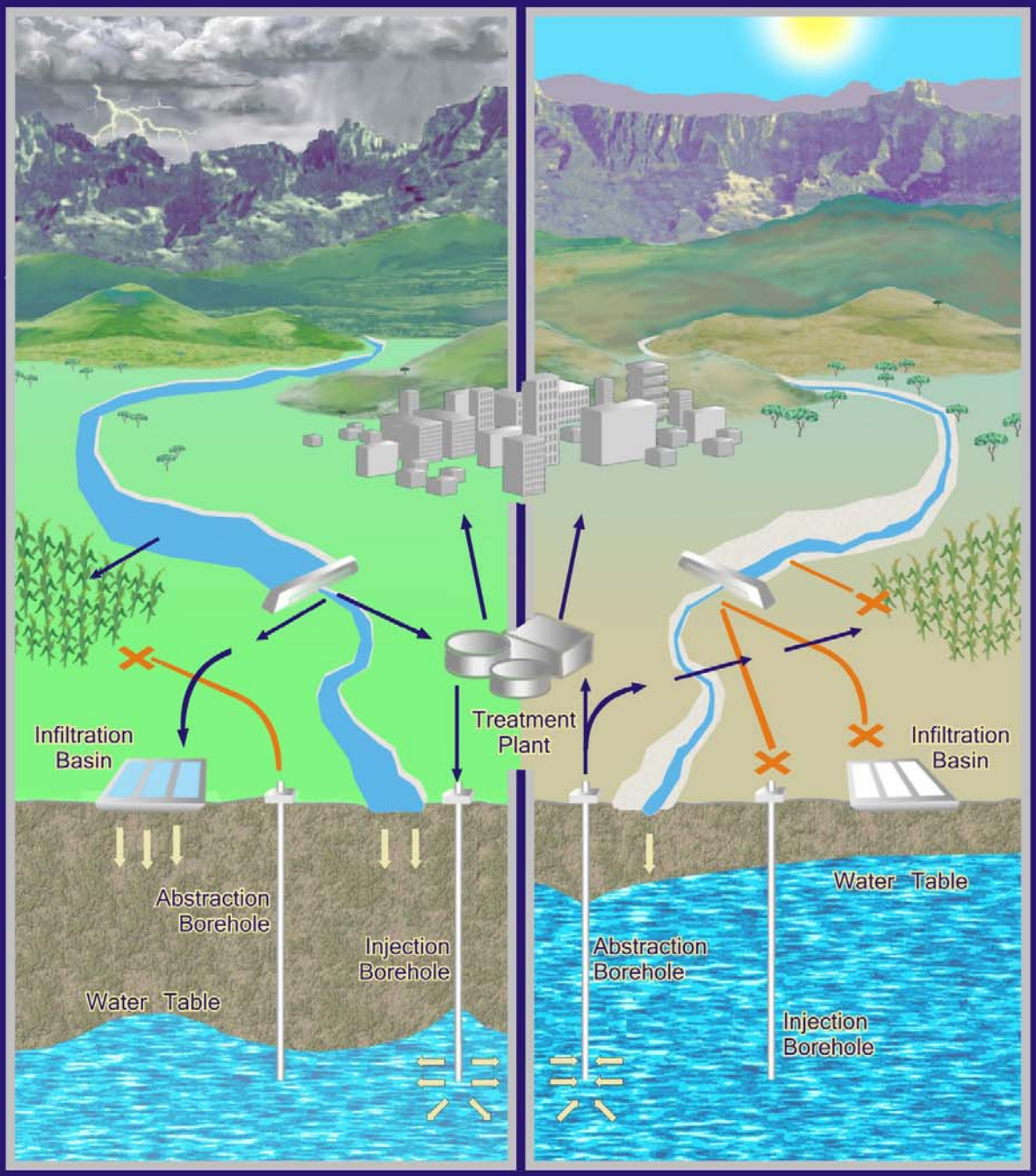
ARTIFICIAL RECHARGE STRATEGY

Version 1.3 - June 2007



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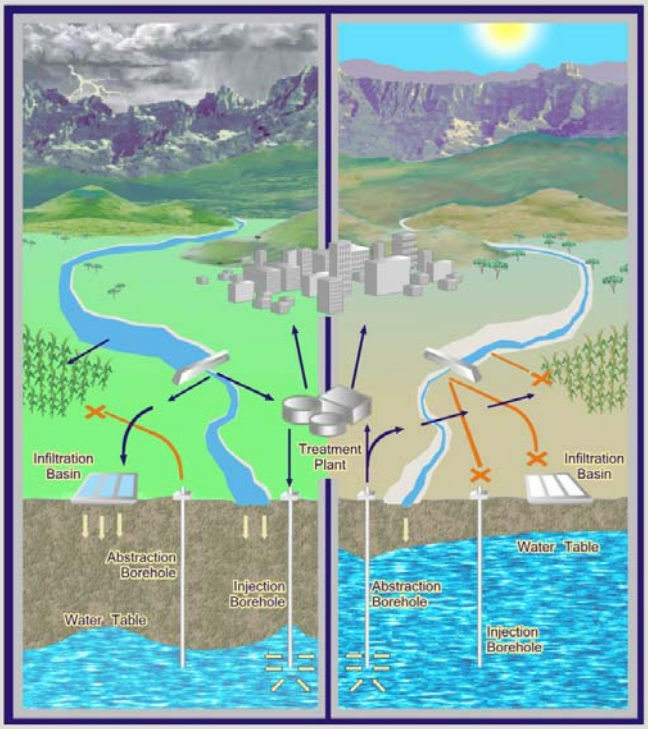
Water Research Commission

When surplus water is available, it is transferred underground via infiltration basins or boreholes. The aquifers are rapidly replenished and the water is held in storage for later use.



In times of need, the stored water is pumped from the aquifer via boreholes to the users.

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Version 1.3

June 2007

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Acronyms

AOC	Assimilable Organic Carbon
AR	Artificial Recharge
ARMS	Artificial Recharge Management and Storage
ASCE	American Society of Civil Engineers
ASR	Aquifer Storage and Recovery
ASTR	Aquifer Storage, Transfer and Recovery
AWWA	American Water Works Association
BCM	Billion Cubic Metres (1000 000 000 m^3)
CBA	Cost Benefit Analysis
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DBP	Disinfection By-Products
DEADP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DNDE	Department of National Development and Energy, Australia
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DWAF	Department of Water Affairs and Forestry
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
Eh	Oxidation-reduction potential, mV
EIA	Environmental Impact Assessment
ENVES	Environmental Engineering Services
EPA	Environmental Protection Agency (USA)
GIS	Geographical Information System
GRA II	Groundwater Resource Assessment Phase II (DWAF)
HAA	Halo-Acetic Acids
HACCP	Hazard Analysis and Critical Control Point Plan
IDP	Integrated Development Plans
IMIESA	Institution of Municipal Engineering of South Africa
ISP	Internal Strategic Perspective
IWRM	Integrated Water Resource Management
MAR	Mean Annual Runoff
MAR	Managed Aquifer Recharge
MARS	Managed Aquifer Recharge and Storage
MFI	Membrane Filter Index
MHa	Million Hectares
Mm^3	Million cubic metres
NamWater	Namibia Water Corporation (Ltd)
NEMA	National Environmental Management Act (Act 107 of 1998)
NGDB	National Groundwater Data Base
NWA	National Water Act (Act 36 of 1998)
NWCDMS	National Water Conservation and Water Demand Strategy
NWP	National Water Policy (for South Africa)
NWRS	National Water Resource Strategy
SAT	Soil Aquifer Treatment
SWECO	SWECO International (Consulting Company)
TDS	Total Dissolved Solids
THM	Trihalomethanes
TOC	Total Organic Carbon
WB	Water Board
WC	Water Conservation
WDM	Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSI	Water Services Institution
WSP	Water Services Provider
WSPF	Water Services Planning Framework
WUA	Water User Association

SECTION A: INTRODUCTION

A.1 INTRODUCTION

A.1.1 Purpose of a national strategy

Artificial recharge (AR) is the process whereby surface water is transferred underground to be stored in an aquifer. The most common methods used involve injecting water into boreholes and transferring water into spreading basins where it infiltrates the subsurface. Underground water storage is an efficient way to store water because it is not vulnerable to evaporation losses and it is relatively safe from contamination. Internationally, artificial recharge is becoming an increasingly recognised form of water storage and conservation. South Africa has one major established artificial recharge scheme, however, this technology is underutilised and together with proper groundwater management, artificial recharge can contribute significantly towards maximising the use and sustainability of available water resources.

The purpose of the national artificial recharge strategy is captured in the vision statement:

Vision

To use natural sub-surface storage as part of Integrated Water Resource Management wherever technologically, economically, environmentally and socially feasible.

In order to realise this vision, the Department of Water Affairs and Forestry (DWAF) has identified seven themes that require attention. These themes are listed below and described in Section D which presents the artificial recharge strategy.

Themes

1. Knowledge Theme
2. Legislation and Regulation Theme
3. Planning Theme
4. Implementation Theme
5. Management Theme
6. Research Theme
7. Strategy Implementation Theme

Artificial recharge or Managed Aquifer Recharge (an alternative term that is commonly used), has many purposes. The most common is to store water in the subsurface for later use, this usually being achieved by allowing water to infiltrate the subsurface via infiltration basins or by injecting water via boreholes into the aquifer. In this context, it is a form of water conservation, in that water that would otherwise be lost through evaporation and evapotranspiration from dams and

rivers, or from outflows to the sea (fresh or waste water), would be captured and made available for later use. Other common uses are to prevent sea water intruding into coastal aquifers by creating hydraulic barriers at the coastline, and to use aquifer media for water treatment, like a large-scale sand filter. A potential use in South Africa may also be to maintain the Reserve, whereby surplus water (fresh or waste) would feed areas where the Reserve is considered to be under threat due to large-scale groundwater or surface water abstraction.

DWAF intends to incorporate artificial recharge as part of water resource planning - both at the Water Resource Level and at the Water Services Level. At the Water Resource Level, this will mean incorporating artificial recharge within Catchment Management Strategies (CMSs) and the National Water Resource Strategy (NWRS); and at the Water Services Level, it will mean including artificial recharge in Integrated Development Plans, in Water Services Development Plans and in the various Water Conservation and Water Demand Management Strategies.

The main aim of this document is to provide a national strategy on how to create an enabling environment for implementing artificial recharge.

For this strategy to be effective, that is, for it to enable authorities to include artificial recharge as a feasible option when assessing, planning and managing water resources, it will need to accomplish four critical objectives:

- It will need to promote awareness on artificial recharge
- It will need to pave the way for artificial recharge to be included in various levels of water resource planning
- It will need to provide basic information on the factors that affect the viability of artificial recharge schemes
- It will need to provide guidance on how to obtain approval from DWAF for implementing artificial recharge projects.

A.1.2 Introduction to the document

The Artificial Recharge Strategy has four main components (Table A.1):

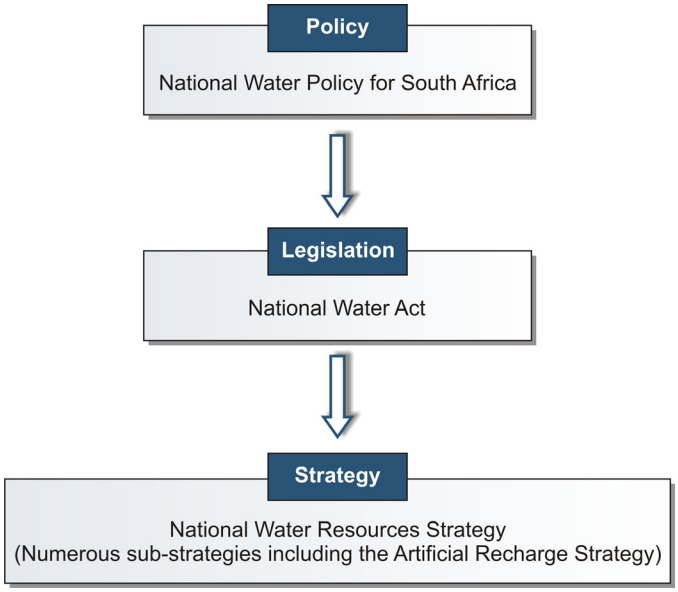
A: Introduction
B: The artificial recharge concept, its application and potential
C: Implementation and authorisation
D: The Artificial Recharge Strategy

Table A.1: Roadmap of the Artificial Recharge Strategy

SECTION	PURPOSE
A: Introduction	
Introduction This section describes the purpose of the Artificial Recharge Strategy, provides the artificial recharge vision and the seven objectives to realise the vision.	To provide a brief explanation of why the Artificial Recharge Strategy is necessary.
Legislative framework Artificial recharge is contextualised within existing national strategies and legislation.	To see where artificial recharge fits in the "big picture".
B: The Artificial Recharge Concept, Its Application and Potential	
What is artificial recharge The types of artificial recharge schemes are described as well as their benefits.	To give the reader a rapid overview of what the artificial recharge concept entails.
International and Southern African experience Describes existing schemes internationally and within Southern Africa.	To highlight the role that artificial recharge plays in integrated water resource management and to illicit key lessons from operational schemes.
Artificial recharge potential in South Africa This section assesses the potential role of artificial recharge in South Africa and quantifies the volume of water per WMA that could be stored using the artificial recharge approach.	To provide an initial assessment of the potential of artificial recharge in relation to the country's total water resources.
C: Implementation and Authorisation	
Criteria for successful implementation Lists and describes the criteria for assessing the viability of artificial recharge schemes.	To provide guidance on the factors that affects the implementation of a successful artificial recharge project.
Project stages, legislation and authorisation This section describes the process of assessing, implementing and authorising artificial recharge projects.	To provide guidance on the process of implementing an artificial recharge project and the legal requirements. This section is aimed at both implementing agents and regulatory authorities.
Guideline documents Provides an overview of artificial recharge guideline documents.	To provide awareness on existing support material.
D: The Artificial Recharge Strategy	
The Artificial Recharge strategy The Artificial Recharge Strategy includes the artificial recharge vision and seven themes. Each theme contains one objective and the actions required to meet the objective. The current status of each theme is described as well as the strategic approach to address each objective.	To describe in detail the Artificial Recharge Strategy
Approach to incorporate artificial recharge in water resource planning This section lists government documents into which artificial recharge should be incorporated.	To provides an initial approach to incorporate artificial recharge in water resource planning.

A.2 LEGISLATIVE FRAMEWORK

This section describes the foundation of this strategy document – the principles, the legislation and the overarching water resource strategy. The diagram below shows how the Artificial Recharge Strategy falls within the legislative framework.



A.2.1 Policy

The National Water Act, 1998 (No 36 of 1998), is based on the **National Water Policy for South Africa** (NWP), which in turn was guided by 28 Fundamental Principles and Objectives for a New South African Water Law. Three of these principles are pertinent to artificial recharge – Principles 7, 13 and 14:

Principle 7:	*The objective of managing the quantity, quality and reliability of the Nation's water resources is to achieve optimum, long-term, environmentally sustainable, social and economic benefit for society from their use.*
Principle 13:	*As custodian of the Nation's water resources, the National Government shall ensure that the development, apportionment, management and use of those resources is carried out using the criteria of public interest, sustainability, equity and efficiency of use in a manner which reflects its public trust obligations and the value of water to society while ensuring that basic domestic needs, the requirements of the environment and international obligations are met.*
Principle 14:	*Water resources shall be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water. Conservation and other measures to manage demand shall be actively promoted as a preferred option to achieve these objectives.*

The terms reliability, sustainability and conservation, as contained in these Principles, provide the basis for pursuing artificial recharge as one of the means to meet the Nation's water supply and management objectives.

Three fundamental objectives for managing South Africa's water resources arise from these principles:

- To achieve equitable access to water, that is, equity of access to water services, to the use of water resources, and to the benefits from the use of water resources.
- To achieve sustainable use of water by making progressive adjustments to water use with the objective of striking a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources.
- To achieve efficient and effective water use for optimum social and economic benefit.
- The concepts of sustainability and efficient and effective use are captured within these objectives. These are also fundamental principles for AR.

A.2.2 Legislation

The **National Water Act (NWA),** 1998 (No 36 of 1998), is the principal legal instrument relating to water resources management in South Africa and contains provisions for the protection, use, development, conservation, management and control of South Africa's water resources. In addition to the NWA, there are many other policies and laws administered by a number of Departments that affect water resources. Of particular relevance are:

- The **Water Services Act,** 1997 (No. 108 of 1997), which relates to the provision of water services by water services institutions including the safe disposal of effluent. The Water Services Act also requires that Water Services Authorities (WSA's) produce an annual water audit including details of water conservation measures.
- The **National Environmental Management Act,** 1998 (No. 107 of 1998) is relevant to the management of water resources within the context of national environmental principles and legislation.

The **National Environmental Management Act** (No. 107 of 1998) (NEMA) and as amended (No. 56 of 2002 and No. 8 of 2004) provides for the control of listed activities. The Government Notices R. 385, R. 386, and R. 387 published in Government Gazette No. 28753 on the 21st April 2006, and promulgated under Section 24(5) of NEMA, have replaced the environmental impact assessment (EIA) regulations that were promulgated in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989) in 1997 and introduce new provisions regarding environmental impact assessments.

The **Environment Conservation Act** (No. 73 of 1989) (ECA) previously provided for the control of certain listed activities that 'may have a detrimental effect on the environment'. These activities were listed in Government Notice R1182 of 5 September 1997 (as amended). The Act further prohibits such activities until written authorisation was obtained from the Minister or his delegated authority. The regulations published in terms of the National Environmental Management Act have replaced the ECA Environmental Impact Assessment regulations with effective from 3 July

2006. However the ECA remains in force as it relates to waste disposal, and the Outeniqua Sensitive Coastal Areas regulations.

While the NWA and the NEMA are the two primary acts that govern artificial recharge projects in South Africa, there is other legislation and local bylaws that may apply to specific projects. These include:

- Water Services Act (Act 108 of 1997)
- National Environmental Management: Biodiversity Act (Act 10 of 2004)
- National Environmental Management: Protected Areas Act (Act 57 of 2003)
- Mineral and Petroleum Resources Development Act (Act 28 of 2002)
- Dam Safety Regulations (published in Government Notice R. 1560 of 25 July 1986)
- Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)
- Promotion of Administrative Justice Amendment Act (Act 53 of 2002)
- National Heritage Resources Act (Act 25 of 1999).

A.2.3 Strategy

As required by the NWA, a **National Water Resource Strategy** (NWRS) has been developed (DWAF, 2004). The purpose of the NWRS as stated in the NWA (Part 1 – Sections 5 - 7) is to *"...provide the framework for the protection, use, development, conservation, management and control of water resources for the country as a whole".* The final artificial recharge strategy will form part of the NWRS. Artificial recharge is one of the many ways in which water resources can be protected, used, conserved, managed and controlled.

The National Water Policy discusses the need for an integrated approach to water resource management, and the NWRS provides the context in which this should happen. Artificial recharge is a good example of an approach that integrates the use of surface and groundwater in an environmentally sustainable manner. Whether the source water is from rivers or dams, or whether it is recycled water (e.g. treated waste water), sub-surface storage and blending with groundwater is an effective way to integrate and optimise the use of various water sources.

Integrated water resources management (IWRM) is defined in the NWRS as more than just the joint management of surface and groundwater. It is seen as the holistic management of natural resources within the context of sustainable and equitable social, economic and environmental principles. The NWRS defines IWRM as "*...a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".* In this context, artificial recharge schemes generally fare favourably when compared with other water development options. A good example is the way in which artificial recharge combines the aspects of both natural water treatment and storage. This is a common goal in many parts of the world where the soils or aquifer media are suitable for both these purposes.

In most cases, artificial recharge schemes are cheaper or more cost-effective than the development of new surface water schemes (Pyne, 1995). This is usually because either they can be implemented incrementally (in phases) as the demand increases, or the capital costs are less, not requiring the construction of new water treatment works and reservoirs, and frequently

being located near the point of use. Further, the environmental costs are usually favourable because the "foot print" on the landscape is relatively small compared with those of new surface water schemes.

The NWRS recognises that instituting IWRM is a complex and challenging process. In this regard, the Catchment Management Agencies (CMAs) will be tasked with, amongst other issues, ensuring that their water-related plans are consistent with the plans of all other role players in their particular catchments. This will require co-operation between all relevant institutions, organisations and individuals. Where groundwater resources (that have been artificially recharged) are accessible to a number of potential users who are located on or near the aquifer, such cooperation will be vital in order to prevent the misuse of the scheme.

At the local level, artificial recharge can be a significant tool in water conservation. Its advantages over dam development include smaller economic sizes and, in arid areas, significantly reduced evaporation losses and avoidance of the growth of blue-green algae that produce toxins. The concept of "wise use" and conservation is common to many internationally recognised goals. By creating an enabling environment for implementing artificial recharge schemes, South Africa is contributing to a number of international development goals and plans. Examples of these are:

Millennium Development Goals, which state among other goals that there should be environmental sustainability by 2015.

World Summit on Sustainable Development, Plan of Implementation, where it was agreed, among other issues, to develop IWRM plans by 2005 that would incorporate national/regional strategies, plans and programmes with regard to integrated river basin, watershed and groundwater management, and to introduce measures to improve the efficiency of water infrastructure to reduce losses and to increase recycling of water.

Southern African Vision for Water, Life and the Environment in the 21st Century, which strives towards, among other issues, a southern Africa where there is equitable and sustainable planning, use, development and management of water resources.