groundwater Resource Potential**		**Utilisable Groundwater Exploitation Potential**		**Utilisable Potable Groundwater Exploitation Potential**	
Catch #	Sv	Svr (5m)	FZ	WZ	HP	Ef	Pf	Di	Bf	At	Re	Re (dry)	AGRP	AGRP (dry)	GEP	GEP (dry)	PGEP	PGEP (dry)	UGRP	UGRP (dry)	UGEP	UGEP (dry)	UPGEP	UPGEP (dry)
	m^3x1000	m^3x1000	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3		m^3x1000		m^3		m^3		m^3		m^3		m^3	
A21F	585 980	128 391	0.000856	0.025608	15 335 600	0.370600	0.979800	1.00	8 158 710	7 899 850	47 168 500	34 694 800	167 417	154 818	73 073 900	68 380 100	71 597 8	66 998 8	31 142 100	18 713 400	11 560 100	6 939 21	11 295 700	6 777 880

The above source data is partially used to populate the Water Use Licensing Assessment Tool

An example of the requirements for groundwater use licensing applications according to Section 21(a) of the NWA and developed by Mrs S Veltman and her DWAF team

REQUIREMENTS FOR WATER USE LICENCE APPLICATION: GROUNDWATER ABSTRACTION [S 21 (a)]

The *Initial Regional* assessment is needed to determine the amount of information necessary for each new Water Use licence application for abstraction from groundwater, based on the amount of recharge that is used by the applicant in relation to the specified property.

Categories A, B and C list the information requirements for the licence application, as should be provided by the applicant to the Department of Water Affairs & Forestry.

Regional - Initial

- Size of property ($AREA_{PROP}$)
- Recharge - HP (RE)
- Existing use volume (ABS_{EX})
- New use volume (ABS_{NEW})
- Scale of abstractions (ABS_{SCALE})

CALCULATION

$AREA_{PROP} * RE = RE_{AREA}$ (m^3/a)

$ABS_{EX} + ABS_{NEW} = ABS_{TOTAL}$ (m^3/a)

$ABS_{SCALE} = (ABS_{TOTAL} / RE_{AREA}) * 100$

Small scale abstractions (<60% recharge on property)	**Category A**
Medium scale abstractions (60-100% recharge on property)	**Category B**
Large scale abstractions (>100% of recharge on property)	**Category C**

The Regional RDM support is info that should be submitted with the request for a Reserve determination. This will not only speed up the process, but also render more confidence to the Reserve determination.

Regional - RDM support

- Delineate resource units (default quaternary, unless geologically different)
- Delineate response units (same as resource unless existing information shows otherwise)
- Drainage (rivers and gauging stations in the resource unit area)
- Climate (average rainfall, reference source)
- Vegter regions (hydrological regions and recharge)
- Geo-hydrology - wq, wl, aquifer tests, main fracture zones – storage, sustainable yield, assurance of supply?
- Aquifer status: Local expert consideration (reference source), natural / impacted (mapping these areas in the resource unit), importance (both socio-economic and strategic), vulnerability, dependent ecosystems, total current use, classification (Parsons and current resource classification system).
- Licensing conditions - wl, wq, level of acceptable degradation?
- Monitoring requirements - according to the Category.
- Site visit necessary to validate all info - regional and applicant

An example of the requirements for groundwater use licensing applications according to Section 21(a) of the NWA and developed by Mrs S Veltman and her DWAF team

Category A

- Volume and purpose of the water required.
- Detail borehole census on the property in question. Information to be collected should include pump depth / borehole depth, depth to water level, yield of the borehole, volume abstracted (daily, weekly, monthly).
- Proximity to surface water discharges (springs, seeps, wetlands streams, rivers, lakes) and groundwater dependant ecosystems.
- Geo-referenced map of the property in question, with boreholes, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol/diesel tanks, irrigation areas) depicted.
- Monitoring programme - monthly water levels, monthly rainfall.

Category B

- Geology of the area / borehole?
- Volume and purpose of the water required.
- Detail borehole census within a 1km width zone around the property in question as well as on the property itself. Information to be collected should at least include pump installation/ borehole depth, depth to water level, yield of the borehole, volume abstracted (daily, weekly, monthly), water quality (one macro analysis per property).
- Proximity to surface water discharges (springs, seeps, wetlands streams, rivers, lakes) and groundwater dependant ecosystems.
- Geo-referenced map of the property in question, with boreholes, surface water features, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol/ diesel tanks irrigation areas) depicted.
- Contact details of relevant parties in the hydro census area.
- Potential impacts of potential use on groundwater and surface water quality.
- Monitoring programme - weekly water levels, weekly rainfall, 6 monthly macro analysis and surface water discharges in the 1km width zone.

Category C

- A geo-hydrological report compiled by an acceptable and qualified geo-hydrological consultant. Report should include appropriate maps, tables and figures to support the conclusions and recommendations.
- Detail geology of the area, including structures, maps etc.
- Detail borehole census within at least 1km width zone around the area of recharge as well as on the area itself. Information to be collected for each borehole should at least include pump installation depth, borehole depth, depth of water level, yield of the borehole, depth of water strike(s), volume abstracted (daily, weekly, monthly) and water quality (one macro analysis per property in the zone).
- Aquifer description and characteristics including extent of the aquifer and hydraulic properties (storativity and transmissivity). This would require testing. Drilling might or might not be required. Groundwater piezometric contour map showing flow direction and a depth to water level contour map.

An example of the requirements for groundwater use licensing applications according to Section 21(a) of the NWA and developed by Mrs S Veltman and her DWAF team

- Effective annual recharge on this property and the safe yield of the aquifer.
- Volume and purpose of the water required and the volume available for abstraction. A water balance that at least cover the aquifer unit in which the property is located should, in other words, is done that includes all gains and losses.
- Contact details of relevant parties in the hydro census area.
- Impact the abstraction will have on existing users and surrounding properties. This should be short- and long-term impact. This might have to be supported by a numerical model.
- Proximity to and potential impact of the abstraction on surface water discharges and groundwater dependant terrestrial ecosystems.
- Potential impact of potential use on groundwater and surface water quality.
- Geo-referenced map of the property in question, with boreholes, surface water features, geological features, physical structures (houses, stores, irrigation equipment) and current pollution sources (septic tanks, pit latrines, petrol/ diesel tanks, irrigation areas) depicted.
- Monitoring programme - weekly water levels, weekly rainfall, 3 monthly macro analysis and surface water discharges and 6 monthly qualities in the 1km width zone.

The Department of Water Affairs and Forestry recommends that the following measures be taken when testing bore holes for sustainable yields and to provide the following information:

- Refer to test procedures in the South African National Standards Code No.: SANS 10299.
- Perform a three (3) hour stepped draw down test to determine the discharge rate of the intended constant rate test OR;
- The constant discharge test should be done at approximately $^{2}/_{3}$ of the blow yield of the bore hole.
- For **HOUSEHOLD** use it as recommended that a 8 hour constant rate test be performed with the draw down and the recovery measured.
- For **IRRIGATION** it as recommended that a 24 constant rate test should be performed while the draw down and the recovery is measured. This test could also be performed for intended **BULK WATER SUPPLY** for a volume of up to 150 000 m^3 per annum.
- For **BULK WATER SUPPLY** in excess of 150 000 m^3 per annum it as recommended that a 72 hour constant rate test should be performed while the draw down and the recovery of the bore hole is measured.
- All data as obtained above should be attached to the relevant Water Use License Application forms, together with an analysis of the data (including draw down curves) and recommendation for the sustainable yield of the borehole(s), by a qualified Geo-hydrologist .

NOTE: The above-recommended requirements may change without prior notice as required by DWAF to effectively manage the respective water resource.

An example of a record of recommendation (DWAF, 2007:57)

RECORD OF RECOMMENDATION

F 🖷 ✍

E 💻 @dwaf.gov.za ☎ (012) 336 7500

🗁 16/2/7/

The Chief Director: Water Use
Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001

RECORD OF RECOMMENDATION AND DECISION

Regarding the application for a licence received from

[Add property description]

FOR THE FOLLOWING SECTION 21 WATER USES INDICATED(X):

Sub-sec	Description as per the Act	Existing Lawful use	Applied for	Licensed	* Not Licensed
a	Taking water from a water resource				
b	Storing water				
c	Impeding or diverting the flow of water in a watercourse				
d	Engaging in a stream flow reduction activity				
e	Engaging in a controlled activity				
f	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit				
g	Disposing of waste in a manner which may detrimentally impact on a water resource				

An example of a record of recommendation (DWAF, 2007:57)

h	Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process				
i	Altering the bed, banks, course or characteristics of a watercourse				
j	Removing, discharging or disposing of water found underground if it is necessary for the effective continuation of an activity or for the safety of people				
k	Using water for recreational purposes				

* Use a separate ROD sheet for water uses not approved

1. BACKGROUND TO APPLICATION (1 paragraph)

Date of application
Previous authorisations

2. SHORT SUMMARY OF TECHNICAL INFORMATION (Max ½ a page)

3. ASPECTS TAKEN INTO CONSIDERATION (Example)

The following aspects were taken into account with regard to this recommendation:

- The area is earmarked as a prime development zone.
- The issuing of this licence will consolidate all the previous Exemptions for the discharges into one licence, which is in line with departmental policy.
- A detailed EIA was undertaken to evaluate the potential impact of increased volumes and loads to be discharged and changes to the characteristics of the watercourse.
- The current discharge is well within acceptable limits and the additional discharge will not jeopardise the acceptable limits in any way. A report substantiating this is included in the Motivation Report.
- Industries discharging into the pipeline have shown commitment to cleaner production practices and the result is already visible.
- There was never any objection from any party to the issuing of a licence.
- No legal constraints exist that prohibit the issuing of a licence.
- A draft licence for discussion was compiled and distributed to the applicant as well as the public forum for comments
- Toolkit results for Section 27 of the NWA

The following aspects were taken into consideration with the drafting of the licence conditions:

a) Specific design changes for safety reasons from what was proposed to what is licensed Condition …
b) Need for continuous improvement addressed in condition …..
c) Comments and concerns raised by I&APs are addressed in Condition ….

An example of a record of recommendation (DWAF, 2007:57)

d) Concern of unknown and as yet un-quantified environmental impacts addressed in Condition …

4. RECOMMENDATIONS AND DECISIONS

Recommended/not recommended	**Recommended/not recommended**
Deputy Director: (Region)* Date:	Director: (Region)** Date:
Recommended/not recommended	
Chief Director: (Region) Date:	
Recommended/not recommended	
Deputy Director: (Authorisation administration) Date:	
Recommended/not recommended	**Recommended/not recommended**
Deputy Director: (Sub-dir)* Date:	Director: (Lead Directorate)** Date:
Hereby the licence is **issued/not issued** (see attached signed licence/letter of decline)	
Chief Director: Water Use Date:	
Hereby the licence is despatched to the Regional Office	
Deputy Director: (Authorisation administration) Date:	

Appendix C
An Example of a Groundwater Use License Application by Corico Trust

Mr Ricus Roux gave permission to the researcher to make use of the documentation included in Appendix C. His father, Mr C.A. (Corrie) Roux, sadly passed away three years ago. The content of Appendix C should be treated as confidential even though permission was granted and the applicant is deceased.

Groundwater use license application forms completed

DW758

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

REGISTRATION/LICENSING PART 1 — **COMPANY, BUSINESS, PARTNERSHIP OR COMMUNITY, NATIONAL OR PROVINCIAL GOVERNMENT**

1. GENERAL INFORMATION

Mark the applicable option(s) with an *X* and/or complete details where applicable/available.

Indicate the nature of this application:
- [X] New registration
- [ ] Minor change
- [ ] Formal amendment

Registration Number

2. PARTICULARS OF THE APPLICANT

Application for: (Mark one block with an X)
- [X] Company, business, partnership or community *(complete part 3,5,6,7 and 8)*
- [ ] National or provincial government *(complete part 4,5,6,7 and 8 excl. 8.1.2)*

3. PARTICULARS OF THE COMPANY, BUSINESS, PARTNERSHIP OR COMMUNITY

3.1 Name of company, business, partnership or community:
CORICO TRUST

3.2 Trading name if different from name of company, business, partnership or community:

3.3 Type of enterprise: (Mark one block with an X)
- [ ] 06 Public Company (Ltd)
- [ ] 07 Private Company (Pty) Ltd
- [ ] 08 Article 21 (Association Inc. under Article 21 of the Company Act No. 61 of 1973)
- [ ] 09 Limited By Guarantee
- [ ] 10 External Company
- [ ] 11 External Company under article 21 of the Company Act No. 61 of 1973
- [ ] 20 Transvaal Ordinance
- [ ] 21 Incorporated (Inc)
- [ ] 22 Unlimited
- [ ] 23 Close Corporation (CC)
- [ ] Parastatal
- [X] Trust
- [ ] Other [i.e. non-CIPRO Company types (e.g. Churches, Schools, Community Groups, etc.) excluding Trust and Parastatal]

3.4 Business enterprise registration number: IT 11193/2011

3.5 Date established: (ccyy/mm/dd) 2011/12/12

3.6 Country where established: RSA

3.7 VAT registration number:

4. PARTICULARS OF NATIONAL OR PROVINCIAL GOVERNMENT

4.1 **National Department:**

N/A

4.2 **a) Provincial Department:**

b) Province:

5. APPLICANT CONTACT DETAILS

5.1 **Postal Address:**

PO BOX 28872

DANHOF

Postal Code 9310

5.2 **Street Address** (only if different from postal address):

14 AKADEMIE STREET

DAN PIENAAR

BLOEMFONTEIN Postal Code 9301

5.3 **Contact telephone number during office hours**

Area/cell code 082 Number 9665720 Ext

Alternative contact number

Area/cell code 051 Number 4362744 Ext

5.4 **E-mail** coriru@iburst.co.za

6. CONTACT PERSON DETAILS

6.1 **Title** MR

6.2 **Name** CORNELIS ANDREAS

6.3 **Surname** ROUX

6.4 **Telephone**

Area/cell code 051 Number 4362744 Ext

6.5 **Cell Phone Number**

Area/cell code 082 Number 9665720

6.6 **Fax**

Area/cell code 0867116799 Number 77 Ext

6.7 **E-mail** coriru@iburst.co.za

6.8 **Preferred Form Of Communication** Telephonic or via post.

Declaration by applicant (or person who was granted power of attorney by the applicant)

Surname of delegated person: ROUX

Title: MR

Initials: CA

ID Number: 5012045080082

Passport Number: (if not a holder of South African ID)

Expiry Date (ccyy/mmdd):

Delete the words that are not applicable I/we CORNELIS ANDREAS ROUX (FULL NAME(S))
hereby declare that the information provided by me/us in this application form is, to the best of my/our knowledge, true and correct.

Signature

Thumb print

051 - 436 2744
Contact number during office hours

ARCHITECT/FARMER/TRUSTEE
Designation of signatory

2012/07/17
Date (ccyy/mm/dd)

It is a criminal offence to provide information that is false or misleading.

7. LIST OF PART 2 DOCUMENTS (WATER USE RELATED FORMS)

Mark with an X which of the following documents have been submitted with this application

☒	DW760 NWA-Section 21(a)	☐	DW768 NWA-Section 21(i)
☐	DW761 NWA-Section 21(b)	☐	DW780 NWA-Section 21(h)
☐	DW762 NWA-Section 21(b)	☐	DW805 NWA-Section 21(j)
☐	DW763 NWA-Section 21(c)	☐	DW806 NWA-Section 21(k)
☐	DW764 NWA-Section 21(d)	☒	DW901 Property or properties where water use occurs
☐	DW765 NWA-Section 21(e)	☒	DW902 Details of property owner
☐	DW766 NWA-Section 21(f)	☐	DW903 Actual/Monitored waste discharge details NWA-Section 21(f/h)
☐	DW767 NWA-Section 21(g)	☐	DW904 Actual/Monitored waste discharge details NWA-Section 21(e/g)

☒ DW 757
☒ DW 754

8. THIS SECTION IS RESERVED FOR OFFICE USE ONLY

8.1 Billing information

8.1.1 1 3 WMA for billing*

* Water Management Area Codes

01 Limpopo	05 Inkomati	09 Middle Vaal	13 Upper Orange	17 Olifants/Doorn
02 Luvuvhu/Letaba	06 Usutu-Mhlatuze	10 Lower Vaal	14 Lower Orange	18 Breede
03 Crocodile (W), Marico	07 Thukela	11 Mvoti-Umzimkulu	15 Fish-Tsitsikamma	19 Berg
04 Olifants	08 Upper Vaal	12 Mzimvubu-Keiskamma	16 Gouritz	

8.1.2 District Municipal Establishment Levy Payable ☐ Yes ☐ No

8.2 Mark with an X which of the following documents have been submitted with this application

☒ Certified copy of South African identity document

☐ Certified copy of passport

DW760

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Registration / Licensing — **Section 21(a) of the National Water Act**

Part 2 — **TAKING WATER FROM A WATER RESOURCE**

Mark the applicable option(s) with an X and/or complete details where applicable/available

1. WATER USE DETAILS

1.1 Have you already registered a water use with the Department of Water Affairs and Forestry?

☐ Yes ☒ No

Registration Number:

Water Use Number:

☐ Licence Related WU

RLA Reference

NRWU Licence Number

RLA Business Unit

(NRWU = National Register of Water Use; RLA = Responsible Licensing Authority; WU = Water Use)

1.2 **Applicant Type** (mark only one block with X)

- ☐ Individual (complete 1.3)
- ☒ Company, business, partnership or community (complete 1.4)
- ☐ National Department (complete 1.5)
- ☐ Provincial Department (complete 1.6)
- ☐ Water Services Provider (complete 1.7)
- ☐ Water User Association (complete 1.8)

1.3 **If the applicant is an individual**

1.3.1 Title Surname Initials

1.3.2 **South African ID (if holder of South African Id) alternatively Passport Number:**

ID Number or Passport Number

Passport Expiry Date (ccyymmdd)

Passport Country Of Issue

For office use only

Allocated Reg. No. WU No.

1.4 **If the applicant is a company, business, partnership or community:**

1.4.1 Name of company, business, partnership or community:
CORICO TRUST

1.4.2 Business Enterprise Registration Number: IT/1193/2011/1

1.4.3 Date Established (ccyymmdd): 20111212

Country Where Established: RSA

1.5 **If the applicant is a National Department:**

1.5.1 National Department Name: N/A

1.6 **If the applicant is a Provincial Department:**

1.6.1 Province: N/A

1.6.2 Provincial Department Name:

..7 **If the applicant is a Water Services Provider:**

1.7.1 Name of WSP: N/A

1.8 **If the applicant is a Water User Association:**

1.8.1 Name of WUA: N/A

Declaration by applicant

Delete the words that are not applicable I/we CORNELIS ANDREAS BOUW (FULL NAME(S)) hereby declare that the information provided by me/us in this application form is, to the best of my/our knowledge, true and correct.

Signature

Thumb print

057 - 436 2744
Contact number during office hours

ARCHITECT/FARMER/TRUSTEE
Designation of signatory

2012/07/17
Date (ccyy/mm/dd)

It is a criminal offence to provide information that is false or misleading.

2. SUCCESSION/TRANSFER AND SOURCE PART 2 DETAILS

2.1 Is this a Succession or a Transfer related Water Use? (Mark only one box with an X)
☐ Yes
☒ No

2.2 N/A If yes, mark with an X the Succession / Transfer Type
☐ Full Temporary Transfer ☐ Partial Temporary Transfer
☐ Permanent Transfer ☐ Succession in Title

2.3
Source Register Number | WU Number
Source Register Number | WU Number
Source Register Number | WU Number

3. WATER RESOURCE INFORMATION

3.1 Name of water resource: GROUNDWATER

3.2 Name or reference number of abstraction point (if any):

3.3 Type of water source (mark only one with X)
☐ River / stream ☐ Spring / Eye ☒ Borehole ☐ Dam ☐ Estuary
☐ Wetland ☐ Lake ☐ GWS (scheme) ☐ Boreholes And Windmills On Government Land

If water source is government water scheme, give the name:

3.4 Geographic location of the abstraction point

Latitude S ° ' . " or S . ° or
Longitude E ° ' . " or E . ° or

BH1: S 29 ° 32 . 553 '
E 25 ° 47 . 234 '

Datum Type: ☐ Cape (Modified Clarke 1880) ☐ WGS-84

BH2: S 29° 32 . 789 '
E 25° 47 . 143 '

3.5 Reliability of water resource (mark only one with an X)
☒ Water always available ☐ Dry during certain seasons ☐ Frequently Dry

3.6 Quaternary Drainage Region: C 5 1 E

BH3: S 29° 32 . 866 '
E 25° 47 . 078 '

4. DESCRIPTION OF WATER USE

4.1 Select only **one** WU sector – purpose of the WU: (NB: Complete a separate DW760/773 form for each sector if more than one is applicable)

☐ Agriculture: Aquaculture
☒ Agriculture: Irrigation (also complete form DW787)
☐ Agriculture: Watering Livestock
☐ Industrial (also complete form DW788)
☐ Mining (also complete form DW788)
☐ Power Generation (also complete DW788)
☐ Recreation
☐ Schedule 1
☐ Urban (excl. Domestic &/or Industrial)
☐ Water Supply Service (also complete form DW789)

4.2 Period of water use

Date of first use or proposed first use (ccyymmdd): 2012/10/01 End date (if applicable) (ccyymmdd): N/A

4.3 Volume of water abstracted (*minus a realistic estimate of the transmission losses in the case of a WUA / WSP related water use)

***WU /WSP: Transmission Loss** (taken into account i.r.o gross volume)

	Start date (ccyymmdd)	Volume		Time interval (mark only one with X)			
a)	2012/10/01	31550	m³	☐ Daily	☐ Monthly	☒ Annually	%
b)			m³	☐ Daily	☐ Monthly	☐ Annually	%
c)			m³	☐ Daily	☐ Monthly	☐ Annually	%

4.4 Estimated water abstraction pattern: in total cubic meters ☐ or % per month ☐

Jan		Apr		Jul		Oct	
Feb		May		Aug		Nov	
Mar		Jun		Sep		Dec	

4.5 Method of abstraction (mark with an X the abstraction method currently used or to be installed)

☒ Pump * ☐ Canal ☐ Gravity or outlet pipe ☐ Other (specify) **

* Also complete supplementary form DW784pmp ('Taking water from a water resource – pump technical data'), if 'pump' was selected.

** If the method of abstraction is not PUMP / CANAL / GRAVITY OR OUTLET PIPE, please define method utilised:

4.6 Number of households served with water (if known)

4.7 Is this water provided by a Water User Association or Water Services Provider? ☐ WUA ☐ WSP

4.8 Name of Water User Association / Water Services Provider:

N/A

5. EXISTING AUTHORISATION AND REGISTRATION (PERMIT INFORMATION)

5.1 Existing permit information

	Permit number	Date (ccyymmdd)
Permit No.		
Permit No.		
Permit No.		
Permit No.		
Permit No.		
Permit No.		

5.2 If water use takes place in terms of the General Authorisation, mark with an X ☐

*If yes complete the following details after confirmation with relevant DWAF/CMA officials:

Date(s) from which applicable GA is/was applicable to this water use

South African Act: [E.g. National Water Act (Act No. 36 of 1998)]

Applicable section of the act: [E.g. Section 21]

Date From (ccyymmdd)

Date To (ccyymmdd)

Government Notice No.

Government Notice Date (ccyymmdd)

Applicable Section Of The General Authorisation

Date From (ccyymmdd)

Date To (ccyymmdd)

Government Notice No.

Government Notice Date (ccyymmdd)

Applicable Section Of The General Authorisation

Date From (ccyymmdd)

Date To (ccyymmdd)

Government Notice No.

Government Notice Date (ccyymmdd)

Applicable Section Of The General Authorisation

5.3 If an authorisation has been issued under other legislation

Law /Regulation N/A

6. SUBSIDY DETAILS

6.1 Resource Poor Farmer (RPF)

Should this WU application be considered for RPF subsidy? ☐ Yes ☒ No

7. PROPERTY RELATIONSHIP DETAILS *(Complete supplementary forms DW901 & DW902)*

Property Name	Surveyed Property		Unsurveyed property		Property Relationship Date	
					From:	To:
Zimmerlaagte Eckenburg District	Title Deed Number	T16427/2011	Surname of the Leader of Village, Community or Tribal Authority			
	Surveyor-General Cadastral Code		Initial of the Leader of Village, Community or Tribal Authority			
	Property Number	352	Local Authority (if applicable)			
	Portion of property	0	Magisterial District (if applicable)			
			Tribal Authority/Council (if applicable)			
	Title Deed Number		Surname of the Leader of Village, Community or Tribal Authority			
	Surveyor-General Cadastral Code		Initial of the Leader of Village, Community or Tribal Authority			
	Property Number		Local Authority (if applicable)			
	Portion of property		Magisterial District (if applicable)			
			Tribal Authority/Council (if applicable)			
	Title Deed Number		Surname of the Leader of Village, Community or Tribal Authority			
	Surveyor-General Cadastral Code		Initial of the Leader of Village, Community or Tribal Authority			
	Property Number		Local Authority (if applicable)			
	Portion of property		Magisterial District (if applicable)			
			Tribal Authority/Council (if applicable)			
	Title Deed Number		Surname of the Leader of Village, Community or Tribal Authority			
	Surveyor-General Cadastral Code		Initial of the Leader of Village, Community or Tribal Authority			
	Property Number		Local Authority (if applicable)			
	Portion of property		Magisterial District (if applicable)			
			Tribal Authority/Council (if applicable)			

8. FOR OFFICE USE ONLY

8.1 List of attached forms and documents

8.1.1 Supplementary forms attached with this form (mark with an X)

- ☐ DW787: Irrigated Field and Crop Information
- ☐ DW788: Power Generation, Industrial or Mining Use
- ☐ DW789: Domestic, Urban, Commercial or Industrial Use

8.1.2 Specify the number of other documents submitted with this form (mark with an X)

- ☐ Environment impact assessment
- ☐ Other: (specify) D W
- ☐ Other: (specify) D W
- ☐ Other: (specify) D W
- ☐ Other: (specify) D W

8.2 Succession transfer and source Part 2 details

Source Register number	WU Number	WU Status to be allocated	WU Close Date (if applicable) (ccyymmdd)

8.3 Billing information

				Start date (ccyymmdd)	End date (ccyymmdd)
8.3.1	Applicant to be billed as	☐ An individual	☐ Via a WUA / WSP		
8.3.2	Applicant to be charged	☐ On actual volume	☐ Registered volume		
8.3.3	Billing frequency	☐ Annually	☐ Bi-annually ☐ Monthly		

8.3.4 If to be billed via a WUA / WSP

Name of WUA / WSP

Is WUA / WSP a Billing Agent? ☐ Yes ☐ No

Billing Agent's Register Number

8.3.5 If this WU is to be billed via a Bulk Billing Party that is not a WSP / WUA, complete the following:

Name of Customer

Bulk-Bill-to-Party Register Number

8.4 Water Resource Information

If water source is a Government Water Scheme, give the GWS name:

8.5 District Municipality

District Municipality Name (if applicable)

8.6 Late Registration Penalty

Is this a late registration? ☐ Yes ☐ No

If yes, mark with an X, the applicable penalty to be levied

☐ R300.00 **OR**

☐ 10% (ten percent) of the annual water use charge outstanding at the date of registration which ever is greater

Specify the penalty amount payable

☐ Waive penalty

File number

Water Use Register Number

Received by:

Surname Initials

Position / Rank

Signature

Captured on NRWU database (ccyymmdd)

Capured by:

Surname Initials

Signature

Date stamp of receiving office

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

SUPPLEMENTARY WATER USE INFORMATION

TAKING WATER FROM A WATER RESOURCE

PUMP TECHNICAL DATA

1. PUMP IDENTIFICATION *Pump will be installed after authorisation is received*

1.1 Pump number (if more than one, enter a sequence number starting from 001) 0 0 1

1.2 Installation date Y Y Y Y M M D D

1.3 Geographic location of the pump (use one format only)

S ° ' " or S ° ' " or S ° ' "
E 0 ° ' " E 0 ° ' " E 0 ° ' "

Cape datum Clarke ☐
WGS-84 datum ☐

2. PUMPING HOURS *Pump will be installed after authorisation is received*

2.1 Maximum pumping hours per week h 2.2 Total pumping hours per year h

3. PUMP DATA *Pump will be installed after authorisation is received*

3.1 Pump type (mark one with X)

☐ a) Centrifugal ☐ b) Positive displacement ☐ c) Turbine ☐ d) Axial flow
☐ e) Other (specify)

3.2 Pump model

3.3 Pulley diameter mm

3.4 Speed rpm

3.5 Impeller size (only for a centrifugal pump) mm

3.6 Suction hose

3.6.1 Hose material

3.6.2 Hose diameter mm

3.6.3 Hose length m

3.7 Type of flow meter (mark one with X)

☐ a) Inline ☐ b) Bypass ☐ c) Doppler effect ☐ d) None ☐ e) Other (specify below)

3.8 Pressure gauge reading At inlet = m At outlet = m

S-abs(pmp) DW784

4. POWER SOURCE DATA Pump will be installed after authorisation is received

4.1 Power source type (mark one with X)

☐ a) Electric ☐ b) Diesel ☐ c) Petrol ☐ d) Tractor ☐ e) Wind

☐ f) Other (specify)

4.2 Model

4.3 Pulley diameter mm

4.4 Speed rpm

4.5 Coupling:

a) Type (mark one with X)

☐ V-belt ☐ Flat belt ☐ Gearbox ☐ Direct ☐ Other (specify below)

b) For *gearbox coupling* or *direct coupling*, enter the ratio :

4.6 Power rating kW

5. PUMP OPERATION Pump will be installed after authorisation is received.

		Maximum pressure	Maximum discharge	Average operation	
5.1	Discharge				litres / second
5.2	Suction height				metres
5.3	Static height				metres
5.4	Working height				metres
5.5	Friction height				metres
5.6	Other losses				metres
5.7	Total head				metres
5.8	Efficiency				%
5.9	Power absorbed				kilowatts
5.10	Ammeter reading				amps

6. BOREHOLE INFORMATION (where applicable)

6.1 a) Borehole number 1

b) Geographic location of the borehole, if different from pump

S ° ' " or S ° ' or BH1 S 29° 32.553'

E 0 ° ' " E 0 ° ' E 0 25° 47.234'

☐ Cape datum Clarke ☐ WGS-84 datum

6.2 Yield of borehole litres / second

6.3 Depth of borehole metres

6.4 Previous authorisation or licensing reference

BH2: Borehole number 2
S 29° 32.754'
E 25° 47.143'

BH3: Borehole number 3
S 29° 32.866'
E 25° 47.078'
Yield: 5.56 litres/second sustainable yield
Depth: 30 metres

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S-abs(pmp) DW784

7. ESKOM TRANSFORMER (where applicable)

7.1 a) ESKOM reference number

b) Geographic location of the transformer, if different from pump

S ° ' " or S ° ' " or S ° ' "
E 0 ° ' " E 0 ° ' " E 0 ° ' "

Cape datum Clarke ☐
WGS-84 datum ☐

7.2 Power rating of the transformer Currently applying for 50 kVA

FOR OFFICIAL USE ONLY

File number

Water use licence or registration number

Water Management Area Upper Orange

Received by:

Surname Initials

Rank

Signature

Captured by:

Initials

Date stamp of receiving office

S-abs(irg)

DW787

water affairs

Department
Water Affairs
REPUBLIC OF SOUTH AFRICA

SUPPLEMENTARY WATER USE INFORMATION

TAKING WATER FROM A WATER RESOURCE
IRRIGATED FIELD AND CROP INFORMATION

TO BE COMPLETED FOR ALL IRRIGATION ABSTRACTION

Field Number	Area (hectares)	Crop	Planting date	Growing season (days)	Rotation factor %	Irrigation system code *	Resource type	Resource name (excluding boreholes)	Annual mm used (official use)
1	2.9	Pecan-nut Trees	10 05 10			A	GROUNDWATER		1100
			M M D D						
			M M D D						
			M M D D						
			M M D D						
			M M D D						
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			M M D D						
			M M D D						

*Code	Irrigation system	*Code	Irrigation system	*Code	Irrigation system
A	Flood: Furrow	H	Sprinkler: Big gun	O	Micro sprinkler
B	Flood: Border	I	Sprinkler: Side roll	P	Micro spray
C	Flood: Basin	J	Sprinkler: Boom	Q	Drip
D	Sprinkler: Dragline	K	Sprinkler: Travelling gun	R	Subsurface

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S-abs(irg)

DW787

E	Sprinkler: Quick-coupling	L	Sprinkler: Travelling boom		
F	Sprinkler: Permanent	M	Centre pivot		
G	Sprinkler: Hop-along	N	Linear		

DESCRIPTION OF ANY IRRIGATION SCHEDULING METHODS USED

DESCRIBE ANY OTHER METHODS USED TO ENHANCE IRRIGATION EFFICIENCY

FOR OFFICIAL USE ONLY

File number

Water use number

Received by:

Surname

Initials

Rank

Signature

Captured by:

Initials

Date stamp of receiving office

version 1 of 2009-12-15

p 2 of 2

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

SUPPLEMENTARY WATER USE INFORMATION
PROPERTY WHERE WATER USE OCCURS

DW901 serves to address the following: The property (or properties) where water use(s) is to take place.
•Complete one DW901 form for each property impacted / applicable to a water use registration application.
•Should more than one property owner be applicable to a "property where water occurs" an additional DW902 must be completed for each additional property owner.

1. PROPERTY WHERE WATER USE(S) OCCURS

1.1 **Property where water use takes place (farm, stand or community): description as per the Deeds Act if applicable, or name of agricultural holding, farm, township, town or city.**

Zamenloop 352, Portion 0, Edenburg District

Registration Date (ccyymmdd): 2011004

1.2 **Property Type** (mark only one with an X)

- ☐ Agricultural Holding
- ☐ Exclusive Use Areas (EUA)
- ☐ Sectional Scheme (To Obtain EUA)
- ☐ Sectional Scheme Unit
- ☐ Unspecified
- ☐ Erf
- ☒ Farm
- ☐ Sectional Scheme (to obtain units)
- ☐ Township
- ☐ Unsurveyed

1.3 **If the property type is unsurveyed, complete the following:**

a) Surname and initials of leader of village, community or tribal authority

Initials

b) Local Authority

&/or

c) Magisterial District

&/or

d) Tribal Authority/Council

1.4 **If the property type is not equal to unsurveyed, complete the following:**

a) Deeds Office: BLOEMFONTEIN

b) Registration Division: EDENBURG

c) Property No (i.e. Farm No./Erf No./Holding Area No./Scheme No.): 352

d) Portion of Property: 0

e) Title Deed Number: TL427/2011

f) Surveyor-General Cadastral Code

1	2	3	4	5

1. Refers to the Surveyor's-General Office (T = Pretoria, F = Free State, C = Cape Town & N = Kwazulu-Natal)
2. Major Code (Registration Division)
3. Minor code
4. Property No (i.e. Farm No./Erf No./Holding Area No./Sheme No.)
5. Portion Number

***Note:** All fields "left padded with 0"*

1.5 Property Area Size

2 / 4.1 3 3 0

Measure Unit: ☒ Hectares ☐ Square Meters ☐ Acres

1.6 Ownership of the property (mark only one with an X)

☒ Property owned by applicant (100% Share value)
☐ Property owned by applicant (Share value less than 100%)
☐ Property leased by applicant
☐ The property is communal land

2. PROPERTY OWNER RELATIONSHIP

Individual (Identity Number or Passport Number)	Company, Business, Partnership or Community (Business Enterprise Registration Number)	Property Owner Name	Property Owner Document Number (Owner's Title Deed Reference Number)	Property Owner and Property Relationship Date		Owner Share Value %
				From:	To:	
	CORDEO TRUST	CORNELIS ANDREAS ROUX	T16427/2011			

3. DECLARATION BY APPLICANT *(or person that was granted power of attorney by the applicant)*

I declare that the property information given by me for registering this Water Use is true and correct.

Signature

Date (ccyymmdd) 20120717

Thumbprint (only if requested)

4. FOR OFFICE USE ONLY

Received by:

Surname

Initials

Position / Rank

Signature

Captured on NRWU database (ccyymmdd)

Captured by:

Surname

Initials

Signature

Date stamp of receiving office

Quality Assurance Executed by:

Surname

Initials

Position / Rank

Signature

Date (ccyymmdd)

DW902

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

SUPPLEMENTARY WATER USE INFORMATION
DETAILS OF PROPERTY OWNER

Should more than one property owner be applicable to a 'property where water use occurs', an additional DW902 must be completed for each additional property owner.

1. DETAILS OF PROPERTY OWNER

1.1 Nature of property owner (mark only one block with X)

- [X] Individual (complete 1.2)
- [ ] Company, business, partnership or community (complete 1.3)
- [ ] National Department (complete 1.4)
- [ ] Provincial Department (complete 1.5)
- [ ] Water Services Provider (complete 1.6)
- [ ] Water User Association (complete 1.7)

1.2 If property owner is an individual

1.2.1 Surname: Roux — Maiden Name: N/A

Initials: C A — Title: MR — Position or official status: ARCHITECT/FARMER/OWNER/TRUSTEE

Marital Status (mark only one):
- [ ] Married In Community Of Property
- [X] Married Out Of Community Of Property
- [ ] Unmarried

1.2.2 If holder of South African ID:

ID Number: 5 0 1 2 0 4 5 0 8 0 0 5 2

1.2.3 N/A **If not holder of South African ID:**

Passport No.:

Expiry Date (ccyymmdd):

Country of issue:

1.3 If the property owner is a company, business, partnership or community:

1.3.1 Name of company, business, partnership or community:

N/A

1.3.2 Trading name if different from name of company, business, partnership or community:

1.3.3 Type of Enterprise (mark only one with an X)

- [ ] 06 Public Company (Ltd)
- [ ] 07 Private Company (Pty) Ltd
- [ ] 08 Article 21 (Association inc under Section 21)
- [ ] 09 Limited By Guarantee
- [ ] 10 External Company
- [ ] 11 External Company under Article 21
- [ ] 20 Transvaal Ordinance
- [ ] 21 Incorporated (Inc)
- [ ] 22 Unlimited
- [ ] 23 Close Corporation (CC)
- [ ] Parastatal
- [ ] Trust
- [ ] Other [i.e. Non-CIPRO Company Types (e.g. Churches, Schools, Community Groups, etc.) excluding Trust & Parastatal]

1.3.4 Business Enterprise Registration Number

1.3.5 Date Established (ccyymmdd)

Country Where Established

1.4 **If the property owner is a National Department:**

1.4.1 National Department Name: N/A

1.5 **If the property owner is a Provincial Department:**

1.5.1 Province: N/A

1.5.2 Provincial Department Name:

1.6 **If the property owner is a Water Services Provider:**

1.6.1 Name of WSP: N/A

1.7 **If the property owner is a Water User Association:**

.7.1 Name of WUA: N/A

1.8 **Postal Address:**

PO BOX 28572

DANHOF

Postal Code 9310

1.9 **Street Address (only if different from postal address):**

14 AKADEMIE STREET

DAN PIENAAR

BLOEMFONTEIN Postal Code 9301

1.10 **Contact Telephone Number During Office Hours**

Area/cell code 082 Number 9665720 Ext

Alternative contact number

Area/cell code 051 Number 4362744 Ext

2. DECLARATION BY PROPERTY OWNER

2.1 Property owner or delegated person:

Surname: ROUX

Initials: CA Title: MR

ID number: 5 0 1 2 0 4 5 0 5 0 0 8 2

2.2 If not a holder of South African ID:

Passport No.:

Expiry Date (ccyymmdd):

Country of issue:

2.3 Position or official status:

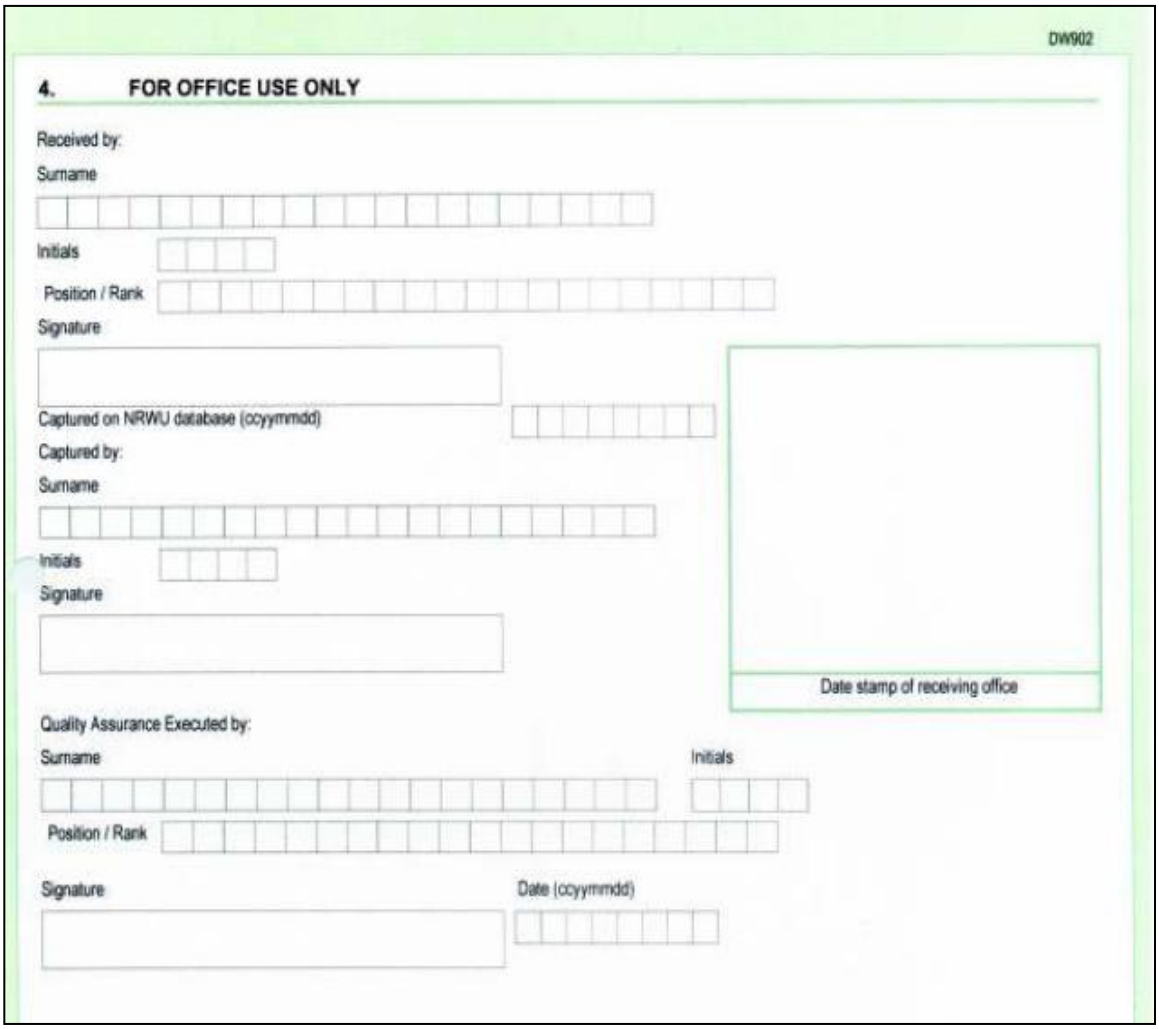
ARCHITECT/FARMER/OWNER/TRUSTEE

2.4 I declare that the applicant defined in this application has lawful access to the property and carry out the water use activity or activities related to this application.

Signature: Date (ccyymmdd): 20/20717 Thumbprint (only if requested):

3. LIST OF ATTACHED DOCUMENTS (mark each document type attached with an X)

- 3.1 ☒ Certified copy of identity document or passport.
- 3.2 ☒ Certified copy of Property Owner Document [refer Section 2 of DW901 (Property Title Deed or Deeds printout)].
- 3.3 ☐ Certified copy of lease agreement (refer paragraph 1.6 of DW901)
- 3.4 ☒ Certified copy of the "power of attorney" or appropriate supporting documentation


DW902

4. FOR OFFICE USE ONLY

Received by:

Surname

Initials

Position / Rank

Signature

Captured on NRWU database (ccyymmdd)

Captured by:

Surname

Initials

Signature

Date stamp of receiving office

Quality Assurance Executed by:

Surname

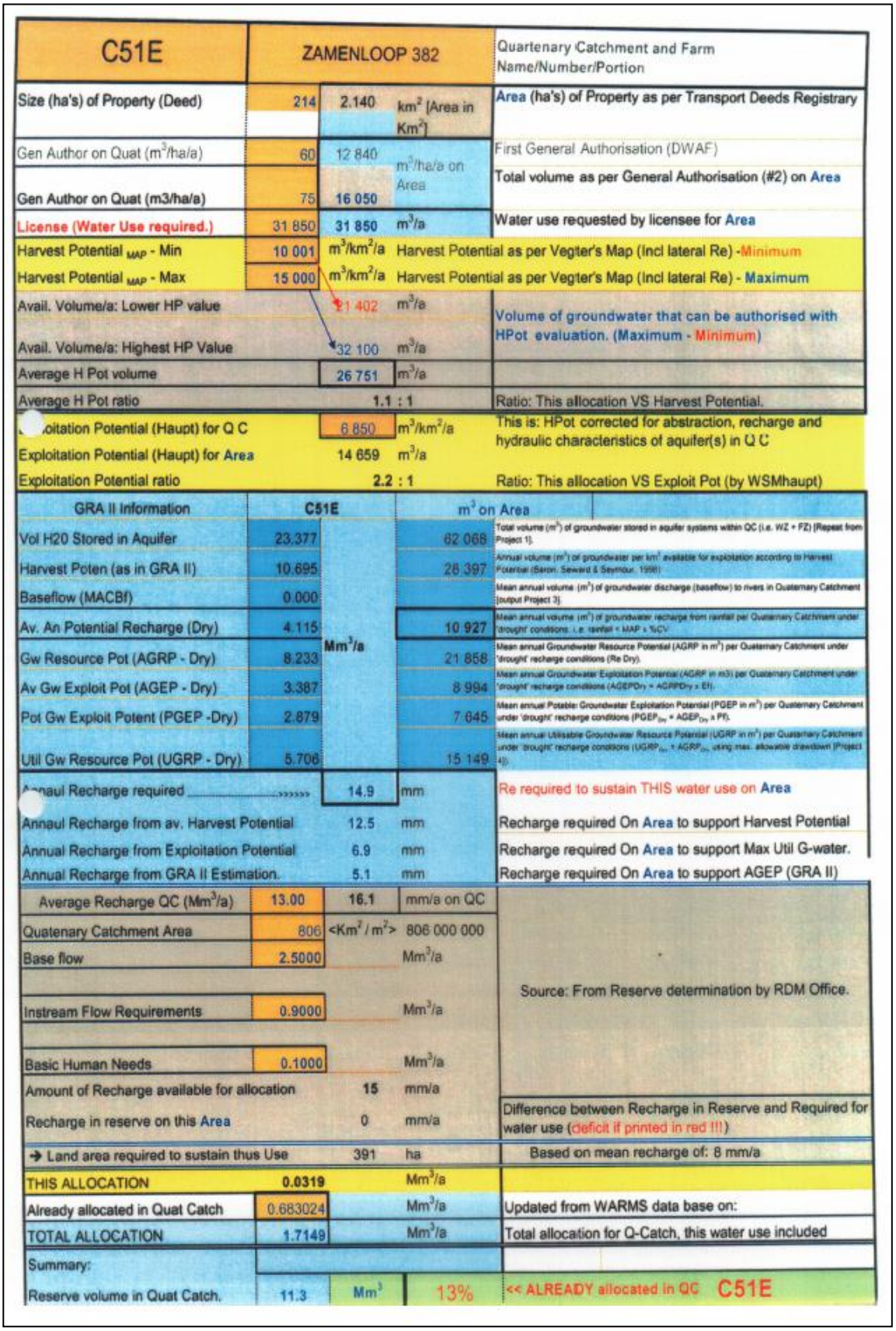
Initials

Position / Rank

Signature

Date (ccyymmdd)

Groundwater use license application evaluation system



C51E	ZAMENLOOP 382			Quartenary Catchment and Farm Name/Number/Portion
Size (ha's) of Property (Deed)	214	2.140	km^2 [Area in Km^2]	Area (ha's) of Property as per Transport Deeds Registrary
Gen Author on Quat (m^3/ha/a)	60	12 840	m^3/ha/a on Area	First General Authorisation (DWAF)
Gen Author on Quat (m3/ha/a)	75	16 050		Total volume as per General Authorisation (#2) on Area
License (Water Use required.)	31 850	31 850	m^3/a	Water use requested by licensee for Area
Harvest Potential $_{MAP}$ - Min	10 001	$m^3/km^2/a$		Harvest Potential as per Vegter's Map (Incl lateral Re) -Minimum
Harvest Potential $_{MAP}$ - Max	15 000	$m^3/km^2/a$		Harvest Potential as per Vegter's Map (Incl lateral Re) - Maximum
Avail. Volume/a: Lower HP value		21 402	m^3/a	Volume of groundwater that can be authorised with HPot evaluation. (Maximum - Minimum)
Avail. Volume/a: Highest HP Value		32 100	m^3/a	
Average H Pot volume		26 751	m^3/a	
Average H Pot ratio		1.1 : 1		Ratio: This allocation VS Harvest Potential.
Exploitation Potential (Haupt) for Q C		6 850	$m^3/km^2/a$	This is: HPot corrected for abstraction, recharge and hydraulic characteristics of aquifer(s) in Q C
Exploitation Potential (Haupt) for Area		14 659	m^3/a	
Exploitation Potential ratio		2.2 : 1		Ratio: This allocation VS Exploit Pot (by WSMhaupt)

GRA II Information	C51E		m^3 on Area	
Vol H20 Stored in Aquifer	23.377		62 068	Total volume (m^3) of groundwater stored in aquifer systems within QC (i.e. WZ + FZ) [Repeat from Project 1].
Harvest Poten (as in GRA II)	10.695		28 397	Annual volume (m^3) of groundwater per km^2 available for exploitation according to Harvest Potential (Baron, Seward & Seymour, 1998)
Baseflow (MACBf)	0.000			Mean annual volume (m^3) of groundwater discharge (baseflow) to rivers in Quaternary Catchment [output Project 3].
Av. An Potential Recharge (Dry)	4.115		10 927	Mean annual volume (m^3) of groundwater recharge from rainfall per Quaternary Catchment under 'drought' conditions. i.e. rainfall < MAP x %CV.
Gw Resource Pot (AGRP - Dry)	8.233	Mm^3/a	21 858	Mean annual Groundwater Resource Potential (AGRP in m^3) per Quaternary Catchment under 'drought' recharge conditions (Re Dry).
Av Gw Exploit Pot (AGEP - Dry)	3.387		8 994	Mean annual Groundwater Exploitation Potential (AGRP in m3) per Quaternary Catchment under 'drought' recharge conditions ($AGEPD_{Dry}$ = $AGRPD_{Dry}$ x Ef).
Pot Gw Exploit Potent (PGEP -Dry)	2.879		7 645	Mean annual Potable Groundwater Exploitation Potential (PGEP in m^3) per Quaternary Catchment under 'drought' recharge conditions ($PGEP_{Dry}$ = $AGEP_{Dry}$ x Pf).
Util Gw Resource Pot (UGRP - Dry)	5.706		15 149	Mean annual Utilisable Groundwater Resource Potential (UGRP in m^3) per Quaternary Catchment under 'drought' recharge conditions ($UGRP_{Dry}$ = $AGRP_{Dry}$ using max. allowable drawdown [Project 4]).
Annaul Recharge required >>>>>>>		14.9	mm	Re required to sustain THIS water use on Area
Annaul Recharge from av. Harvest Potential		12.5	mm	Recharge required On Area to support Harvest Potential
Annual Recharge from Exploitation Potential		6.9	mm	Recharge required On Area to support Max Util G-water.
Annual Recharge from GRA II Estimation.		5.1	mm	Recharge required On Area to support AGEP (GRA II)

Average Recharge QC (Mm^3/a)	13.00	16.1	mm/a on QC	
Quatenary Catchment Area	806	<Km^2 / m^2>	806 000 000	
Base flow	2.5000		Mm^3/a	
Instream Flow Requirements	0.9000		Mm^3/a	Source: From Reserve determination by RDM Office.
Basic Human Needs	0.1000		Mm^3/a	
Amount of Recharge available for allocation		15	mm/a	
Recharge in reserve on this Area		0	mm/a	Difference between Recharge in Reserve and Required for water use (deficit if printed in red !!!)
→ Land area required to sustain thus Use		391	ha	Based on mean recharge of: 8 mm/a
THIS ALLOCATION	0.0319		Mm^3/a	
Already allocated in Quat Catch	0.683024		Mm^3/a	Updated from WARMS data base on:
TOTAL ALLOCATION	1.7149		Mm^3/a	Total allocation for Q-Catch, this water use included
Summary:				
Reserve volume in Quat Catch.	11.3	Mm^3	13%	<< ALREADY allocated in QC C51E

Borehole testing certificates (These certificates are no longer recognised by DWS, as aquifer characteristics cannot be determined with this form of testing performed)

Waterpas Waterwerke

BOREHOLE TESTING CERTIFICATE

No 0161

Date: 16/03/2012

Client: CA Rouse Contractors
Zamenloop 382

From: Waterpas Waterwerke
P.O. Box: 35582, Faunasig, 9325
Cell: 082 877 9729 (Jan)
VAT Reg. nr.

Tel:

Borehole nr.: 3 Borehole depth: 36 m

Pump depth: 29 m S.W.L: 8 m

Description:

TIME		G/hr / L/hr
11.00		32 600
12.00		32 580
1.00		32 500
2.00		32 500
3.00		32 500
4.00		32 500

Tested for 5 hr at 32 500 G/hr / L/hr

Recommended for 20000 G/hr / L/hr for 8 HOUR PER DAY

Signature:

Waterpas Waterwerke

BOREHOLE TESTING CERTIFICATE

№ 0159

Date: 16/02/2012

Client: CA Louw Canine Trust
Jamanloop 382

Tel:

From: **Waterpas Waterwerke**
P.O. Box: 35582, Faunasig, 9325
Cell: 082 877 9729 (Jan)
VAT Reg. nr.

Borehole nr.: 4 Borehole depth: 27 m

Pump depth: 26 m S.W.L: 5 m

Description:

TIME		G/hr / L/hr
9.00		29600
10.00		29400
11.00		29180
12.00		29180
1.00		29180
2.00		29180

Tested for 5 hr at 29180 G/hr / L/hr

Recommended for 175-00 G/hr / L/hr for 8 HOUR PER DAY

Signature:

Waterpas Waterwerke

BOREHOLE TESTING CERTIFICATE

№ 0160

Date: 16/2/2012

Client: CA Louw Concor Jnr
Jamenbosch 382

Tel:

From: **Waterpas Waterwerke**
P.O. Box: 35582, Faunasig, 9325
Cell: 082 877 9729 (Jan)
VAT Reg. nr.

Borehole nr.: 5 Borehole depth: 24 m

Pump depth: 25 m S.W.L: 7 m

Description:

TIME		G/hr / L/hr
8.00		6900
9.00		6820
10.00		6806
11.00		6806
12.00		6806
1.00		6800

Tested for 5 hr at 6800 G/hr / L/hr

Recommended for 4000 G/hr / L/hr for 8 HOUR PER DAY

Signature:

Broad Based Black Economic Empowerment Certificate

CCW Financial Services (Pty) Ltd
accounting, tax & consulting

REG No. 2011/119524/07
NELSON MANDELA RLN / DRV 196
PHG GEBOU / BUILDING
BLOEMFONTEIN 9301
P.O. BOX 7871 BLOEMFONTEIN 9300
TEL: (051) 444 3190
FAKS/FAX: (051) 444 3107
EPOS/EMAIL: cw@ccwca.co.za
WEBTUISTE/WEBSITE: www.ccwca.co.za

EME no:

To Whom It May Concern:

We as accounting officer of **CORICO TRUST** with registration number **IT1193/2011,** hereby confirm that the client is classified as an Exempt-Micro Enterprise(EME) as the turnover per annum is under R5 million and therefore qualifies automatically as a 100% BEE (Black Economic Empowerment) compliant (level 4)

Should you have any queries do not hesitate to contact our office.

Yours truly,

CHRISTI WAGENAAR

Issue date: 06 February 2012
Expiry date: 05 February 2013

DIRECTOR/DIREKTEUR: CHRISTI WAGENAAR - CA (SA)
"assisting our clients in achieving their financial goals"
ASSISTED BY/BYGESTAAN DEUR: CC.WAGENAAR - I.PIETERSE - F.DE WITT - R.GOLDES
IN ASSOCIATION WITH: IN ASSOSIASIE MET: CCW Secretarial Services (Pty) Ltd Christi Wagenaar

sera
BEE Verification Agency

Small Enterprise Rating Agency Pty Ltd t/a SERA

Certificate number: 528 / 08 / 2011

Date of issue: 31 AUGUST 2011

BBBEE VERIFICATION CERTIFICATE

In accordance with the Codes of Good Practice issued in terms of Section 9(1) of the Broad Based Black Economic Empowerment Act, 2003 (act 53 of 2003 Gazetted 9 February 2007)

CA ROUX T/A CORRIE ROUX ARGITEKTE

REGISTRATION NUMBER: SOLE PROPRIETOR

VAT REGISTRATION: 4240111353

PHYSICAL ADDRESS: 14 AKADEME STREET
DAN PIENAAR
BLOEMFONTEIN

received an overall B-BBEE status level of a

LEVEL 4 (FOUR) with a score between 65 and 75

EFFECTIVE BLACK OWNERSHIP: 0%

BLACK MALE: 0%

BLACK FEMALE: 0%

VALUE ADDED SUPPLIER: NO

with a B-BBEE Procurement Recognition level of 100%

SCORECARD: EXEMPTED MICRO ENTERPRISE

VALID FROM: 31 AUGUST 2011

EXPIRY DATE: 30 AUGUST 2012

TECHNICAL SIGNATORY:
SERA (PTY) LTD

DWA Authorisation letter to be used by consultant

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

PRIVATE BAG 528, BLOEMFONTEIN, 9300
SANLAM PLAZA BUILDING, c/o MAITLAND & EAST BURGER STREETS
TEL: 051 – 405 9210

TO WHOM IT MAY CONCERN

Herewith I,

CORNELIS ANDREAS ROUX
(full name and surname)

Identity number: 5012045080082
(copy of ID document must be attached)

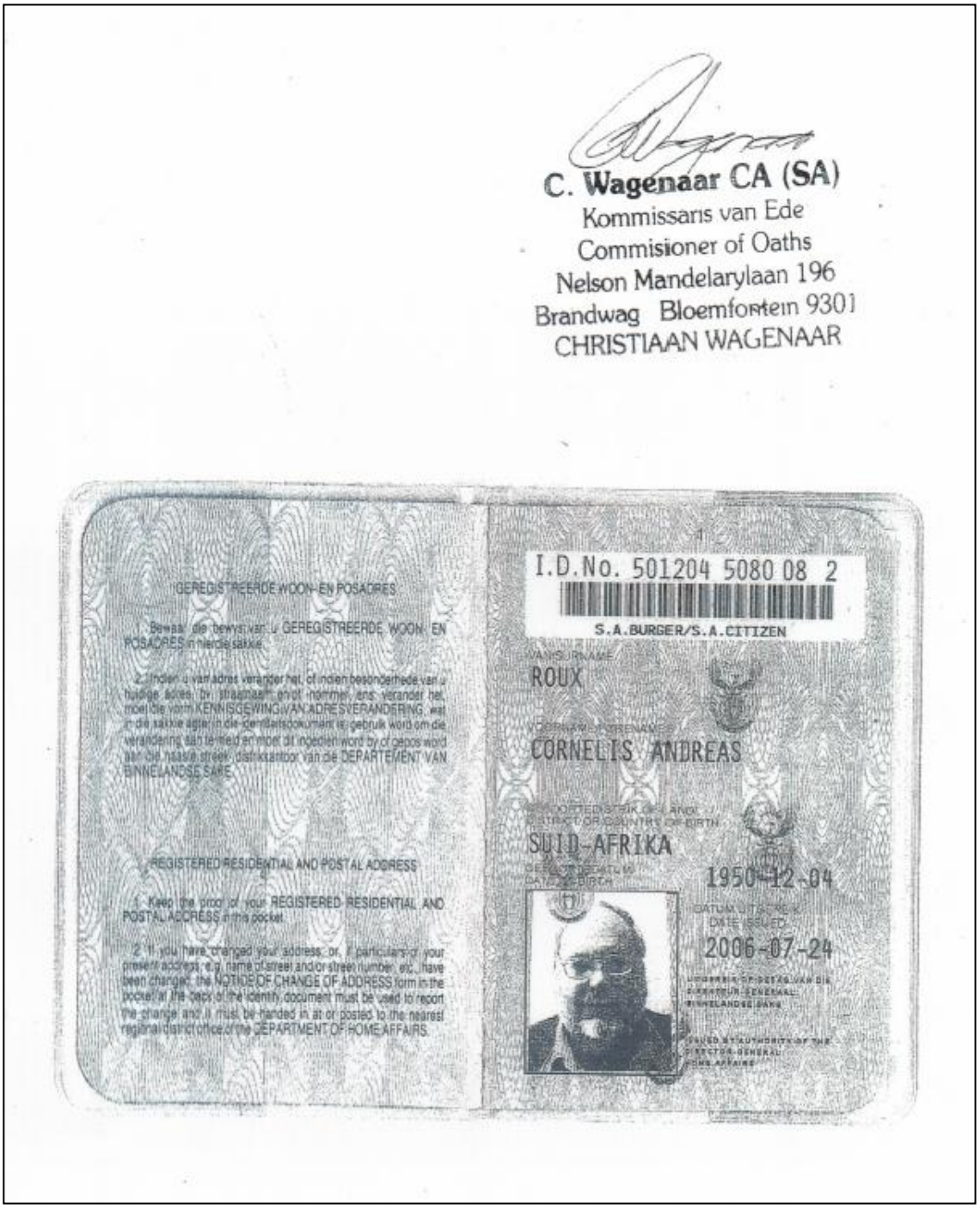
Property: ZAMENLOOP 382
(name of property)

Give authority to **Hydra Deinotes Consulting** to submit my water use applications and to communicate and make enquiries regarding my water rights and applications with the Department of Water Affairs.

SIGNED AT Bloemfontein ON 11 July 2012

SIGNATURE

Certified copy of identity document



Title deed of farm

Claude Reid

SINCE **1902** SEDERT
IN ASSOSIASIE MET• NEUHOFF PROKUREURS
IN ASSOCIATION WITH• NEUHOFF ATTORNEYS
ATTORNEYS• NOTARIES• CONVEYANCERS• BABUELEDI
PROKUREURS• NOTARISSE• AKTE-UITMAKERS• BABUELEDI

TRANSPORTAKTE

T16427/2011

CLAUDE REID
ST. ANDREW STRAAT 165
BLOEMFONTEIN
9301
Tel: 051-4479881

17

SEËLREG
STAMP DUTY R.....
FOOI
FEES R 650-00

CLAUDE REID
ST. ANDREW STRAAT 165
BLOEMFONTEIN
9301

Opgestel deur my

TRANSPORTBESORGER
VAN SCHALKWYK J H

VERBIND MORTGAGED

VIR
FOR R 600 000-00

B 000006410/2011

03 OCT 2011

REGISTRATEUR/REGISTRAR

T 000016427/2011

TRANSPORTAKTE

HIERBY WORD BEKEND GEMAAK DAT

JOHAN HELGARD VAN SCHALKWYK

voor my verskyn het, REGISTRATEUR VAN AKTES te Bloemfontein, hy die genoemde komparant synde behoorlik daartoe gemagtig deur 'n Volmag aan hom verleen deur

Die Trustees vir die tyd en wyl van
M.E.G.A. BOERDERY TRUST
Registrasienommer TMP3512

geteken te BLOEMFONTEIN op 1 September 2011

GhostConvey 13.4.3.14

En genoemde Komparant het verklaar dat sy prinsipaal, op 12 Augustus 2011, waarlik en wettiglik verkoop by Privaat ooreenkoms, en dat hy, in sy voorgenoemde hoedanigheid hierby sedeer en transporteer aan en ten gunste van

CORNELIS ANDREAS ROUX
Identiteitsnommer 501204 5080 082
Getroud buite gemeenskap van goed

sy Erfgename, Eksekuteurs, Administrateurs of Regverkrygendes in volkome en vrye eiendom, in volkome en vrye eiendom

DIE PLAAS ZAMENLOOP 382, DISTRIK EDENBURG, PROVINSIE VRYSTAAT

GROOT 214,1330 (TWEE HONDERD EN VEERTIEN KOMMA EEN DRIE DRIE NUL) Hektaar

AANVANKLIK oorgedra kragtens Kroongrondbrief gedateer 22 April 1912 met kaart wat daarop betrekking het en gehou kragtens Transportakte T7262/2011

WESHALWE die komparant afstand doen van al die regte en titel wat

Die Trustees vir die tyd en wyl van M.E.G.A. BOERDERY TRUST
Registrasienommer TMP3512

voorheen op genoemde eiendom gehad het, en gevolglik ook erken het dat hulle geheel en al van die besit daarvan onthef en nie meer daartoe geregtig is nie en dat, kragtens hierdie akte, bogenoemde

CORNELIS ANDREAS ROUX , Getroud soos vermeld

sy Erfgename, Eksekuteurs, Administrateurs of Regverkrygendes, tans en voortaan daartoe geregtig is, ooreenkomstig plaaslike gebruik, behoudens die regte van die Staat en ten slotte erken hy dat die verkoopprys die bedrag van **R1 083 000,00 (Een Miljoen Drie en Tagtig Duisend Rand)** beloop.

TEN BEWYSE WAARVAN ek, genoemde Registrateur, tesame met die Komparant hierdie Akte onderteken en dit met die ampseël bekragtig het.

ALDUS GEDOEN EN VERLY op die Kantoor van die REGISTRATEUR VAN AKTES te Bloemfontein op

03 OCT 2018

a.g.

In my teenwoordigheid

REGISTRATEUR VAN AKTES

KOPANONG MUNICIPALITY

All correspondence to be addressed to:

THE MUNICIPAL MANAGER
P.O. Box 23
TROMPSBURG
9913

Telephone/Telefoon Nr:051-713-9200

E-mail:kopanfin@mweb.co.za

Datum: 01 SEPTEMBER 2011

Our ref: VINCENT PETERSON
Your ref: CHARLEEN

For attention: CLAUDE REID PROKUREURS
POSBUS 277
DOCEX 14
BLOEMFONTEIN
9300

CLEARANCE CERTIFICATE -FARMS/UITKLARINGSERTIFIKAAT-PLASE

TRANSFER:TRANSPORT//M.E.G.A BOERDERY TRUST/CA ROUX.

This is to certify that there are no rates/other amounts due to the KOPANONG MUNICIPALITY in terms of Section 118 of the Local Government: Hiermee word gesertifiseer dat daar geen grondbelasting of ander dienste bedrae verskuldig is aan KOPANONG MUNISIPALITEIT, ingevolge bepaling 118 van die Wet op Plaaslike Regering: Municipal Systems Act 32/2000 in respect of the undermentioned properties.

1. PLAAS ZAMENLOOP 382 EDENBURG, PROVINSIE VRYSTAAT.

Certificate valid until **31 OCTOBER 2011**.....
Sertifikaat geldig tot

Authorised Officer:.....
Gemagtigde Amptenaar

Datum: .....

**Edenburg, Reddersburg, Philippolis, Bethulie,
Springfontein, Trompsburg, Gariep Dam, Jagersfontein**

*The Municipality of Kopanong reserves the right to correct any **bona fide** errors with the correct correspondence./Die Munisipaliteit van Kopanong hou homself die reg voor om enige **bona fide** administrasie fout wat begaan mag word, by wyse van korrespondensie reg te stel.*

Signature authority legal letter

J246

REPUBLIC OF SOUTH AFRICA

MAGTIGINGSBRIEF
LETTERS OF AUTHORITY

Ingevolge Artikel 6(1) van die Wet op Beheer oor Trustgoed, 1988 (Wet 57 van 1988)
In terms of Section 6(1) of the Trust Property Control Act, 1988 (Act 57 of 1988)

NO. IT 1193/2011

Hiermee word gesertifiseer dat
This is to certfy that

CORNELIS ANDREAS ROUX (501204 5080 082),
HENDRIK JOHANNES ROUX,
CORNELIS ANDREAS ROUX (930301 5310 088),
CHRISTIAAN WAGENAAR

gemagtig word om op te tree as trustee(s) van die/
is/are hereby authorized to act as trustee(s) of the

CORICO TRUST

Gegee onder my hand te BLOEMFONTEIN op hede die 12 dag van
Given under my hand at BLOEMFONTEIN at this ..... day of

DESEMBER 2011.

ASSISTENT MEESTER
ASSISTANT MASTER

Department of Justice and Constitutional Development

MASTER OF THE HIGH COURT
2011 -12- 12
BLOEMFONTEIN
MEESTER VAN DIE HOOGGEREGSHOF

Trust deed

TRUSTAKTE

VAN

CORICO TRUST

MEMORANDUM VAN 'N OOREENKOMS MET BETREKKING TOT 'N SKENKING IN TRUST, GEMAAK EN AANGEGAAN DEUR EN TUSSEN

CHRISTIAAN WAGENAAR

(hierna die OPRIGTER genoem)

en

CORNELIS ANDREAS ROUX

en

HENDRIK JOHANNES ROUX

en

CORNELIS ANDREAS ROUX (JNR)

en

CHRISTIAAN WAGENAAR
(ONAFHANKLIKE TRUSTEE)

(hierna die TRUSTEES genoem)

TEN BEHOEWE VAN:

DIE BEVOORDEELDES HIERNA IN
PARAGRAAF 1.2 AS BEGUNSTIGDES BENOEM

(hierna die BEGUNSTIGDES genoem)

AANGESIEN die Oprigter begerig is om 'n trust by wyse van 'n skenking aan die trustees te skep met die doel om 'n trustfonds daar te stel om die inkomste- en kapitaalbegunstigdes (hierna gesamentlik die begunstigdes genoem), te bevoordeel, op die terme en onderhewig aan die voorwaardes wat deur die Oprigter bepaal is en in die trustakte vervat word;

EN AANGESIEN die trustees hulle self bereid verklaar het om as trustees op te tree en om die skenking te aanvaar en dit ten behoewe van die begunstigdes te hou en aan te wend, onderhewig aan die voorwaardes wat deur die Oprigter bepaal is en in die trustakte genotuleer word;

Soil potential certificate

agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

Directorate: Land Use and Soil Management
P.O Box 34521, FAUNASIG, 9325
Omni Building, 73 Aliwal Street, 1st floor, Bloemfontein
Tel: 051 409 2624, Fax: 051 409 2625, Email: KefilweD@daff.gov.za
Enquiries: Ms K Disipi, Reference: 19.1.4.2.2, Date issued: 30.04.2012

Mr. C.A. Roux

PO Box 28872

DANHOF

9310

Dear Sir

CULTIVATION OF VIRGIN SOIL (Regulation 2)

FARM UNIT: ZAMENLOOP 382 DISTRICT: EDENBURG

With reference to your application dated **14/02/2012** in terms of the provision of Regulation 2 of the Conservation of Agricultural Resources Act 1983 (Act 43 of 1983):

[x] Permission is hereby granted to cultivate **49 ha** of virgin soil on above mentioned farm for **irrigation** as mentioned in your application.

[ ] Permission to cultivate virgin soil can unfortunately not be granted for the following reasons:

[x] Protection of the land by means of soil conservation works is under present circumstances not necessary. Should it in future occur that the land is liable to erosion the necessary protection measures must be implemented

[ ] Soil Conservation works must be implemented

[ ] Before any cultivation may take place, a proper water runoff control planning must be done or planning against wind erosion must be done to the satisfaction of the Executive Officer.

[x] If in future it occurs that land is subject to drowning conditions or the soil become salinated the necessary steps must be taken to install a subsurface drainage system.

[ ] Planning and designing of soil conservation works can be done by any institution of your choice but these plans and specifications must comply with the regulations as stipulated by the Department of Agriculture and constructed to the satisfaction of the Executive Officer

[ ] Other conditions:.....

.....

Your attention is drawn to the fact that above mentioned conditions are granted in terms of Act 43 of 1983. Failure to comply with the conditions is an offence and may lead to prosecution. If you experience any problem with the interpretation of this letter or any other problem concerning the above mentioned, do not hesitate to contact our office on the above mentioned address.

Should you feel aggrieved by this decision you may lodge an appeal in writing within 14 days of receipt of this letter to: The Director: Land Use and Soil Management, Private bag X120, Pretoria. 0001

.....

pp EXECUTIVE OFFICER: ACT NO.43 of 1983

Section 27 motivation according to the National Water Act (Act 36 of 1998)

SECTION 27 MOTIVATION: Corico Trust

The following considerations were taken into account according to Section 27(1) of the National Water Act, 1998 (Act 36 0f 1998) for the processing of the water use authorisation application on Zamenloop 382, Edenburg District, Free State Province for the:

(a) **Existing lawful water uses:**
To be determined by the Department of Water Affairs.

(b) **The need to redress the results of past racial and gender discrimination:**
Corico Trust has currently 2 permanent workers on the farm Zamenloop 382, Edenburg District. They are male workers. Currently a house is being built on the farm and 11 workers are employed. If the water use authorisation applications are approved, then an additional 14 workers will be employed for agricultural functions. All local communities, including local communities from Kairo and Ebedneser will get first priority for employment. The permanent workers will have sheep and vegetables and farm together with Corico Trust on the farm. The permanent workers will produce vegetables, which they sell to people at the nearest town.
Corico Trust provides the permanent workers with:

- Basic human needs,
- Free tick treatment for their livestock,
- Free access to make use of water, the tractors and implements for their farming activities. They also may make use of the tractors to transport their wood and feed for their sheep on the farm.

Corico Trust will make arrangements to transport the permanent workers every Friday to town for the weekend.

(c) **Efficient and beneficial use of water in the public interest:**
The water will be sustainably abstracted to ensure that there is enough water for use for basic human needs now and in the future for agricultural purposes from the Riet River, Tierpoort River, and groundwater if water use authorisation applications are authorised. Groundwater will also be used for drinking water purposes, domestic use, and watering livestock. Feed for livestock will be bought. Pecan-nuts will be produced, as well as sheep farming.
Farm workers and people in the Edenburg District will not only make use of meat from sheep for eating purposes, but also for religion purposes.

(d) the socio-economic impact –
(i) of the water use or uses if authorised:
The farm is situated in an area where livestock farming is the main farming activity, therefore with minimal employment opportunities. Corico Trust will be one of the largest employers with 14 permanent workers employed, if the water use authorisation applications are approved. With approval of the applications additional workers will have the opportunity to be employed as the vegetable farming for workers can be extended. The permanent workers will also benefit by receiving more land for irrigation purposes; or

(ii) of the failure to authorize the water use or uses:
If the abstraction is not authorised, it will result in rendering the farm as a non-viable economic unit, which will result in limited employment opportunities and limit the extension of the workers' vegetable farming activities.

(e) Catchment Management Strategy applicable to the relevant water resource: Available from Department of Water Affairs, as and when applicable.
(f) **The likely effect of the water use to be authorised on the water resource and on other water users:** It is not foreseen that the sustainable volume of abstraction will have any negative effect on the Riet River, Tierpoort River, and groundwater resources in the surrounding area. The surrounding users mainly use water for purposes such as watering of livestock and feed for livestock. Data and records will be kept of the volume of abstraction and will be available on request.
(g) The class and the resource quality objectives of the water resource: The water from the Riet River, Tierpoort River, and groundwater is suitable for watering of livestock and irrigation purposes. Groundwater will be used for drinking water and domestic purposes as well. Other information which is applicable is available from department of Water Affairs.
(h) Investments already made and to be made by the water user in respect of the water use in question: Greater than R2 million. The farm was purchased during 2011. The main house and additional houses for permanent workers needs to be built. An application for electricity on the farm was submitted, as no electricity is available. Farming infrastructure and implements needs to be purchased and so forth. More financial details are available on request.
(i) The strategic importance of the water use to be authorised: The financial advantage for farming will be ensured and secured for the future, resulting in secured employment and community development opportunities.
(j) The quality of water in the water resource which may be required for the Reserve and for meeting international obligations: The water from the Riet River, Tierpoort River, and groundwater is suitable for watering of livestock and irrigation purposes. Groundwater will be used for drinking water and domestic purposes as well.
(k) the probable duration of any undertaking for which a water use is to be authorised: To be determined by Department of Water Affairs. The farming on the farm as an economic unit can continue permanently, therefore securing permanent employment opportunities and extension thereof.

The preliminary geohydrological and hydrological report is included in Chapter 7.

Summary

South Africa has adopted a law and policy framework for water, which is based on the constitutional recognition of the right of access to water. The National Water Act, Act 36 of 1998 is currently internationally recognised as one of very few acts that recognise basic human needs. South Africa as a country can be proud of this, even though proper implementation of the act is still lacking. The act is in line with the Constitution of the Republic of South Africa.

In South Africa, groundwater resources are lacking proper management and effective groundwater governance. This is mainly due to a lack of knowledge and skills, especially with regard to the development, sustainable use, protection and principles of groundwater resource management and groundwater governance. Proper and effective management of groundwater resources and groundwater governance principles may contribute to the alleviation of poverty in many areas of South Africa. In order to manage groundwater resources in a sustainable manner, the greatest groundwater challenge is to ensure efficient groundwater governance and proper effective groundwater resource management.

The over-abstraction of groundwater within certain areas of South Africa is of great concern and may have many negative consequences. The depletion of groundwater resources and the deterioration of groundwater quality have a negative health impact on large sections of rural communities that solely and/or partially rely on groundwater to meet their basic human needs. Water quantity- and quality-related problems are directly linked to many other crises such as poor school attendance, food insecurity, poor nutritional status among both children and HIV/Aids affected people and decreased productivity. Competing demands for water between households, communities, agriculture and industries will increase over time and will be as a result of population growth and tension and conflict.

Proper groundwater governance and groundwater resource management will significantly contribute to the reduction of over-abstraction, increase in sustainable groundwater abstraction and better groundwater quality.

The research study focused on challenges and solutions that will positively contribute to the improvement of groundwater governance, groundwater resource management and the handling of groundwater use authorisations for irrigation purposes with special reference to the agricultural sector in South Africa.

The main objective of this study was to develop a framework for groundwater use authorisations as part of groundwater governance in South Africa and was reached by means of a stages approach.

The research methodology used in this study was action research and the researcher and practitioner was the author of this thesis. The study repeated the action research methodology over five stages:

Stage 1 provided an overview and discussion on groundwater governance in South Africa.

Stage 2 provided an overview of food security, water security and the economic value of water in the agricultural sector *versus* the allocation of groundwater use authorisations.

Stage 3 provided a comparison and evaluation of the National Water Act (Act 36 of 1998) with international water laws.

Stage 4 provided a discussion on the groundwater reserve determination process of South Africa.

Stage 5 provided a framework for processing groundwater use authorisation applications in the agricultural sector.

Various problems were identified during the research study and possible solutions were discussed.

This study concluded that even though the South African water related legislation is too diverse, broad and with contradicted regulations and policies, it was extremely difficult but not impossible to develop a framework for groundwater use authorisations as part of groundwater governance within South Africa. As stated in chapter 1 the research hypothesis can therefore be accepted. The researcher, however, recommends that this framework should be used as a basis to improve groundwater governance and the National Water Act of South Africa.

Key words: framework; groundwater governance; groundwater management; food security; water security; water laws; groundwater reserve determinations; groundwater use authorisations; guideline; action research

Opsomming

Suid-Afrika het ‘n wetlike en beleidsraamwerk aangeneem wat gebaseer is op die grondwetlike erkenning van die reg van toegang tot water. Die Nasionale Waterwet, Wet 36 van 1998 word tans internasionaal erken as een van min wette wat basiese menslike behoeftes in ag neem. Suid-Afrika kan baie trots wees hierop, selfs al is die behoorlike implementering van die Nasionale Waterwet nie na wense nie. Die Nasionale Waterwet stem ooreen met die Grondwet van die Republiek van Suid-Afrika.

Die Suid-Afrikaanse regering het die oorhoofse verantwoordelikheid om alle waterbronne in die land te beskerm, te gebruik, te ontwikkel, te bewaar en te bestuur in ‘n standhoudende en regverdige wyse.

Ondergrondse waterbronbestuur en ondergrondse waterbeheer word oneffektief bestuur in Suid-Afrika. Die hoofrede hiervoor is ’n gebrek aan kennis en vaardighede, veral aangaande die ontwikkeling, standhoudende gebruik, beskerming en beginsels van ondergrondse waterbronbestuur. Geskikte en effektiewe ondergrondse waterbronbestuur en ondergrondse waterbronbeheer beginsels kan ‘n positiewe bydrae lewer tot die verligting van armoede in groot gedeeltes van Suid-Afrika. Die grootste uitdaging ten opsigte van ondergrondse waterbronne is om te verseker dat effektiewe ondergrondse waterbronbestuur en ondergrondse waterbeheer op ‘n standhoudende manier toegepas word.

Die ooronttrekking van ondergrondse water in sekere gebiede van Suid-Afrika is problematies en het verskeie nadelige gevolge. Die uitputting van ondergrondse waterbronne en die agteruitgang van die ondergrondse watergehalte gee aanleiding tot nadelige effekte op menslike gesondheid in groot gedeeltes van landelike gemeenskappe wat gedeeltelik of algeheel afhanklik is van ondergrondse waterbronne vir die bevrediging van hulle basiese menslike behoeftes. Watervolume en watergehalte probleme hou direk verband met krisisse soos swak skoolbywoning, voedselsekerheid, ondervoeding by kinders en HIV/Vigs-besmette persone, asook ‘n afname in produktiwiteit. ’n Kompetisie vir water tussen huishoudings, gemeenskappe, landbou en industrieë neem voortdurend toe as gevolg van bevolkingsgroei, spanning en konflik.

Geskikte, effektiewe ondergrondse waterbronbestuur en ondergrondse waterbronbeheer sal ‘n positiewe bydrae lewer tot die beperking van ooronttrekking van ondergrondse waterbronne, toenemende verbeterde en standhoudende onttrekking en verbruik, asook die verbetering van die ondergrondse watergehalte.

Die navorsingstudie het gefokus op uitdagings en oplossings om ‘n positiewe bydra te lewer met betrekking tot die verbetering van ondergrondse waterbronbestuur, ondergrondse waterbronbeheer en die hantering van ondergrondse waterverbruikmagtigings vir besproeiingsdoeleindes in die landboubedryf in Suid-Afrika.

Die doelwit van hierdie studie was om ‘n raamwerk te ontwikkel vir ondergrondse waterverbruikmagtigings as deel van ondergrondse waterbronbeheer in Suid-Afrika. Hierdie doelwit is bereik met behulp van ‘n fasebenadering.

Aksienavorsing is as navorsingsmetodologie toegepas. Die navorser en praktisyn was albei skrywers van die tesis.

Die aksienavorsingsmetodologie het oor vyf fases plaasgevind:

Fase 1 lewer ‘n oorsig en bespreek ondergrondse waterbronbeheer in Suid-Afrika.

Fase 2 lewer ‘n oorsig aangaande voedselsekerheid, watersekerheid en die ekonomiese waarde van water in die landboubedryf in vergelyking met die toekenning van ondergrondse waterverbruikmagtigings.

Fase 3 vergelyk en evalueer die Nasionale Waterwet met Internationale Waterwetgewings.

Fase 4 bespreek die ondergrondse waterreserwe bepalingsproses van Suid-Afrika.

Fase 5 verskaf ‘n raamwerk vir die verwerking van ondergrondse waterverbruikmagtigings in die landboubedryf.

Verskeie probleme is tydens die studie geïdentifiseer en moontlike oplossings is bespreek.

Die gevolgtrekking van die studie is dat Suid-Afrika se waterwetgewing, waterbeleide en waterregulasies te breedvoerig is, nie duidelik en spesifiek is nie en dat verskeie waterregulasies en waterbeleide mekaar weerspreek. Al het hierdie gevolgtrekking die navorsingstudie besonder moeilik gemaak, was dit wel moontlik om die raamwerk vir ondergrondse waterverbruikmagtigings as deel van ondergrondse waterbronbeheer in Suid-Afrika te ontwikkel. Die navorsingshipotese, soos genoem in hoofstuk 1, kan om hierdie rede wel aanvaar word. Die navorser is van mening dat die ontwikkelde raamwerk gebruik moet word as grondslag vir die verbetering van ondergrondse waterbronbestuur en ondergrondse waterbronbeheer, asook vir die verbetering van die Nasionale Waterwet van Suid-Afrika.