



Department : Water Affairs
and Forestry

Integrated Water Resources Management



**Guidelines for Groundwater Resources Management
Summary**



DEPARTMENT OF WATER AFFAIRS AND FORESTRY

INTEGRATED WATER RESOURCES MANAGEMENT

**GUIDELINES FOR GROUNDWATER RESOURCES MANAGEMENT
IN WATER MANAGEMENT AREAS,
SOUTH AFRICA**

SUMMARY

INTEGRATED WATER RESOURCE MANAGEMENT
STRATEGIES, GUIDELINES AND PILOT IMPLEMENTATION
IN THREE WATER MANAGEMENT AREAS, SOUTH AFRICA

DANIDA
FUNDING AGENCY

Edition 1

March 2004

TITLE: GUIDELINES FOR GROUNDWATER RESOURCES
MANAGEMENT IN WATER MANAGEMENT AREAS,
SOUTH AFRICA: SUMMARY

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CATEGORY: Guideline

PURPOSE: To provide guidelines for integration of co-ordinated groundwater management into IWRM at different levels of resource managers within Catchment Management Agencies.

TARGET GROUP: DWAF, IWRM Project Consultants and Resource Managers in three Water Management Areas.

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1. INTRODUCTION

South Africa is a developing country with limited water resources, and effective water resource management is critical. The National Water Act recognises that effective water resource management can only be achieved if all water resources are managed in a holistic manner. To achieve this, the Department of Water Affairs and Forestry is developing integrated water resource management strategies and guidelines, which will be implemented on a pilot basis in three, selected water management areas.

This document provides a summary of the guidelines for managing the groundwater resources in South Africa.

2. INSTITUTIONAL ARRANGEMENTS

Water resource management is presently in a state of transition, with many new water resource management institutions being established, or existing institutions being aligned with the National Water Act. Water resources governance will occur in an integrated manner, with water management authorities acting in a co-ordinated manner.

VOLUME 1

3. CHAPTER 1: GROUNDWATER CO-ORDINATOR FUNCTIONS

It is envisaged that each catchment management agency will employ a groundwater co-ordinator who will ensure the integration of groundwater into water resource management, and interaction with all water management authorities and stakeholders (Figure 1). A groundwater co-ordinator should have good management skills and an understanding of groundwater systems, but not necessarily be a groundwater specialist.

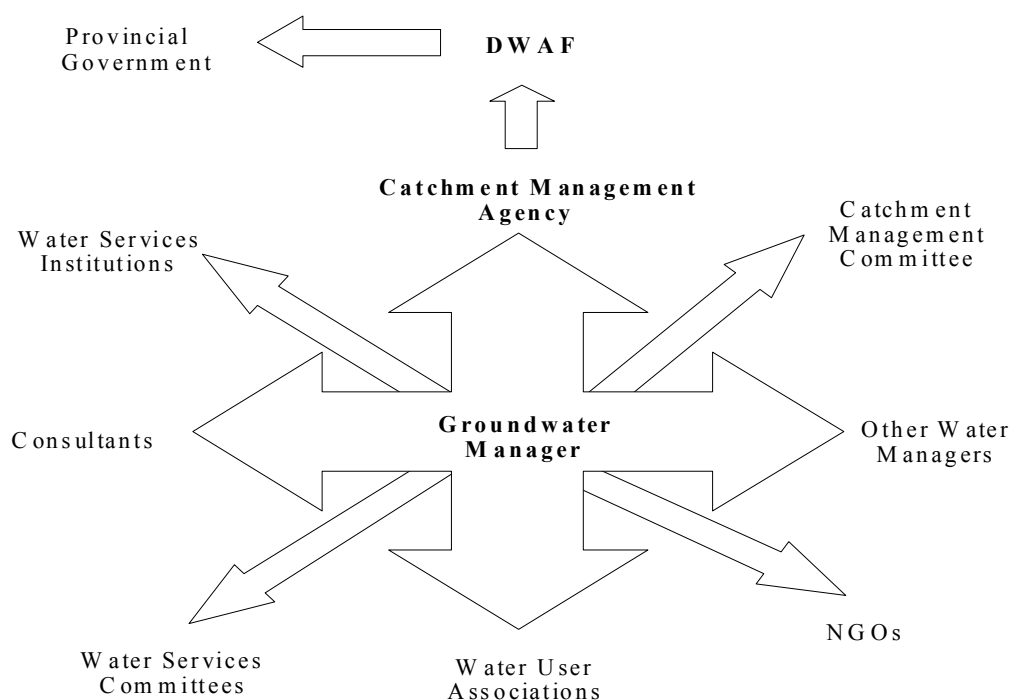


FIGURE 1: RELATIONSHIP BETWEEN THE GROUNDWATER CO-ORDINATOR AND WATER MANAGEMENT AUTHORITIES.

The responsibilities of the groundwater co-ordinator will include:

Contribution to the regular review of the National Water Resource Strategy to ensure that groundwater is integrated into the national strategy;

Implementation of catchment management strategies developed by the catchment management agencies;

Ensuring groundwater conservation and protection - in particular implementing existing groundwater quality management strategies;

Integration groundwater development into water resource management – particularly through the concept of conjunctive use;

Assessment of the groundwater resource, including determination of the contribution of groundwater to the Ecological Reserve, assessment of the safe yield of an aquifer and determination of aquifer vulnerability to land use activities;

Registration of groundwater use and allocation of groundwater to users;

Monitoring of borehole use, groundwater quality and water table draw down, and

Management of an effective groundwater information system.

4. CHAPTER 2: GROUNDWATER IN THE NATIONAL WATER RESOURCE STRATEGY

The National Water Resource Strategy is being developed by the Department of Water Affairs and Forestry as a guide to the implementation of the National Water Act. It provides the framework for the protection, use, development, conservation, management and control of water resources in South Africa, and is based on the concept of integrated water resource management at catchment level.

4.1 Groundwater Strategy

As input into the National Water Resource Strategy, a Groundwater Strategy was developed by the Department (available as Document 1 of this series), based on the following vision:

VISION

GROUNDWATER IS ACKNOWLEDGED BY ALL WATER MANAGERS AS AN IMPORTANT AND INTEGRAL PART OF SOUTH AFRICA'S WATER RESOURCES, AND IS MANAGED AS SUCH.

INSTITUTIONS INVOLVED IN WATER RESOURCE MANAGEMENT WILL ABIDE BY IWRM PRINCIPLES, AND GIVE ADEQUATE ATTENTION TO THE ROLE OF GROUNDWATER IN THE ENVIRONMENT AND AS A STRATEGIC

Twenty-nine strategies were developed to ensure the optimal development and management of groundwater resources in South Africa. However, five core strategies were identified as the most important with regard to initiating the required change:

Integrate groundwater into the management of water resources for the benefit of all of South Africa's peoples;

Promote groundwater so that water resource managers, water users and the public are more aware of the role, occurrence and value of groundwater;

Encourage and enable hydrogeologists to work outside their line function, and be integrated into the broader water resource planning and management functions;

Develop a larger, skilled and experienced specialist hydrogeological workforce, and

Develop a groundwater monitoring network and a hydrogeological information system to assist in the provision of data to those who need it.

4.2 Groundwater Strategy as part of integrated water resource management

Groundwater resources has been overseen and shamefully neglected in planning processes in South Africa in the past. It is however probably the most obvious answer to our water shortages and in addressing past inequities. If only for these reasons, it is vital that the groundwater coordinator ensure that groundwater strategies are incorporated in Catchment Management Strategies and to oversee the execution thereof.

5. CHAPTER 3: GROUNDWATER IN CATCHMENT MANAGEMENT STRATEGIES

An important component of integrated water resource management is the development of a catchment management strategy. The role of the catchment management strategy is to provide the direction and intermediate objectives to achieve the vision of the stakeholders in the water management area. It should outline objectives, strategies, plans, guidelines and procedures to achieve effective integrated water resource management.

5.1 Groundwater components of a catchment management strategy

Groundwater should not have an independent strategy but be included where appropriate in the general catchment management strategy. Much of the technological and management expertise in the catchment management agencies is, however, expected to have surface water focus. This may result in a bias toward surface water resources at the cost of groundwater. It is recommended that special attention be paid to the inclusion of groundwater in the first catchment management strategy to establish direction for future revisions. The following strategies outline groundwater components of catchment management strategies.

Groundwater components in a Catchment Management Strategy will include to types of strategies, i.e. **foundation strategies** (RDM strategy, stressed catchment strategy, cooperative governance strategy, etc.) and **supporting strategies** (water resource protection strategies, water use strategies, water conservation strategies, etc.)

5.1.1 Integration of Strategies

The foundation strategies are not totally independent of the supporting strategies, but should be kept separate to facilitate preparation of the catchment management strategy. The catchment management agency should bear in mind the potential linkages before preparing the individual strategies so that duplication can be avoided and streamlining optimised.

6. CHAPTER 4: STRATEGIES TO DEVELOP, CONSERVE AND ENHANCE AVAILABLE WATER RESOURCES IN A CATCHMENT

New approaches to water management are necessary to make groundwater a successful component of general water supply in South Africa. The new approaches will have to focus on efficiency, effectiveness and demand management, rather than on simply predicting, planning and supplying water needs. Optimal development of groundwater resources will require the most efficient and effective use of the resource in a sustainable manner. This means that the long-term integrity of the aquifer is preserved and the water, once abstracted, is used with minimal losses.

6.1 Conservation of groundwater resources

Conservation of water resources is defined in the National Water Act as the efficient use and saving of water, achieved through measures such as water saving devices, water-efficient processes, water demand management and water rationing. Water conservation should be an integral part of any catchment management strategy and catchment management agencies should play a lead role in promoting conservation in their catchment areas.

A series of key questions can be used by the groundwater co-ordinator to assess opportunities for groundwater conservation from the point of abstraction to the point of use. The groundwater coordinator needs to be pro-active and able to seek opportunities for groundwater conservation in his/her catchment area.

A more detailed checklist is provided in the main document in this series.

6.2 Enhancement of groundwater resources

Groundwater resources may be enhanced through land care, conjunctive use, managed and artificial recharge and urban design.

6.2.1 Land Care

Land-care programmes in catchments typically aim to reduce negative impacts of development and agriculture, and may include:

Soil conservation through terracing, contour-tilling, wind-breaks, mulching, etc., which reduces runoff and promotes infiltration and groundwater recharge;

Afforestation, which stabilises soil and increases utilisable catchment water yields, and

Alien vegetation removal, which improves biodiversity and increases recharge to groundwater and surface water.

In South Africa, the Working for Water Programme is a well-established example of a land-care initiative that has been successful in creating jobs and removing alien vegetation. The programme is aimed at increasing runoff; enhanced groundwater recharge and baseflow to streams, and uplifting local communities. Other land-care programmes are being co-ordinated through the National Department of Agriculture, in particular Land Care South Africa.

The groundwater co-ordinator should link with these programmes where they are being undertaken in recharge areas to ensure maximum positive impacts on groundwater resources and warn against potential negative impacts.

6.2.2 Conjunctive Use

Conjunctive use is the simultaneous use of both surface- and groundwater resources to ensure the best yield spatially and temporally. It includes initiatives and schemes such as transfers of water between surface and groundwater resources, transfers of water between wet and dry periods and artificial recharge as a method of storing water.

Schemes developed under a conjunctive use management system could be used to address such problems as: developing more groundwater-based urban water supplies; controlling earth subsidence; managing groundwater quality deterioration, and other overdraft-related problems. Conjunctive use may also assist in maintaining adequate water supplies during multi-year droughts when shortages of surface water are severe.

6.2.3 Artificial Recharge

Because evaporation losses are so high in South Africa, in many cases, it will be cost effective to store water below the ground. To assess this, both the evaporation losses and the economics associated with treating, transferring and recovering the artificially recharged water need to be determined. Unused aquifer storage capacity can for the most part be developed at a significantly lower cost than surface storage facilities, and without the environmental and social problems frequently associated with surface storage.

Artificial recharge schemes may be considered in areas where there are surplus surface water resources at certain times of the year and available unsaturated storage with sufficient permeability for injection and recovery. Opportunities for artificial recharge should also be considered in areas where evaporative losses from open water bodies are excessively high.

A variety of artificial recharge methods are in use, involving direct recharge techniques, induced recharge and even artificial aquifers, where water is introduced to otherwise dry but permeable geological formations.

6.2.4 Water Sensitive Urban Design

Urbanisation of the catchment often leads to a decrease in infiltration to aquifers due to increased paved surfaces and efficient drainage systems, which remove storm water from the recharge area. Water sensitive urban design aims to reduce those losses by incorporating more vegetated surfaces and soakaways to maintain groundwater recharge.

It is important to recognise the value of water sensitive urban design early in the land-use planning process. Early planning provides developers, industry and government with a framework for implementing ecologically sustainable development principles in buildings and supporting public infrastructure.

Water sensitive urban design can create new solutions and efficient systems that are more attractive to prospective purchasers, increases the value of adjacent land, and avoid expensive new infrastructure.

6.2.5 Development of resources

Strategic sustainable development of groundwater resources is the key to the optimal use of aquifers. This means that the abstraction of groundwater and other activities impacting the aquifer are managed within the limits of the integrity of the system. Typically water levels should not fall below their annual range, subsidence should not occur and water quality parameters should remain within the functional range of the unmodified system.

Development of groundwater resources should be achieved in an integrated manner with all components of groundwater management, integrated water resource management and catchment management being taken into account (Figure 2).

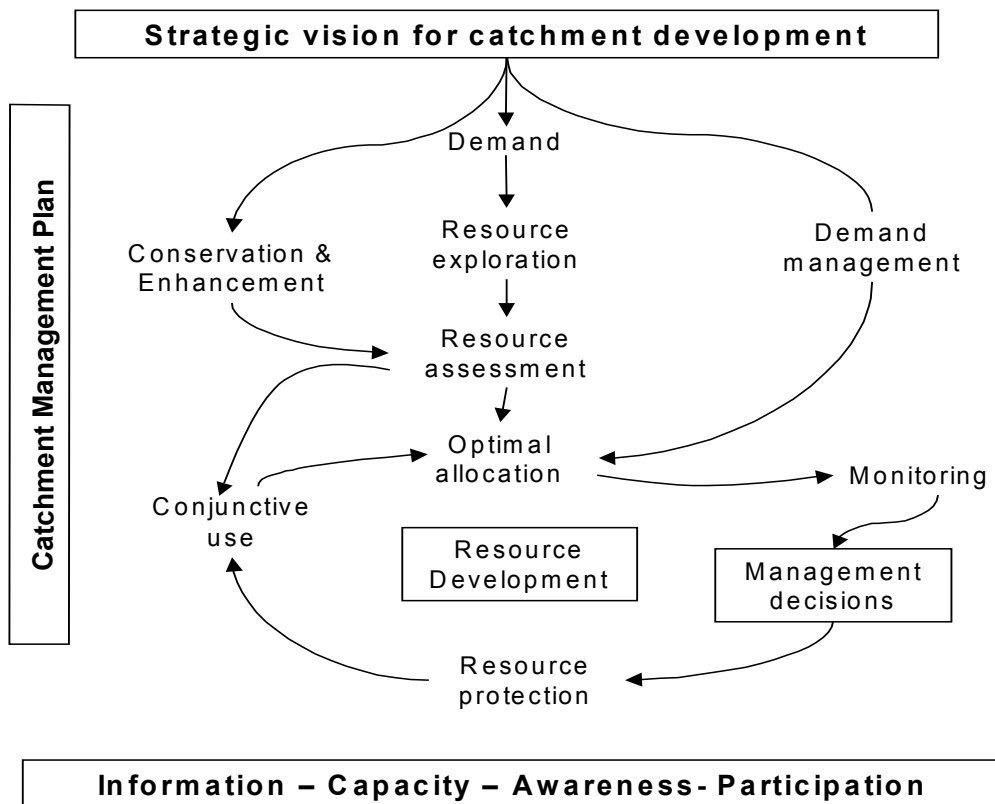


FIGURE 2: INTEGRATED DEVELOPMENT OF RESOURCES

VOLUME 2

7. CHAPTER 1: GROUNDWATER RESOURCE ASSESSMENT AND SITUATION ANALYSIS

The extent of groundwater resources can be complex to assess and, as a result, groundwater resources have often not been included in the general assessment of regional water resources. The National Water Act now requires water managers to consider all the water resources of a region.

The groundwater co-ordinator must develop a sound understanding of the aquifer potential of the water management area, and the relationship to the surface water bodies. The accuracy of recharge estimation, which is critical for sustainable yield determination, should be improved around the country and in a greater variety of hydrogeological settings.

Details of the methods used to undertake groundwater assessments are provided in the main document. The process to undertake a groundwater assessment is shown in Figure 3.

The calculation of a water balance for the catchment together with proper aquifer characterization methods is arguably the most important steps in the resource assessment process. This chapter deals with other detail in the assessment process as well, eg. hydrocensus, formalising a conceptual model.

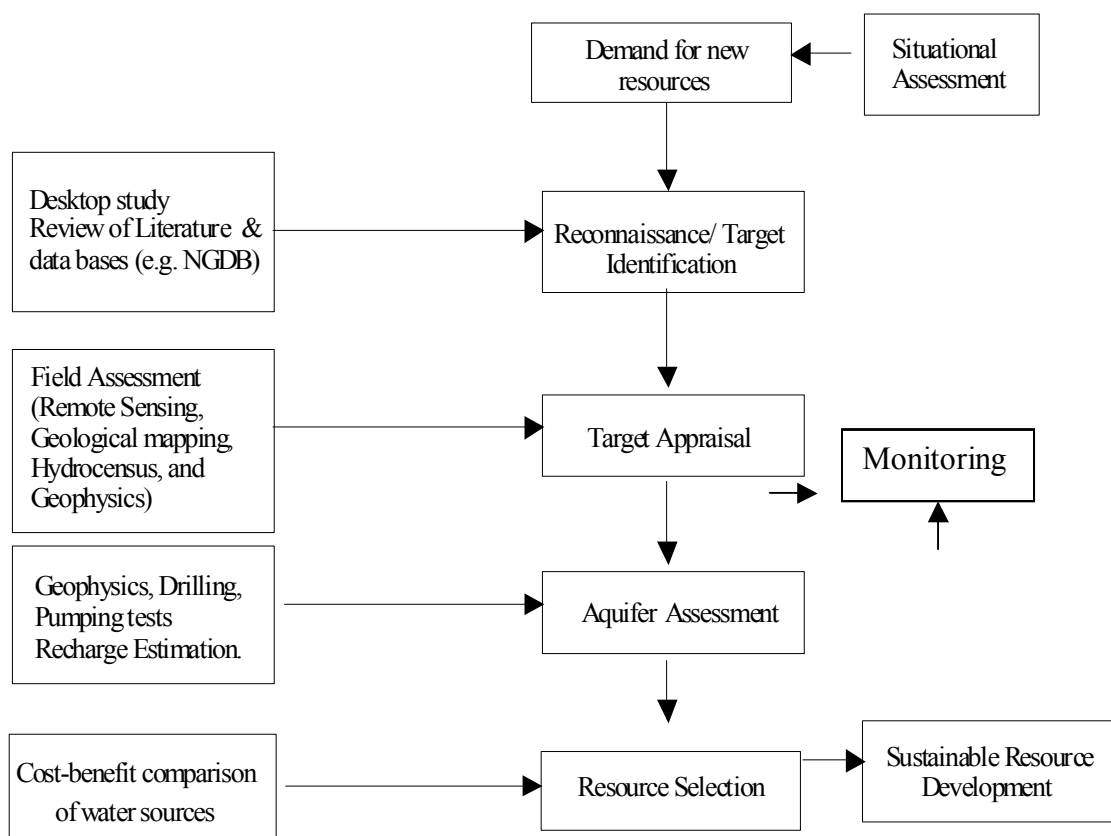


FIGURE 3: PROCESS DIAGRAM FOR A GROUNDWATER RESOURCE ASSESSMENT STUDY

8. CHAPTER 2: GROUNDWATER RESOURCE ALLOCATION

Water resource allocation is one of the core functions of the Department of Water Affairs and Forestry and catchment management agencies. Groundwater can play a major role in the water shortage in South Africa and is an economically viable resource that has been underestimated in the past.

In order to realise these principles the groundwater co-ordinator will need to integrate with surface water co-ordinators, integrated water resource managers, water service providers, water user associations and other catchment stakeholders.

8.1 Sustainability, equity and efficiency in allocation

8.1.1 Sustainability

The following legal and regulatory tools are available to the groundwater co-ordinator in the catchment management agency to protect the sustainable functioning of aquifers:

Determining the Reserve, setting the management class and establishing resource quality objectives will outline the limits of socially acceptable impact to the functioning of the groundwater system.

Non-allocation to unsustainable uses or levels of use.

Setting licensing conditions that: limit drawdown; prescribe the type of pumping technology used; limit the depth of boreholes, well or pump installation; prescribe monitoring data to be collected, and demand abstraction to be managed within certain boundary conditions.

In addition to using the regulatory instruments, the groundwater co-ordinator needs to ensure a greater level of understanding and awareness of the importance of sustainability to assure groundwater supply, and resolve competition between users for short-term, unsustainable gains.

8.1.2 Equity

The allocation of groundwater can play an important role in redressing the imbalances of the past and alleviating poverty. The groundwater co-ordinator is often in a position to assist emerging farmers and previously disadvantaged communities to develop their local economies by allocating groundwater resources as a priority.

Groundwater resources are particularly important in this regard because they are widely distributed, can be locally managed, often require lower levels of capital investment and are often less stressed than surface water resources.

8.1.3 Efficiency

Water use efficiency ensures that water is consumed in a way that minimises wastage and losses. For this to happen it is necessary that the water users have a full appreciation of the value of water and a desire to maximise their benefit from the water supplied to them.

Water conservation and demand management measures also attempt to ensure efficiency of use and should be implemented for water service institutions and rural and urban end-users.

A set of guidelines on water conservation and demand management has been produced by the Department of Water Affairs and Forestry, and provides details on the tools and measures, such as leakage detection and repair in bulk reticulation, and household retrofitting of water-saving devices like dual flush toilets.

8.2 Allocation of groundwater resources

The amount of groundwater available for licensed allocation can be determined by the following equation:

$$\begin{aligned} \text{WATER FOR LICENSED ALLOCATIONS} = & (\text{AVAILABLE WATER}) - (\text{RESERVE}) - \\ & (\text{INTERNATIONAL OBLIGATIONS}) - (\text{SCHEDULE 1 USES}) - \\ & (\text{GENERAL AUTHORISATIONS}) - (\text{EXISTING LAWFUL USE}) \end{aligned}$$

The information to determine a water balance for groundwater within a catchment is often insufficient for a high (or even moderate) degree of confidence in the amount of water available to be allocated. For this reason it is advisable to follow a precautionary and phased approach to allocation.

Tools and guidelines for the groundwater coordinator to aid in the allocation process is under development in DWAF and will be available within the next year.

9. CHAPTER 3: GROUNDWATER PROTECTION APPROACHES

The protection of water quality in South Africa is to be achieved by the combination of the strategies as shown in Figure 4.

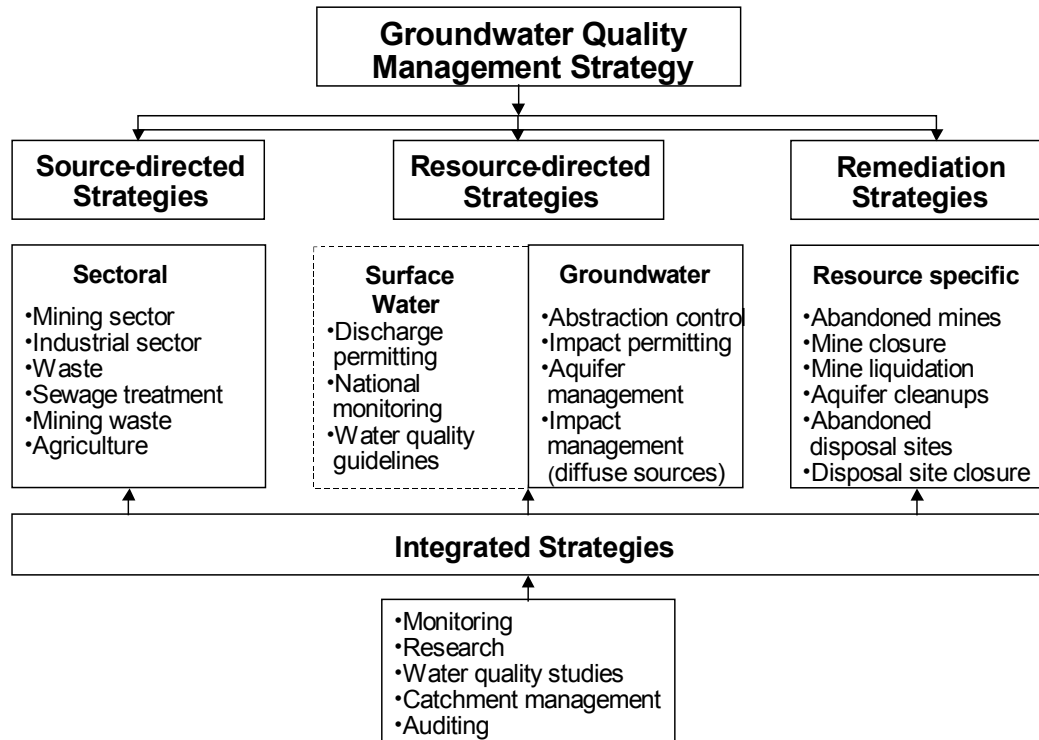


FIGURE 4: INTEGRATED STRATEGIES TO MANAGE GROUNDWATER RESOURCE QUALITY IN SOUTH AFRICA

Resource-directed measures focus on resource quality, including both water quantity and water quality. They are implemented through the determination of the Reserve, management class and resource quality objectives for each resource.

Source-directed controls are primarily designed to control water use activities at the source of impact, through tools such as standards, regulations and water use authorisations.

Remediation strategies are aimed at existing pollution that threatens the groundwater quality.

Other important approaches to the management of the groundwater resource quality include:

Well-head protection – The Department of Water Affairs and Forestry has proposed that the implementation of a well-head protection programme should be a priority for groundwater quality management. Tools to facilitate well-head protection include the setting of minimum borehole construction standards, and the establishment of well-head protection zones.

Co-operative governance in land-use planning - Catchment management agencies should participate in land use planning activities and co-operate with authorities responsible for the allocation of land for prescribed purposes, so that groundwater interests can be addressed. A land-use planning programme has been proposed by the Department of Water Affairs and Forestry through which the Department will seek to play an increasingly prominent role in influencing land-use planning processes and decisions in order to provide the best possible level of protection to groundwater resources.

Public awareness, -participation and capacity building - The core strategies described above are supported by cross-cutting strategies of public participation and capacity building. Catchment management agencies must play a role in educating communities to protect their own groundwater resources by the implementation of initiatives such as wellhead protection programmes.

They should provide educational material for learners, stakeholders and staff. Local government, communities and non-government organisations must be invited to contribute to the development of catchment management strategies, and catchment management agencies must communicate groundwater protection issues and promote capacity building in the institutions responsible for land use planning.

10. CHAPTER 4: GROUNDWATER MONITORING AND INTEGRATED MONITORING NETWORKS

Efficient and sustainable use of a catchment's groundwater resources cannot take place without adequate monitoring. Especially in the case of groundwater, where impacts are not immediately obvious, monitoring is required to quantify the effects of water and land use management decisions and to make adjustments where these are necessary.

10.1 Why would we want to monitor?

When developing a monitoring strategy, the purpose of monitoring should be well-defined and communicated to the stakeholders who need to support the monitoring efforts. Monitoring needs must be established at the outset and all participants in groundwater monitoring, from the monitoring system designer to the sampling technicians and data capturers, must understand the **monitoring needs**. Groundwater monitoring data should be used to **support planning decisions** for taking actions that might lead to the improvement of resource protection and management. Information collected through groundwater monitoring programmes may also be useful in refining resource classification, delineating future protection zones or updating receiving water quality objectives.

10.2 Roles and responsibilities

The roles and responsibilities of water management institutions to groundwater monitoring is provided in Figure 5.

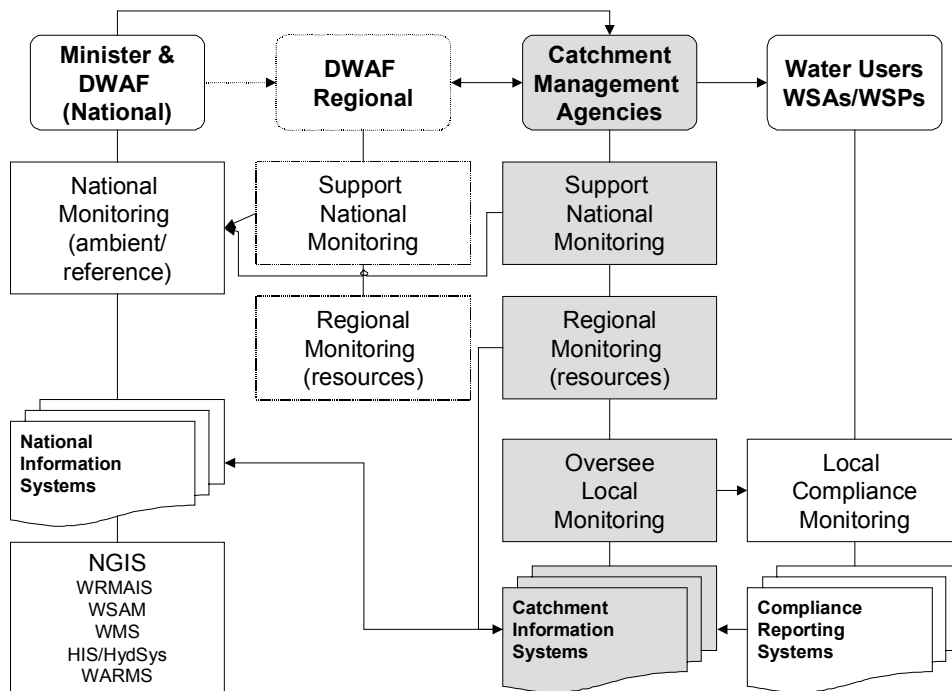


FIGURE 5: GROUNDWATER MONITORING AND DATA MANAGEMENT RESPONSIBILITIES

Under the National Water Act is the responsibility of the Department of Water Affairs and Forestry to implement national monitoring systems, to co-ordinate with other institutions on national level and to establish guidelines for catchment level monitoring networks. The responsibility for the actual collection of water samples and data will be devolved to catchment and local level.

10.3 Guiding principles for monitoring strategies

A set of guiding principles should be followed through all levels of the planning and implementation phases for groundwater monitoring networks, including:

Planning should proceed from a general policy level downwards to a specific detailed design of each component.

Each component of the monitoring strategy should have a clearly defined purpose.

Data collected should be relevant to the decisions that need to be taken.

Data collected should be compatible with the models that use them.

Monitoring should be physically and financially feasible.

Monitoring should make use of the best available technologies and resources, without entailing unnecessary costs.

All components of monitoring programmes should be updated periodically to take into account changing management problems, resource availability and decision-making models.

10.4 Designing a catchment monitoring system

The details of the design and implementation of a catchment monitoring system are provided in the main document in this series. These steps include:

- Set monitoring goals;
- Establish monitoring status quo;
- Co-ordinate with other monitoring initiatives;
- Design monitoring programme;
- Address support services and training requirements;
- Draw up a planning document, and
- Implement and update the groundwater monitoring programme.

Each of these steps are discussed in detail in the main document.

10.5 Integration of monitoring networks

DWAF is currently developing a 5-year integrated monitoring plan with the aim to move away from “data-rich but information-poor” information by integrating monitoring data. Also to have a cost-effective and efficient total monitoring programme in South Africa that is based on cooperative governance and mutual benefit. This will also help the groundwater coordinator to streamline groundwater monitoring in the catchment i.t.o. other monitoring networks.

11. CHAPTER 5: GROUNDWATER INFORMATION SYSTEMS FOR INTEGRATED WATER RESOURCE MANAGEMENT

It is essential that collection of new general hydrogeological and monitoring data be accompanied by development of powerful and robust information tools such as databases, information systems, maps, reports and booklets. These are to be used to convey the relevant information to hydrogeological specialists, water resource managers, decision makers and the public and can greatly support groundwater awareness- and promotion campaigns.

The Directorate Information Management of the Department of Water Affairs and Forestry is responsible for the custodianship of all hydrogeological information nationwide. This includes capturing, management and dissemination. In the future, catchment management agencies will have an important role as the suppliers of data and users of the outputs from the information systems.

Several computer-based systems are available for storing and dissemination of hydrogeological data and information, in addition to libraries and technical reports. The key characteristics of the databases that are envisaged for use by catchment management agencies (most are presently available at the Head Office) are provided in Table 1.

TABLE 1: FEATURES OF INFORMATION SYSTEMS IN DWAF

	REGIS	WSAM	HYDSYS	WMS	WARMS
Primary Function	Hydrogeology	Water situation assessment	Surface hydrology	Water quality	Authorised water use
Mapping component:	ArcView, using ESRI shape files and coverages	ArcView, using ESRI shape files	Proprietary mapping module, however this module can include shape files	ArcView, using ESRI shape files	None present
Database	Oracle	Access	Proprietary	Informix	Informix
Data exchange	ASCII tables	ASCII tables	ASCII tables	ASCII tables	ASCII tables
Spatial data exchange	Shape files	Shape files	Shape files	Shape files	n/a

A new portfolio titled the National Groundwater Information Systems is presently being designed to meet increasing demands for groundwater information in a rapidly changing water business environment. The portfolio of the National Groundwater Information Systems project includes several subprojects. Amongst the most important are REGIS Africa and the National Groundwater Archive. The later one is a relational database management system that is to replace the Open-National Groundwater Database currently being used.

A successful groundwater information system should comprise five main components: adequate hardware, appropriate software, good data, well-trained personnel, and well-defined procedures (including project maintenance and financing). Hardware capabilities affect processing speed, ease of use and the type of output available. This includes not just the actual GIS software, but also various database, drawing, statistical, imaging and other software. The availability and accuracy of data can affect the results of any query or analysis. Data analysis requires well-defined, consistent methods to produce correct and repeatable results. However, the personnel component is considered to be the most important. People must develop the procedures and define the tasks of the information systems. People can often overcome shortfalls in other components of the information systems, but the opposite is not true.

It is recommended that catchment management agencies establish an on-line information service to provide hydrogeological data and information. The users are expected to be drillers, consultants, land owners, farmers, researchers and non-governmental organisations. Having easy access to data will promote a greater awareness of groundwater and the concepts of integrated water resource management.

Recommendations are also made regarding other databases and information systems that will be user friendly to the groundwater coordinator to enable him/her to maintain an appropriate information system to aid in planning decisions and management of the groundwater resource.