REPUBLIC OF KENYA

Ministry of Water and Irrigation

THE NATIONAL POLICY GROUNDWATER RESOURCES DEVELOPMENT AND MANAGEMENT

Draft Finale

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Executive Summary

Kenya experiences high levels of vulnerability and water insecurity due to rainfall variability and climate change. The present National Policy on Groundwater Development and Management (2013) has been developed within the mandate, vision and mission of the Ministry in charge of water affairs and constitutional and governance structure of the Government of Kenya. The formulation of the policy has been predicated by reforms that have been implemented in the last two decades and the urgency to streamline and resolve groundwater governance issues. The policy has also been aligned to other natural resources management policies. A number of issues addressed are: (a) availability and vulnerability of groundwater resources; (b) institutional arrangements for groundwater management, including groundwater management capacity and financing; (c) integrated water resources management; and (d) groundwater quality management.

Groundwater is increasingly being recognized as an important water source for both urban and rural areas. The policy will contribute to national framework for sustainable development and management of groundwater resources by protecting water quality by minimising the risks posed by poor governance and ignorance, conserving by regulating abstraction, promoting development for the public good, and maintaining a balance between sustainability and national development. It will inform and guide all stakeholders in the water sector on groundwater development and use in Kenya.

The policy principles have been derived from home-grown experiences, and international best practices on groundwater development and management. Covering political/institutional, social-cultural, economic, and ecological (environmental) imperatives, the principles shall guide decision making in groundwater development and management for national development.

The table below provides a summary of the issues, policy objectives and policy direction.

	Issue	**Policy Objective**	**Policy Direction**
1.	Limited understanding of groundwater resources and aquifer	To obtain sufficient scientific information to increase knowledge and	Put in place mechanisms to develop capacity and provide sufficient funding to sustain the investigation

	characteristics	understanding of aquifer characteristics	and exploration of aquifers in order to meet growing water demand.
2.	Lack of adequate monitoring and assessment of groundwater resources	To carry out continuous and timely data collection of specified water quantity and quality parameters of the various aquifers.	Field and laboratory tests, appropriate planning and monitoring tools are necessary for addressing aquifer-specific monitoring requirements.
3	Protection of groundwater from pollution	To enhance investment in groundwater monitoring of vulnerable aquifers, protection and rehabilitation of degraded aquifers	Appropriate planning and monitoring tools to address aquifer-specific monitoring requirements
4	Need for an integrated management of surface & groundwater using IWRM and River Basin management principles	To ensure a planned and coordinated approach in surface and groundwater plans and development including conservation of water for ecosystems maintenance.	Integration of groundwater and surface water (conjunctive) management including all aspects of planning to meet conservation and ecosystem water requirements as well as maintaining groundwater-dependent ecosystems
5	Integrated Land Use planning and sustainable groundwater resources	To ensure that all pollutant sources are monitored and determined in land use planning.	Evaluate the effects of all activities that may affect groundwater resources including mineral extraction, landfills, waste disposal, etc
6	Managed Groundwater Recharge	To develop MAR based on costs, security, quality of supply and environmental and social benefits and constraints	Aquifers are protected and managed in such a manner that their beneficial use and environmental values are maintained or enhanced over the long term.
7	Legal, Institutional and Policy Frameworks for Sustainable Management	To review the policy, legal and institutional frameworks and ensure that groundwater related natural resources are managed with a view to remedying groundwater degradation.	Review the policy, legal and institutional frameworks that exist in order to rectify any deficiency in law with respect to groundwater management and give guidelines on groundwater extraction and utilization

8	Institutions developed for surface water are weak and inappropriate for groundwater management	To decentralize/establish relevant institutions appropriate for groundwater management	Decentralise WRMA activities according to demarcated aquifer boundaries for effective groundwater management, a coordinating framework for cross-sectoral issues.
9	Research, Databases and Information sharing	To carry out survey and determine areas of groundwater research and development requirements that require prioritized attention	The ministry in charge of water shall introduce incentives for groundwater research and purchasing equipment for research and development.
10	National level Capacity Building Needs	To manage groundwater, at both the strategic and local levels.	In order to manage and monitor professional development of groundwater professionals, the ministry in charge of water shall introduce incentives for purchasing groundwater management equipment for the private sector.
11	Climate change	To increase and sustain resilience of vulnerable communities to climatic hazards through diversification of their livelihoods and coping mechanisms.	Disaster Risk Reduction and Management including Early Warning Systems (EWS), preparedness, institutional arrangements to mitigate against increase frequency of droughts.
12	Gender mainstreaming in all decision making organs and programmes	To institutionalise gender as a core value in all decision making organs and programme.	Women take up 30% of positions in WRUAs and other decision making committees i.e. appointments to Water Boards/Committees and to CAACS.
13	Importance of sustainable financing	To ensure sustainable financing for groundwater resources development and management	Modalities for sustainable financing are put in place.

The policy document is a live document that will be revised every three years in line with the dynamic changes associated with new technology in hydrogeology.

Acronyms

ASDS	Agricultural Sector Development Support
CBOs	Community based Organisations
CoPs	Codes of Practice
EMCA	Environmental Management and Coordination Act
GDEs	Groundwater-dependent Ecosystems
GCAs	Groundwater Conservation Areas
GIS	Geographical Information System
KFS	Kenya Forest Service
KWS	Kenya Wildlife Service
MAR	Managed Aquifer Recharge
MDG	Millennium Development Goals
MoWI	Ministry of Water and Irrigation
NEMA	national Environmental management Authority
NGOs	Non Governmental Organisations
NWRMS	National Water Resources Management Strategy
PES	Payment for Ecosystem Services
RO	Regional Office
SRO	Sub Regional Office
WASREB	Water Services Regulatory Board
WRUAs	Water Resources Users; Associations
WRMA	Water Resources management Authority
WSP	Water Services Provider
WSTF	Water Sector Trust Fund

Definitions

Demand management is "Any measure or initiative that will result in the reduction in the expected water usage or water demand" (WASREB 2009).

Groundwater is defined as water that infiltrates into the ground, collects or flows beneath the Earth's surface, filling the porous spaces in soil, sediment, and rocks and is the source of water for aquifers, springs, and wells. The upper surface of groundwater is the water table.

Groundwater Protection is a loose term applied to any measure (physical and legislative) that is designed to protect groundwater, groundwater abstraction points including springs, and associated social and natural environments.

Inclosed spring is a spring which is situated wholly within the boundaries of land owned by any one landholder, or which does not naturally discharge water into a watercourse abutting on, or extending beyond the boundaries of that land.

Hazard is the potential of an activity or pollutant from the past, the present or the future to cause environmental damage. A hazard assessment weighs the effects of an activity or pollutant, or the margin of safety for the environment by comparing concentrations causing toxic effects with estimates of exposure to the environment. Hazard evaluation determines whether an activity causes adverse effects on the environment. Hazard depends on the specific characteristics of the pollutant or pollutants.

Risk is a measure of the probability that damage to the environment will occur as a result of a given hazard. Risk assessment is qualitative and quantitative evaluation of a risk posed to the environment by the actual or potential presence of specific pollutants or activities. A risk-based approach calls for devoting resources to those areas that have been identified as having the highest potential for actual adverse effect on the environment. The risk of any activity is inevitably site-specific.

Vulnerability depends on intrinsic characteristics of a specific site, and includes consideration of physical, chemical and biological properties of soil and rock beneath

the site. These characteristics control the movement of a hazard towards the groundwater resource. Vulnerability analysis assesses parts of the environment that are susceptible to damage if hazardous materials are released.

CHAPTER 1: BACKGROUND AND RATIONALE

1.1 Introduction

The present National Policy on Groundwater development and management (2013) has been developed within the mandate, vision and mission of the Ministry in charge of water affairs in the Government of Kenya. It has taken in to account the constitutional and governance changes that have been implemented in the last two decades within the overall government structure and more specifically within the water sector, while at the same time anticipating innovative ways for which to use the water resources in an integrated and sustainable manner. The policy is structured to embrace developments in the transboundary water resources management and other ratified water-related legal instruments including the Nile River Basin Cooperative Framework.

The policy has been informed by the Constitution of Kenya (2010), Draft National Policy on Water Resources Management and Development, National Water Policy 2011 (NWP 2011), National Transboundary Water Policy (2013), the National Water Master Plan (2012) as well as the revisions in the sectors related to water including the Environmental Management and Coordination Act (EMCA (1999), Agricultural Sector Development Support (ASDS 2012), Forestry Act (2005) and Draft Forestry Policy, and Mining Bill (2012). Other reports and documents that have been reviewed for the present study included Draft National Water Master Plan, Water Supply Masterplan for Nairobi and Satellite Towns, Water Supply Masterplan for Mombasa and Coast Region, and other regulations touching on water resources management and development amongst many others. It is anticipated that the groundwater development and management policy will build on and extend the work done earlier by WRMA and other agencies and integrate new and emerging knowledge about groundwater management in Kenya and around the world.

1.2 Surface and groundwater resources availability

Kenya's water resources comprise surface waters (rivers, lakes, springs and wetlands) and groundwater. Based on geographical setting and geology, Kenya experiences high levels of vulnerability and water insecurity due to rainfall variability and climate change. Vulnerability is a result of the economy (agriculture, tourism, trade, and manufacturing) that is fully dependent on the water availability both in the right

quantity and quality in a timely manner where it is demanded most. Introduced institutional and legal frameworks have caused improvement of performance and service delivery in the last decade. The surface water resources that contribute more than 80 percent of water demand occur within the five water catchments, namely Lake Victoria Basin, Rift Valley, Tana River, Ewaso Ngiro North and Athi River catchments.

Ground water resources are dependent on the rock types and recharge conditions. Presently groundwater meets water supply for domestic, industries, irrigation as well as environmental needs. Wetlands for example regulate both recharge and discharge of groundwater, support habitats and provide other products and services. Groundwater-dependent ecosystems (GDEs) such as Mzima Springs, Njoro Kubwa, Lari Swamp in Limuru, the Kibwezi "groundwater forest" and Ondiri Swamp, and Kikuyu Springs are important sources of groundwater that provides for domestic use and environmental services.

Groundwater is increasingly being recognized as an important water source for both urban and rural areas. In the ASAL areas, it is often the dominant water source for livestock and humans. Recent developments in knowledge pointed to new groundwater resources that were previously not recognized to be important. At the present rate, use of groundwater is likely to increase food production and household income especially in the counties that are experiencing heightened irrigation expansion such as Nakuru, Laikipia and Kirinyaga; reduce water shortages in both urban and rural areas, reduce risk of crop failure in smallholder irrigated agriculture, increase the area of land in productive use especially in western Kenya. The MDG targets of hunger and poverty reduction shall be met through improved domestic water supply and increased employment due resulting from development of new groundwater sources. This also meets the disaster risk reduction strategy of developing a resilient community against climate variability and climate change.

1.3 Challenges facing water sector

Kenya faces enormous challenges in meeting human and ecological needs for water. The Kenya Vision aims at ensuring that improved water and sanitation are available for all by 2030 in spite of the present low service coverage; and so does the ambitious irrigation and drainage targets. Population growth, urbanisation and rising standards of living across the country has put water resources under increasing stress; while at the

same time catchment degradation and poor waste management continue to reduce freshwater availability. The water shortage in the future is expected to be more severe than the present due to increase of water demands.

Water resources in Kenya are irregularly distributed in both space and time. Surface water resources are heavily dependent on the seasonal rainfall variability, limited water storage and sustainable water catchment management. The water deficit of Athi Catchment, for example, like other catchments indicates that the catchment is facing tremendously severe water shortage and or stress as the large water demand is exceeding the renewable surface water resources. The situation within the remaining four catchments (Lake Victoria Basin, Rift Valley, Tana River, and Ewaso Ngiro North catchments) remains the same. Further uncertainty is imposed by climate change.

Surface water resources are becoming increasingly becoming scarce as the impact of climate change and catchment degradation begun to take effect. As a result the advantages of using groundwater have been recognised. The initiative to develop groundwater on a large scale, particularly for agricultural purposes, is largely taken by water users, not governments. It has been largely unregulated. With the growth of intensive groundwater abstraction has in most cases been largely unnoticed by governments. As groundwater use rises care must be taken to avoid permanent or long-term damage to aquifers. The Water Resources Management Authority (WRMA) is mandated to regulate and protect water resources quality and to manage and protect water catchments. This obligation is further supported by the National Water Resources Management Strategy (NWRMS). It therefore follows that pro-active groundwater resources management is needed, and this is the subject of this policy document.

1.4 Challenges facing development and management of groundwater

1.4.1 Invisible and often poorly understood

Groundwater is invisible and often poorly understood; its value is often underestimated. Due to this poor understanding groundwater resources is poorly planned, developed and conserved to the extent that there are already demonstrable instances of degradation of groundwater systems.

There are a number of sources of information on groundwater resources of Kenya, including: (i) the ministry in charge of water and irrigation and the Water Resources Management Authority databases that include hydrogeological reports and raw data on water quality and other parameters, (ii) research-based studies in journals, technical reports, and MSc./PhD studies, and (iii) internal reports for various government and non-governmental agencies that deal with investigation, exploration and exploitation of groundwater resources for public water supplies. Commissioned hydrogeological reports for site-specific on groundwater development also constitute a major source of groundwater information in Kenya. Information on groundwater is archived in the Ministry of Water and Irrigation as well as the Water Resources Management Authority databases (accessible at a cost), as well as in diverse, highly diffused and mostly difficult to access technical reports, journal publications and MSc./PhD theses (accessible freely in most cases). There is currently no strategy for sharing and dissemination of information on groundwater in Kenya.

A limited understanding has also meant that areas that have depended heavily on groundwater such as the Coastal strip, Lamu and Northern Kenya have lagged behind in their socio-economic development. The opposite is true where regions that were endowed with plenty of surface water have forged far ahead compared to others.

1.4.2 Groundwater Quality

Groundwater quality easily can be affected by pollution and remediation becomes very costly. The disposal of wastes (in landfills or pits), the discharge of effluent to the soil or seepage infiltrating from pit latrines or septic tanks, agro-chemicals from agriculture and effluents from industry as well as accelerated urban development with uncontrolled growth of informal and unplanned settlements may lead to the contamination of groundwater resources. Pollution has very long-term implications because the speed with which groundwater moves is slow (except in karstic and fractured aquifers) means that a pollutant plume in a groundwater body may take years to reach a borehole or spring with clean-up operations typically being expensive and in many cases virtually impossible. Once polluted, a groundwater resource typically takes considerably longer to return to its former quality than surface water.

1.4.3 Groundwater Monitoring

Very limited monitoring of water levels and water quality has meant that the impact of land and groundwater use on aquifer systems has often gone unnoticed. Groundwater monitoring is an essential element in the effective management of an aquifer, and commensurately more so in an aquifer that is vulnerable. There is relatively little information available describing the extent and significance of depletion in Kenya, though some cases of depletion have been identified. Monitoring must be considered the most important since WRMA has categorized aquifers as being strategic, major or special, each category representing its human or socio-economic importance to the country.

1.4.4 Limited existing capacity

It has been noted that there is limited existing capacity for groundwater development and management. Very few people have so far taken up groundwater science as a profession of choice, leading to inadequate technical capacity. The number of trained hydrogeologists, drillers, groundwater inspectors, etc in the public sector is in short supply. WRMA inherited the majority of its staff from the Ministry of Water and Irrigation (MoWI), many of whom joined WRMA on secondment. In spite of decentralization of services, the regional (RO) and sub-regional (SRO) office levels are not as effective as they ought to be due to institutional, human resource, technical capacity and finance limitations.

1.4.5 Stakeholders' Participation

Groundwater is managed as private enterprise rather than public utility. In this regards, it has experienced limited stakeholders' participation. Stakeholders' rights to equitable access to groundwater resources development is now enshrined in the present constitution, and cannot be ignored.

The capacity in the private sector regarding groundwater management which employs a number of hydro-geologists as consultants is also limited both in terms of numbers and capacity. Within the sector there is sometimes lack of professional integrity, transparency and accountability in the apportionment of water and the management of groundwater projects. Failure to enforce laws relating to allocation and groundwater use, and poorly-managed groundwater projects have been attributed to limited capacity in the groundwater sub sector.

Gender mainstreaming in water resource management is one of the key issues that need great attention. This is due to the fact that without deliberate efforts men and women will continue to have unequal access and control over water resources.

1.4.5 Policy and legislative frameworks

Surface water and groundwater resources development and management have been approached in the past within the same policy and legislative frameworks. However, aquifer boundaries do not necessarily follow surface water drainage boundaries. These results into two consequences, first, the water management has always emphasized surface water disproportionately.

In summary inadequate policies, strategies and legislation relating to groundwater resources and their management on one hand and/or the ineffective application of those policies, strategies or legislation on the other have hindered the growth of the sub sector.

While there may have been limited transparency in the operations of groundwater management, evidence of corruption in groundwater management processes, such as nepotism/favouritism in awards of water permits or construction contracts in groundwater projects are known to exist. Low-level and small-scale corruption at the water service provider (WSP) / water user interface has been reported also.

1.4.6 Financing for groundwater

Secondly, in terms of allocation of resources, the government funding for groundwater resources management has not matched, and indeed has traditionally fallen far below the level of funding for surface water development and management. The public financing for groundwater development and management has been limited compared to surface water. Individuals, private sector and civil society organization have played a large part in groundwater financing.

1.4.7 Transboundary aquifers

More that 50% of the water resources are transboundary and therefore are shared by two or more countries. The countries are obligated to cooperate in observing a shared vision aimed at reducing chances of conflicts over use of these resources. While the quantity and quality of surface water resources is relatively known, the amount and distribution of groundwater is less well understood. Finally, although Kenya has five transboundary aquifers, and the National Water Policy recognises that Kenya has shared water resources, no specific proposals for the management of shared groundwater resources are included in the previous policy objectives. This weakness covers surface water which there is no provisions for cooperative management with neighbouring countries either. More recently, in 2009, the Ministry formulated a draft policy paper on transboundary water resources. However the draft policy paper has not given particular prominence to shared groundwater resources, either.

CHAPTER 2: RATIONALE FOR A NATIONAL POLICY ON GROUNDWATER MANAGEMENT

2.1 Introduction

Improvements of technology and geological mapping have demonstrated that the potential of groundwater resources in Kenya is huge. According to the ongoing National Water Masterplan work, groundwater in Kenya is now thought to comprise almost 20% of the national freshwater source. This represents a nearly tenfold increase from the estimates made under the 1992 National Water Master Plan. It is estimated that less than 10% of Kenya's available groundwater resource is currently used. These new developments have meant that invisibility and pivotal role of groundwater to the socio-economic development is changing very fast.

Groundwater is particularly important because it occurs widely, even in the drier two-thirds of the country where there is little or no surface water. A significant proportion of the population, especially small villages and pastoral communities depends on groundwater for their domestic water needs because it is cheap to develop in small scale. Because of its widespread occurrence, basic domestic needs can be met cost-effectively from groundwater sources. The Government of Kenya must therefore address groundwater issues in order to equalize development of the devolved system according to the constitution. The role of this groundwater policy is to guide sustainable development and management of groundwater in the country in general and the counties specifically.

The national goal is to ensure sustainable utilization of national and trans-boundary groundwater resources for social economic development while taking in consideration social and environmental concerns thus promoting Kenya's green economy.

2.2 Purpose, Principles and Objectives

2.2.1 Purpose of this Policy

This policy is to contribute national framework to sustainable development and management of groundwater resources by protecting quality by minimising the risks

posed by poor governance and ignorance, conserving by regulating abstraction, promoting development for the public good, maintaining a balance between sustainability and national development and protecting groundwater

This policy is intended to inform and guide all stakeholders, especially the ministry in charge of water management, WRMA, NEMA and external audiences, including planning authorities and ministries responsible for planning and land use, developers, industry, and anyone with an interest in groundwater development and use in Kenya.

2.2.2 Policy Principles

These are political/institutional, social-cultural, economic, and ecological (environmental) principles that guide decision making in groundwater development and management. The summaries below highlight the key ones.

a) *Groundwater contributes to the sustainable development and socio-economic growth*;
b) *Sustainable groundwater development and management* - that activities shall be compatible with the long-term protection of water resources;
c) Development of groundwater resources should be based on rational and reasonable use;
d) *Dependent ecosystems and the quality of groundwater are preserved*;
e) *Groundwater is valuable and vulnerable;* and should be protected from pollution, over abstraction, and water quality deterioration;
f) *Groundwater and surface water are parts of a single resource and should be managed conjunctively*;
g) *Groundwater is better managed with cross-sectoral understanding and support* within the *Principle of Subsidiarity*;
h) *Proper land use planning is essential for groundwater protection*;
i) The Precautionary Principle;
j) User/polluter pays principle
k) *Water users and the general public require clear understanding/ awareness of groundwater development and management*;
l) Inter-generational equity as well as intra-generational equity;
m) Groundwater decisions must be informed by sound science and by taking a long-term view;
n) *Partnership with both the public and private sectors is essential;*
o) *Stakeholders' participation is necessary to ensure sustainability;*

p) *Gender equity in the development and management of groundwater*.

2.2.3 Policy Objectives

The National Policy on Kenya's groundwater resources provides long-term direction by increasing visibility and contribution of groundwater resources to the economy, providing a common framework to conserve and utilize groundwater resources equitably by balancing sustainable use and national development and protect groundwater quality by minimising the risks posed by pollution.

The specific objectives of the National Groundwater Policy are:

a) To ensure that groundwater is developed and managed in a sustainable manner;
b) To review and establish appropriate legal, environmental and regulatory frameworks for sustainable development and management of groundwater resources;
c) To provide a national basis for decisions making in relation to groundwater resources;
d) To monitor groundwater quality and quantity to assist identification of vulnerable aquifers, groundwater protection and restoration of degraded groundwater resources;
e) To develop mitigation measures on the impact of climate change;
f) To improve cooperation and enhance coordinating amongst the groundwater-related sectors and stakeholders;
g) To promote research and information sharing on groundwater quality and compatible environmental systems.

CHAPTER 3: GROUNDWATER DEVELOPMENT AND MANAGEMENT

3.1 Investigation, Exploration and Monitoring of Groundwater

Understanding aquifer characteristics and quality of groundwater involves investigation, exploration, and monitoring. Numerous groundwater systems in Kenya are less known. Groundwater investigation in the past has essentially been carried out at site-specific (or micro-level) scale and targets shallow to medium depth (<300m) aquifers for potable, irrigation, and industrial water supplies. Potentially high yielding deep aquifers can be found in the sedimentary basins within the rift and the coastal areas of the country, but these have only just begun to be investigated in the Turkana region using a combination of traditional hydrogeological methods and costly but highly effective state-of-the-art technologies.

The current groundwater resource estimates are beleaguered by high uncertainty levels due to lack of adequate data, and only the small Baricho aquifer has been adequately characterised. Groundwater development has therefore proceeded without an adequate scientific understanding of many of the parameters that relate to the groundwater resources, including the water balances, quality, quantity, and recharge amounts. In such a scenario, there can be no rational manner in which to allocate or sustainably utilise the groundwater resources.

The current paradigm of groundwater exploration is based on a geophysical approach, where most boreholes are sited on anomalies identified from magnetic or electromagnetic traverses, often with little or no consideration of the geological and structural complexity of the target area. In many areas of complex hydrogeology this technique has proved to be unsuccessful for a variety of reasons.

Without proper management and monitoring, it is difficult to determine whether groundwater resources are being or have been impacted by human activities. It is only recently that WRMA initiated a groundwater monitoring network in the country that targets important aquifers. However, the parameters being monitored are in many cases inadequate to inform interventions and management. The majority of boreholes used for measurement of water levels are production boreholes and require water levels to return to static levels prior to the measurements, while the water quality parameters that are measured are also restricted in scope and do not adequately address the specific

needs of a proper and functional groundwater monitoring network. In addition, information flow is characterized by data gaps due to weak monitoring systems and an inadequate user database.

There is insufficient scientific data on the characteristics of most of Kenya's known aquifers. Indeed, only one aquifer (Baricho aquifer) is sufficiently well characterised to be able to inform sustainable management of the resource. All other aquifers are being exploited without adequate knowledge of their characteristics, behaviour and sustainability under current and future projected uses.

Policy Objective is to obtain sufficient scientific information to increase knowledge and understanding of aquifer characteristics in order to inform and guide on their sustainable use.

Policy Direction 1: Put in place mechanisms to develop capacity and provide sufficient funding to sustain the investigation and exploration of Kenya's aquifers in order to meet growing demand.

There are planned activities that involve investigation, exploration, and development and monitoring to improve the understanding of the occurrence of groundwater and the factors affecting permeability in complex terrains, and so lead to appropriate exploration planning**.**

In so doing carry out

a) Hydrogeological mapping of shallow to deep aquifers;
b) Estimation of groundwater reserves;
c) Determination of macro- and micro-scale aquifer geometry and hydrogeological parameters;
d) Determining surface-groundwater interlinkages;
e) Describing ecosystems dependent on groundwater and environmental flows; natural and artificial groundwater recharge estimation;
f) Delineation of recharge and discharge zones;
g) Determining the vulnerability of aquifers to pollution;
h) Determine management and water quality protection requirements;

i) Carry out water balance and modeling studies of aquifer parameters to improve site investigation, risk assessment and restoration techniques; and
j) Determine the likely impact of climate change on resource availability.

Other activities that will support robust, science-based information for the sustainable utilisation and management of groundwater include:

a) Establishment of an open-access database for scientific data on groundwater;
b) Investment in state-of-the-art tools and equipment;
c) Development and establish partnerships with various stakeholder agencies to carry out collaborative assessments; and
d) Capacity building of expert personnel to carry out world class hydrogeological investigations.

Activities that improve understanding of the occurrence of groundwater include:

- Carry out and sustain the necessary field and laboratory tests, appropriate planning and monitoring tools to address aquifer-specific monitoring requirements, skilled/ technical personnel and funding for equipment must be defined and acquired.
- Creating an adequate understanding of the occurrence of groundwater and the factors affecting permeability in complex terrains, leading to appropriate exploration planning;
- Provide training in the siting of boreholes on geophysical anomalies using appropriate geophysical methods and with a clear conceptual understanding of the geological framework and how it affects the geophysical response,
- Prepare a manual for ensuring that test pumping is carried out and interpreted properly; and
- Procure for the public sector appropriate drilling tools and equipment, particularly for deep aquifers.

Activities to be carried out include:

- Improving the understanding of regional and long-term groundwater quality and quantity which will allow for optimal management of groundwater resources;

- Identification and mitigation of possible human impacts;
- Identification and monitoring of major pollutant sources (which could be area specific), including their locations and the movement of pollutants in the aquifers;
- Determination of compliance with regulations and standards;
- Assessment of the effectiveness of pollution control measures, such as groundwater protection zones;
- Determination of the quality of groundwater, as a source of drinking water, for industry, or for irrigation purposes;
- Development of the understanding of recharge areas (zones), recharge mechanisms and recharge rates; and
- Development of an understanding of the hydraulic properties of aquifer.

3.2 Water quality monitoring

The importance of groundwater as a reliable source of clean water cannot be overemphasized; many towns and rural areas rely overwhelmingly on groundwater supplies and in many cases solely, particularly in semi-arid areas. Natural groundwater contaminants such as fluoride in the Kenya rift and nitrates in sedimentary aquifers in northeastern Kenya, as well as natural and anthropogenic heavy metal and microbiological contamination are common problems that affect groundwater quality in various parts of the country. Falling groundwater levels have also led to increased pumping costs and to increased competition for this common pool resource, with consequences such as boreholes running dry, lateral movement of poor quality water, salt water intrusion in the coastal zone, and increased mineral content.

The National Water Policy deals with water quality issues and states that pollution of surface and groundwater resources has become a major problem due to human activities; however, all the solutions proposed relate to surface water. They include strict stream effluent discharge standards, a process of water quality monitoring (which could extend to groundwater) and prior authorisation of discharge of undesirable substances in the water system. There is no express mention of groundwater.

Lack of adequate monitoring and assessment of groundwater resources has resulted in uncertainty on whether or not water being consumed is safe, and has also resulted in poor attention being paid to groundwater planning at all levels. This is particularly

serious for drought-risk management in which groundwater resources should play a critical role. Proper groundwater level monitoring has largely not been instituted in the various aquifers, and where monitoring wells exist, they are largely using production wells, which is poor practice. Water quality monitoring is ongoing for some aquifers, but is largely insufficient in terms of type and frequency of parameters measured. Monitoring is also hindered by lack of adequate field and laboratory equipment, lack of funds to travel to the field to carry out sampling, as well as shortage of field and laboratory personnel.

There are three types of monitoring, namely, (a) baseline monitoring (or proactive monitoring) (b) trend monitoring (or reactive monitoring(c) project-specific monitoring Given the largely uncontrolled growth in large-scale groundwater development, monitoring water quality is an important aspect of WRMA's mandate to manage water resources. And indeed it is important to maintain the quality of groundwater to avoid undue (a) harm to human health and animal either by chemical or bacteriological agents; (b) harm to aquatic ecosystems or groundwater-dependant terrestrial ecosystems; (c) damage to property, including the value of land; (d) impairment or interference with amenity or other legitimate uses of the environment. Different land uses and activities present a range of possible impacts, both in terms of quantity and quality of groundwater resources.

Policy Objective for baseline monitoring is to carry out continuous and timely data collection of specified water quantity and quality parameters of the various aquifers.

Policy Direction 2: Put in place appropriate planning and monitoring tools to address aquifer-specific monitoring requirements, skilled/technical personnel, and funding for equipment must be defined and acquired.

Activities to be carried out for baseline monitoring include:

- Carry out continuous data collection of specified water quantity and quality parameters.

- Improving the understanding of regional and long-term groundwater quality and quantity which will allow for optimal management of groundwater resources;
- Identification and mitigation of possible human impacts;
- Identification and monitoring of major pollutant sources, pathways, and the movement of pollutants in the aquifers;
- Determination of compliance with regulations and standards;
- Assessment of the effectiveness of pollution control measures, such as groundwater protection zones;
- Determination of the quality of groundwater, as a source of drinking water, for industry, or for irrigation purposes;
- Development of the understanding of recharge areas (zones), recharge mechanisms and recharge rates; and
- Development of an understanding of the hydraulic properties of aquifers.

Policy Objective for trend monitoring is to enhance access to reliable and safe water supplies for multiple uses and ecosystems maintenance.

Policy Direction 3: Enhancement of investment in groundwater monitoring of vulnerable aquifers, protection and rehabilitation of degraded aquifers will be enhanced.

Activities to be carried out for monitoring for pollution control include:

- Increase monitoring frequency and appropriate density of monitoring points are increased to optimum levels.
- Identify groundwater bodies supplying water to the public and will designate resource protection areas to safeguard against pollution.
- Establish dedicated water level monitoring, especially for heavily utilised aquifers;
- Monitor an aquifer specific basin.
- Identify and work towards reversing pollution in groundwater resources using best available technologies that are not disproportionately expensive.
- Report groundwater quality status in the NWRMS or annual report to the public.

Activities to be carried out Aquifer vulnerability and risk

Modern approaches to the assessment of groundwater vulnerability typically assess the following variables involve: –

- Monitor and re-assess periodically and establish Resource-directed measures (RDM) as a component part of the NWRMS in the classification of groundwater resources.
- Apply the DRASTIC model to classify aquifers in terms of their general vulnerability to pollution
  i. **D**epth of the aquifer below ground level;
  ii. **R**echarge to the aquifer;
  iii. **A**quifer media;
  iv. **S**oil characteristics;
  v. **T**opography (slope);
  vi. **I**mpact of the vadose (unsaturated) zone; and
  vii. **C**onductivity (hydraulic conductivity) of the aquifer material

- Define and quantify the Reserve for each groundwater body;
- Identify groundwater bodies which are at risk of over-abstraction or water quality deterioration;
- Produce a groundwater vulnerability map of Kenya, with greater detail as and where required;
- Identify groundwater bodies which have been subject to significant pollution;
- Improve the classification scheme for Kenya's groundwater resources;
- Develop a robust and representative monitoring network for groundwater quantity and quality in order to monitor the status of groundwater resources in the Republic.
- Develop a coherent and comprehensive overview of the status of groundwater quantity and quality in Kenya.

Activities to be carried out include participation of water users and the general public regarding groundwater protection is a prerequisite for prudent management:

- Addressing groundwater protection in the context of sustainable development, taking into account social, economic, and environmental factors where appropriate.

- Raising the level of understanding, starting with vulnerable aquifers based on Resource Quality Objectives (RQOs) for groundwater characteristics;
- Preventing over-abstraction or pollution through pro-active measures (protection) rather than retro-active measures (remediation).
- Protecting groundwater by using non-regulatory tools to protect groundwater
- Promoting the restoration of damaged groundwater resources in Kenya.

3.3 Integrated Management of Surface & Groundwater

As the demand for groundwater grows and the more obvious aquifers and target features become increasingly exploited, it can be expected that further development will have to consider alternative targets in what today are considered problematic and complex geological environments. Significant savings in exploration and especially drilling costs can be realised if success rates could be improved. To improve the borehole success rate in these terrains, and to develop groundwater resources in a sustainable manner, a multi-disciplinary approach is needed. This approach must incorporate:

- An understanding of the structural geology and its influence on the occurrence of groundwater so that target features can be identified;
- Identification of appropriate methods, state-of-the-art technologies, and interpretative techniques to delineate target features in the field; and
- Use of simple yet effective groundwater resource evaluation methods.
- Establishment of a database for scientific data on groundwater;
- Investment in state-of-the-art tools and equipment for drilling; and
- Capacity building of expert personnel.

At present there is a gap separating surface water and groundwater practitioners despite both groups working within the hydrological cycle. This silo approach to water planning creates real problems for integrated water resources management (IWRM) as there is little practical recognition that changing the water balance of one component inevitably changes the water balance of the other. Similar failures to interact between the groundwater sector and non-water actors extends to land use planners who fail to recognise that some land uses will either accelerate groundwater exploitation or reduce groundwater recharge; the latter by creating large areas of impermeable or paved surfaces. Additionally there is a growing recognition that diffuse pollution of

groundwater by fertilizer nitrogen and pesticides from farmlands constitutes an intractable problem for long-term groundwater management.

The importance of maintaining water for ecosystem services has been recognised both in the context of the nation's five water towers but also in maintaining forest and recreational value of ecosystems. Groundwater as such is not explicitly recognised as a key ecosystem component while it is often the principal component as for Amboseli National Reserve that owes its existence to the presence of springs fed from Kilimanjaor's melting snows and mid-elevation rainfall; ditto the Kibwezi Groundwater Forest, which relies on the Chyulu Hills aquifer system. Baseflow to rivers is a vital part of maintaining the Reserve as well as meeting basic human needs for drawers of water. Wetlands, important for their great biodiversity, frequently exist as points of groundwater recharge or discharge.

Groundwater is a valuable integral component of Kenya's water resources and it is significance as a potentially important source of potable and irrigation waters. This is the case particularly in arid and semi-arid lands (ASALs) and also in major urban centres such as Nairobi and Mombasa where the role of groundwater in public water supply. While it is common to understand the conjunctive nature of surface and groundwater particularly in augmenting water supplies, it inadequately appreciated in water conservation and management. Whenever surface water abstraction application is made, the implications for groundwater recharge are not factored in the decision to award a permit or reject it. At a practical level there is very limited recognition that surface or groundwater resources may be affected by abstraction from one or the other. Indeed, far from developing a joint policy, each of the sectors (land, water, and forests) has developed its own policy.

The policy objective is to ensure a planned and coordinated approach in surface and groundwater planning and development including conservation of water for ecosystems maintenance.

Policy Direction 4: There will be integration of groundwater and surface water management including all aspects of planning to meet conservation and ecosystem water requirements as well as maintaining groundwater-dependent ecosystems.

Activities conjunctive management of groundwater with surface water particularly in augmenting water supplies to be carried out includes:

a) Establish a National Standing Committee to deal with cross-sectoral issues especially on land, water and forests.
b) Representatives from all main water and related sector actors under the guidance of the Ministry in charge of water affairs will
c) Specifically address rights of access to groundwater;
d) Carry out groundwater allocation mechanisms; and
e) Establish rational water resources management.

3.5 Integrated Land Use planning and sustainable groundwater resources

Groundwater use and protection is affected to a great extent by land use and land use change. Kenya does not have a national land use policy at present, but the law provides for the formation of regional and local physical development plans, which in effect provide the framework for land use planning in areas where these have been formulated. However, there is in place a land policy, which is a precursor to the formulation of a national land use policy.

A number of the land policy objectives are pertinent to groundwater management, particularly in areas of institutional frameworks. It identifies as key institutional weaknesses the absence of a coordinating framework for cross-sectoral issues, the lack of effective land use planning and limited management and technical skills for natural resources management. It calls for putting in place the necessary mechanisms for effective coordination across sectors. Notably, however, no concrete steps have been taken to put in place such coordinating mechanisms, and therefore the policy statements remain mere aspirations (see Annex 1 on National Land Policy).

Notwithstanding the recognition of the need for coordinated management of land-based resources, no action has been taken to achieve the policy objective. Land based resources are still managed on a sector specific basis. This undermines the sustainable management of groundwater resources.

There are land use categories that physically disturb aquifers, increase or lower groundwater levels or impede, intercept or divert groundwater flow. For these land use

types, WRMA: (a) may object to any proposal for mineral extraction that will harm water resources (including groundwater resources) unless measures are to be taken to mitigate harm; (b) may object to any proposal that is likely to increase or lower groundwater levels or impede, intercept or divert groundwater flow unless measures are to be taken to mitigate these affects; (c) will encourage best practice in the abandonment of any borehole, well, mine, shaft or tunnel in order to prevent pollution to or loss of groundwater resources.

The discharge of wastes to deep strata is little practiced in Kenya, though there are a number of industries that do undertake such practices. The WRMA has limited legal powers to influence deep waste injection activities, this being the responsibility of NEMA. Diffuse pollution occurs over space and time and is not attributed to point discharges or activities. Diffuse pollution includes the following: –

- Deposition of atmospheric pollutants on land;
- Leaching of fertilisers or pesticides from fields into underlying groundwater resources; and
- The combined effect of poor pollutant management across an entire catchment (e.g. farm animal and chemical wastes, industrial solvents).

Liquid or slurry wastes may be disposed of by spreading them over land. In many cases, as with some agricultural wastes, land spreading can be beneficial; however, in some circumstances such practices constitute a potential threat to groundwater resources.

Policy Objective is to ensure that all pollutant sources are monitored and determined in land use planning.

Policy Direction `6: Evaluate the effects of all activities that may affect groundwater resources including mineral extraction, landfills, waste disposal, etc.

Land use activities to be observed include:

- Ensure that all groundwater abstraction are regulated by permits;

- Put in place operational measures to mitigate and correct adverse impacts of mining, deep drilling, quarrying, deeply-founded buildings, roads, railways, cuttings and tunnels gravel and sand extraction amongst many other activities;
- Ensure there are guidelines for establishment of landfills locating in low permeability materials;
- Assess field drainage that may intercept and divert recharge to groundwater resources; and
- Promote measures for the minimisation or remediation of diffuse pollution in groundwater resources;
- Waste disposal to land especially sanitary landfills for the disposal of waste.

3.6 Managed Groundwater Recharge

Land use changes in groundwater recharge zones, escalating groundwater abstraction in many parts of the country, and changes in precipitation patterns and amounts as a result of climate change, raise serious questions about the long-term sustainability of groundwater resources as sources of public water supply. Reliable estimates of groundwater recharge are needed for a number of reasons, including:

- Quantification of groundwater resources at micro- and macro-scale;
- Issuance of abstraction licenses;
- Assessments of groundwater contributions to rivers (baseflow) and to sensitive wetland habitats, and hence for the protection of these resources;
- Assessment of groundwater vulnerability (high recharge implies high vulnerability);
- Delineation of groundwater recharge protection areas;
- Identification of the implications of changes in land use and/or climate on the groundwater resources;
- Describing possible conjunctive uses; and
- Identification of areas suitable for artificial groundwater recharge.

Managed aquifers have not been adopted as a management strategy for groundwater resources in Kenya. Recharged water may be sourced from rainwater, stormwater, reclaimed water, mains water or other aquifers. Opportunities in other cities and in regional areas await assessment. Substantial opportunities for Managed Aquifer Recharge (MAR) are expected, but not yet assessed, in urban and coastal catchments where stormwater and water recycling have not been considered.

Policy Objective is to develop MAR based on costs, security, quality of supply and environmental and social benefits and constraints.

Policy Direction 7: Aquifers are protected and managed in such a manner that their beneficial use and environmental value are maintained or enhanced over the long term.

Activities to be carried out include:

a) Consultancy on the characterization of aquifers and types or recharge;
b) Identification of groundwater conservation zones.
c) Identifying potential sites and aquifers for managed aquifer recharge (MAR)
d) Mapping strategic aquifers and conjunctive water uses;
e) Preparing project designs for aquifer exploitation;
f) Harvesting aquifers to increase supply from groundwater; and
g) Identifying Groundwater Conservation Areas (GCAs).
h) Determine the impact of siltation, run-off, the water balance and groundwater recharge.

3.7 Legal, Institutional and Policy Frameworks for Sustainable Management

The tradition legal position regarding the management of groundwater has been centred on the idea that groundwater is a "private" resource. In a legal regime which reveres private ownership of land, the assumption has been that private ownership of land gives the landowner an absolute right to the water beneath it. Legislation has to some extent eroded this absolute right by vesting ownership of all water resources in the state. This notwithstanding due to weaknesses in the legal and institutional framework the use and management of groundwater is still largely vested in the landowner.

Kenya does not have policy, legislation and institutions dedicated specifically to the management of its groundwater. Rather, groundwater management is subsumed under broader policy, legal and institutional frameworks dealing with the management of water resources, or more broadly, natural resources, and with land use and physical planning. Currently therefore policy and legislation relating to groundwater

management are gleaned to the extent possible from policy statements on water resources, natural resources or land use planning.

Surface and groundwater resources are unevenly distributed both in space and time, due to rainfall variability and diverse climatic and geographical conditions. As a result the flow regimes of rivers and streams as well as groundwater vary considerably. Groundwater resources also are vulnerable to human and land use activities, and as human activities intensify particularly in water catchment areas, the threat of water quality deterioration, loss of areas under forest and reduced runoff, increased siltation, changes in the water balance and groundwater recharge are inevitable. The runoff data show diminution of rivers discharges and decreasing water levels in boreholes in Njoro, Nakuru and other catchments that have witnessed wanton destruction of land cover.

Policy objective is to review the policy, legal and institutional frameworks and ensure that groundwater related natural resources are managed with a view to remedying groundwater degradation.

Policy Direction 8: Ministry will review the policy, legal and institutional frameworks that exist in order to rectify any deficiency in law with respect to groundwater management and give guidelines on groundwater extraction and utilization.

Activities to be carried out include:

a) Establish appropriate policy and regulatory framework at the aquifer level manage groundwater at the level of individual aquifers;
b) Strengthening specific aspects of the 2007 WRM Act and regulations;
c) Nominate representatives from all main water and related sector actors under the guidance of the Ministry in charge of water affairs;
d) Registration and regulation of contractors (groundwater drillers) and groundwater consultants among others
e) Institute standards and good practice in groundwater management
f) Formulate a joint policy on land, water and forests.
a) WRMA to decentralize regulation and management functions;
b) Ensure local participation by both groundwater users and other stakeholders.

3.8 Groundwater institutions

On institutional frameworks, the review identified the problems existing in water WRMA to include (a) over-centralised decision making processes, inappropriate and run-down monitoring network, (b) inadequate database, (c) discontinuous assessment programmes, (d) uncoordinated source development, (e) non-operative water rights, (f) absence of special courts to arbitrate on water use conflicts and a generally weak institutional set up.

Information flow in the Ministry is characterised by data gaps due to discontinuous water resource assessment programmes, weak monitoring systems and an inadequate user database. WRMA has the lead role in protecting groundwater; it shares this responsibility with other organisations. The Authority must work to promote closer with other organisations. Currently WRMA has no coordinating framework for cross-sectoral issues, lacks effective land use planning and has limited management and technical skills for natural resources management.

The groundwater sector remains the neglected sibling in the hydrology/hydrogeology sisterhood, both in terms of resource allocation and of public understanding. Groundwater is typically considered a common pool resource by its users, and in the absence of a rational management regime is open to abuse by individuals or groups pursuing their own interests that are not necessarily of long-term. This is very much the case for a number of the more heavily exploited aquifers in Kenya. Institutions that have been developed for surface water management are weak and inappropriate for groundwater management

Policy Objective is to decentralize/establish relevant institutions appropriate for groundwater management

Policy Direction 9: Decentralise WRMA activities according to demarcated aquifer boundaries for effective groundwater management, a coordinating framework for cross-sectoral issues.

Activities to be carried out include:

a) increase the number of the sub-regional offices for effectiveness, to capacitate the present organization of WRMA;

b) set up mechanisms for the continuous assessment of water resources, which includes strengthening the institutional capacity of the agencies responsible for the collection, storage and analysis of water resources data
c) establish or upgrade a fully-fledged hydrological, hydrogeological, water quality, water permit and socio-economic database
d) Coordinate data collection from other organizations such as local authorities (land use planning) and NEMA (environmental data and records);
e) Establish the fast track regulation of water rights.

3.9 Research, Databases and Information sharing

The uncertainty over the future of intensive groundwater use is aggravated by the lack of knowledge about groundwater and the common perception that because it is a common pool resource it faces unique and possibly insuperable management challenges. Groundwater has enormous potential to mitigate the looming global water crisis, given appropriate management and a better understanding of its costs, benefits and limitations on the part of water users, regulators, the private sector and the political cadre1. Appropriate groundwater use will also do much to mitigate the impacts of climate change, and underlies the cross-sectoral nature of groundwater resources management.

Challenges and key issues in groundwater research and information sharing are identified as:

a) No clear policy of data management in water sector,
b) Ineffective inter-ministerial cooperation,
c) Overlapping responsibilities between WRMA and MWI in managing groundwater database,
d) Ineffective management of water-related database among WRMA headquarters and its regional offices,
e) Scattered database among different organizations, and
f) Inefficient use of Geographical Information System (GIS) in WRMA

The groundwater section in the MWI is still updating their database related to groundwater data. The GIS and Cartographic Centre in MWI, including the GIS software and hardware, was lost except for some PCs that still using GIS with limited functionality.

Policy Objective is to carry out survey and determine areas of groundwater development and management in Kenya that require prioritized attention.

Policy Direction 10: The Ministry will promote information, demand-driven research and establishment of data sharing protocols.

Activities to be carried out include:

a) Carry out a survey to determine capacity needs in groundwater development and management.
b) Establish establishment of research networks, institutional partnerships to interact and ensure that groundwater management receives the best share of attention.
c) Establish National Groundwater Research and Education Foundation;
d) Establish data sharing protocols.

3.10 National and local level Capacity Needs

There is need to manage groundwater, at both the strategic (national water security) and local (aquifer management) levels. There are two types of needs, namely technical and day-to-day regulatory functions.

Kenya has approximately 45 registered hydrogeologists, of whom all but seven were based in Nairobi; this reflects market factors and not groundwater resources distribution across the country as the majority of companies, NGOs, development partners and Government departments are headquartered in Nairobi. This does not take account of hydrogeologists in public service, who are deemed to be registered. The public sector hydrogeologists prepare Hydrogeological Assessment Reports as do those in the private sector, but are neither registered nor regulated by the Ministry, which regulates private sector hydrogeologists. Private sector water resources professionals are registered by the Ministry of Water and Irrigation. Most are members of the Geological Society of Kenya and are registered as geologists by the Geologists Registration Board.

There are 154 drilling contractors registered by the Ministry; the majority is based in Nairobi. All but 25 of these contractors are considered by the Ministry to be capable of

constructing boreholes greater than 150 m. deep. The capacity of technical staff within the public water sector is not as developed as is desirable, and insufficient groundwater staff are available to meet aquifer management needs within the WRMA. However, within the sector itself there are doubts as to the capacity of some of these drilling contractors, often considered "briefcase" contractors. It is not certain that all of these contractors actually possess a drilling rig. The quality of drilling works has fallen dramatically in the past decade or so.

The private sector plays a key role in borehole drilling. Others are qualified water resource professionals, i.e. geologists/hydrogeologists, engineers and so on. They are regulated under Part XIII of the Rules. These require that qualified water professionals and contractors be licensed by the Ministry. The Ministry is required to introduce Codes of Practice for compliance by the professionals and the contractors, but to date this has not been done.

The Ministry therefore acts as the regulator of the professionals and contractors. The Ministry as the regulator undermines WRMA's authority and ability to impose its requirements on these contractors. Thus WRMA is left with the option of reporting the matter to the Ministry to take no action. Indeed, there is no recorded instance since the commencement of the Water Act, 2002 in which the Ministry has taken disciplinary action against a drilling contractor for drilling a borehole without an authorisation.

The nature of training of hydrogeologists and hydrologists in Kenya and the shape of career paths in the public and private sectors accentuates differences between these two disciplines, rather than encouraging their working together. This has led to the perception among both private and public sector hydrogeologists that groundwater is separate from surface water.

These capacity shortfalls affect all actors including WRUAs, WRMA and the private sector. Human resources (skills and experience in groundwater management) are currently limited in the country. WRMA inherited the majority of its staff from the ministry in charge of water, many of whom joined WRMA on secondment. There is limited groundwater management capacity in the private sector, which employs a number of hydro-geologists as consultants. WRMA is in place at the regional (RO) and sub-regional (SRO) office levels, but is not as effective as it might be due to institutional, human resource, technical capacity and finance limitations.

The catchment area management strategy provides mechanisms and facilities for enabling the public and communities to participate in managing water resources within each catchment area. WRUAs registered as a society to promote public participation, conflict mitigation, gender mainstreaming and environmental sustainability. A number of WRUAs have proved to be effective in resolving water use conflicts, particularly in those catchments which are prone to water use conflicts. However, WRUAs are voluntary associations and therefore they are not uniformly spread across the country. Groundwater management WRUAs are rare. Additionally, the general public may participate in water resources management decisions, particularly as regards water use (i.e. abstraction etc) by lodging objections and comments when an application for a water use is made. These mechanisms enable the pubic generally and interested stakeholders, particularly the WRUAs to be involved in decision making.

The key weakness of these mechanisms is that WRUAs depend on pro-activity by members of the public, and have tended to be used largely by professional persons rather than members of the public *per se*. Registers of WRUAs are in many cases not established, notwithstanding the clear legal provisions. The WRUAs that have been set up tend to deal with conflicts and management of surface water rather than groundwater resources, and mainly in those areas that are prone to water use conflict.

Policy Objective is to manage groundwater, at both the strategic and local levels.

Policy Direction 11: In order to manage and monitor professional development of groundwater professionals, the ministry in charge of water shall introduce incentives for purchasing groundwater management equipment for the private sector.

Activities to be carried out include:

a) WRMA, which issues permits and monitors the activities of the professionals and contractors, should regulate the professionals.
b) Introduce a bill in Parliament to streamline training, registration and activities of groundwater professionals.
c) WRUAs should be trained on groundwater management and conflict resolution.

d) Establish an e-network of drillers and groundwater equipment manufacturing firms.
e) Procure technical equipment and logistic support
f) Improve the ability of staff to generate aquifer models are constrained more by lack of data and operating platforms.
g) Establish a dedicated research function.
h) Improve the rigour of the registration process to eliminate quacks in the profession.

3.10 Cross Cutting Issues

3.10.1 Policy on Climate Change and Climate Variability

The increase of the surface air temperature will raise the potential evapotranspiration. The western part of Kenya is expected to be more wetted, while the eastern part is anticipated to be drier due to increase of potential evapotranspiration. From the seasonal view, more water resources are expected in the rainy seasons and most of the country will be drier in the long dry season (June - August). The renewable water resources are more unevenly distributed in terms of spatial and temporal viewpoints in the future. Disaster Management and Risk Reduction Unit and Flood Management Unit have been established in MWI and WRMA, respectively.

The policy does not make any reference to the impacts of climate change on groundwater and opportunities for adaptation. This could be explained by the fact that the issue of climate change had not, at the time the policy was formulated, become a key national policy issue. More recently a strategy on climate change has been formulated. The National Climate Change Response Strategy (GoK 2010) proposes that the environmental act should be reviewed in light of the need for response to climate change. The climate change response strategy in respect of water resources apparently does not deal with issues of groundwater management adequately.

If Kenya is to meet the challenges of climate change then it must fully embrace the conjunctive use of water resources, by

- Increasing the volume of water stored in reservoirs (wet season water and flood flows captured for year-round use).

- Increasing the use of groundwaters in dry seasons and during droughts, making use of the inter-seasonal buffering capacity that aquifers offer.
- Study and then implement managed aquifer recharge (MAR) schemes that complement conjunctive use.

The Policy objective is to increase and sustain resilience of vulnerable communities to climatic hazards through diversification of their livelihoods and coping mechanisms. It also will aim at alleviating suffering by providing timely and appropriate response mechanisms for disaster victims.

Policy Direction 12: Disaster Risk Reduction and Management including Early Warning Systems (EWS), preparedness, institutional arrangements to mitigate against increase frequency of droughts.

Activities to be carried out include:

a) Harmonise sectoral approaches for drought mitigation.
b) Strengthen the linkages between groundwater resources and climate change.
c) Build stock capacity for drought preparedness.
d) Establish explicit plan for groundwater restriction during droughts.

3.10.2 Gender mainstreaming

The Government has a gender mainstreaming policy which requires that women take up 30% of positions. Further WRUAs are supposed to demonstrate that they have provided opportunities for women to participate. The Water Act also provides that, in making, the Minister shall take account of the need for gender equity. In practice this has not been complied with, although there is a positive trend towards providing opportunities for women in decision making in water resources management issues.

Policy Objective is to institutionalise gender as a core value in all decision making organs and programme.

Policy Direction 13: Women take up 30% of positions in WRUAs and other decision making committees i.e. appointments to Water Boards/Committees and to CAACS.

Activities to be carried out include:

a) Increase public awareness on gender issues.
b) Carry out a baseline survey on gender aspects;
c) Develop and disseminate gender mainstreaming guidelines; and
d) Mainstream gender in all policies, plans and projects on groundwater.

CHAPTER 4 FINANCING MECHANISMS AND THE DEVOLVED GOVERNMENT

4.1 Sustainable Financing

The importance of sustainable financing for water resources management is critical for the water sector. Expenditure for the recurrent costs of water resources management has been derived primarily from three sources; the exchequer provides funds through budgetary allocations to the Ministry responsible for Water, through charges for water abstractions and effluent discharge and donor and private sector support to specific areas of water resources management. There is inadequate investment in developing capacity and its associated infrastructure. This revenue is shared between WRMA Regional Offices and Headquarters. As at present the WRMA lacks the financial resources they need to manage water resources without any particular emphasis on groundwater, it follows that raising the necessary money to manage aquifer management plans and associated activities also lacks sufficient financing.

Water use charges include charges for acquiring permit for abstraction or diversion of groundwater, water usage, wastewater discharge, although WRMA does not segregate the charges it collects from groundwater and surface water. WRMA with the approval of the Treasury determines charges to be imposed for the use of water from a water resource to costs of performing its functions. WRMA may review water use charges taking account of (a) inflation rate; (b) cost of managing the water resources and water catchment areas; (c) the use of water charges as a tool for water demand management; and (d) the use of water as a social and economic good. The accounting system does not differentiate between surface and groundwater management processes in day-to-day business.

The issues that have been raised are that

a) The apportionment of revenues for groundwater is low priority given to groundwater.
b) The collection of this charge from groundwater had been inadequate.
c) Revenue collection data is not disaggregated on the basis of groundwater or surface water, so it is not easy to ascertain specific levels for groundwater;
d) There is widespread belief that raw water is a free good which the WRMA has no justification to charge for since the WRMA has not created storage or other works to augment the water available to justify its levying a charge.

e) Groundwater where it is widely viewed as the private property of the landowner.

Some of the difficulties that WRMA is facing from groundwater users are:

a) resistant to verifying their water use status and obtaining water permits,
b) the current structure of WRMA does not lend itself to individual aquifer management,
c) Strengthen local participation by both groundwater users and other stakeholders any management measures are likely to fail.
a) Increase public awareness on the importance of managing groundwater in a sustainable manner.
b) Ministry in charge of water to increase the proportion of water allocation to groundwater management.
c) Lobby with stakeholders including Committees of Parliament to increase allocation from the Exchequer.

Policy Objective is to ensure sustainable financing for groundwater resources development and management

Policy Direction 14: Modalities for sustainable financing are put in place.

Activities:

a) Improving water user capture will improve revenue,
b) revenue raised from groundwater fees (water and wastewater charges) should be ring-fenced and dedicated solely to groundwater resources management
c) bi-lateral partners
d) Leverage private-public partnership funding as seed resources for the management of individual aquifers, particularly Naivasha; Nairobi; North Mt Kenya that are of commercial importance
e) Water Sector Trust Fund (WSTF) is a potential source of funding for community-level/Water Resources User Association (WRUA) activities, within which aquifer management planning is a part.

f) CDF and to an extent the CDTF are both potential sources of funding for WRUAs that are involved in groundwater resources management, in particular the CDTF with its emphasis on mechanisms that improve climate change resilience.
g) Investigate other sources of funding including climate change funds, Trust Funds and Endowments, and Payment for Ecosystem Services (PES)
d) Carry out a study on the feasibility of establishing new revenue streams for groundwater management,

CHAPTER 5 IMPLEMENTATION AND MONITORING

5.1 Implementation Modalities

Weak implementation is due to a perception that groundwater is an inexhaustible resource, because of poor knowledge of groundwater resources, weak institutional capacity, poor funding and weak political commitment at senior policy-making level. The result is that over-abstraction and poor management has continued. In this sense the statement made in the National Water Policy remains substantially true in regard to groundwater today.

5.2 Implementation Schedule

5.3 Action Plan with Specific Recommendations for Priority Aquifers

The Aquifer management Plan (AMP) approach has been adopted to improve areas of managed aquifers. The priorities will depend on the following characteristics:

a) Aquifer importance based on whether strategic, major/minor, poor or special;
b) Threats resulting from the effects of over abstraction;
c) Aquifer vulnerability;
d) Uncertainties or risks of pollution threats.

The policy will be executed in three phases save for annual projects that will be concluded in one year or so. The short term Phase 1 programme will run for 5 years or less. Phase 2 shall be implemented between 5 and 10 years, while Phase 3 will exceed 10 years. It anticipated that activities for phase 3 may not be very clear and the budget cannot be determined at the moment. A detailed activity plan has been shown as Annex 1.

The immediate tasks in the Action Plan are shown in the Table below.

Activity	Duration	Estimated Budget (KES)	Responsibility

Development and institutionalization of groundwater management instruments	6 months		Maji Hse/WRRA/ Parliament
Policy Implementation planning&Formulation of National GW Management Strategy:	12 months		Consultant; Maji Hse/WRRA)
Development of AMP training packages etc	6 months		Consultant; Maji House
WRRA/BWRB selection of target aquifer for AMP	3 months		Consultants; Stakeholders
Training and development of AMPs:	9 months		
Implementation of AMPs: thereafter (no specific timescale: a timescale would be developed for the implementation of each AMP within the AMP itself)			
Monitoring and evaluation amend as required:	@ 12 months		

5.4 Monitoring and Evaluation

This policy has been targeted to run for 10 years, in two phases, each phase being for five years. Logframe analysis will be developed complete with monitoring indices for the 5 year policy implementation schedule. The one-year projects will be monitored and concluded according to their schedules. The rest of the programme will run for a period of five years. Care will be taken to ensure that the process receives support from all stakeholders. The budget for monitoring will also be determined at that stage.

There shall be annual programme reviews. Midterm evaluation as well as Phase ! Implementation of the policy.

5.5 Estimate budgets for investigation, exploration and monitoring of groundwater

The budget estimates are for the period less than 10 years only. A budget of about KES. 60 billion in ten years is deemed appropriate.

ACTION PLAN

Notes to table: ST - short term (<5 yr); MT - medium term (5-10 yr); LT - long term (>10 yr)

No.	Issue	Objective	Policy Direction	Activities	Timeframe			Budget Estimates (Ksh)
					ST <5 yrs	**MT 5-10 yrs**	**LT <10 yrs**	
1.	Invisibility		Increase awareness of the contribution of groundwater to national development	a) Prepare brochures, campaigns (electronic, print, drama, etc) and publicity materials; b) Organise workshops and training of different stakeholders				**9 million**
2..	Inadequate Database	Promote information and data sharing	Capacity development and funding for GW research	a) Establish establishment of research and data collection networks, b) institutional partnerships to interact and ensure research and funding; c) Establish physical infrastructure d) Procure equipment; e) Train GW experts on data management.				45 million
3.	Inadequate scientific information on aquifers	Scientific focus on GW investigation and exploration		a) Hydrogeological mapping of shallow to deep aquifers; b) Determination of macro- and micro-scale aquifer geometry and hydrogeological parameters;				800 million

				c) Estimation of groundwater reserves d) Determining surface-groundwater interlinkages; e) Describing ecosystems dependent on groundwater and environmental flows; f) Natural and artificial groundwater recharge estimation; g) Delineation of recharge and discharge zones; h) Determining the vulnerability of aquifers to pollution; i) Determine management and water quality protection requirements; j) Carry out water balance and modelling studies of aquifer parameters to improve site investigation, risk assessment and restoration techniques; k) Procure for the public sector appropriate investigation and drilling tools and equipment, particularly for deep aquifers l) Develop and establish partnerships with various stakeholder agencies to carry out collaborative assessments				
4.	Inadequate monitoring	Establish continuous and timely	Capacity development and funding for	a) Improve spatial and temporal resolution and sampling frequency for groundwater quality and				45 million

		and well funded monitoring programme	monitoring	quantity monitoring; b) Identify and mitigate possible human impacts; c) Identify and monitor major pollutant sources, pathways, and their movement in the aquifers; d) Determination of compliance with regulations and standards; e) Assess effectiveness of pollution control measures, such as groundwater protection zones; f) Development of the understanding of recharge areas (zones), recharge mechanisms and recharge rates; g) Development of an understanding of the hydraulic properties of aquifers.				
5.	Groundwater vulnerable to overuse and pollution	Protection and assurance of groundwater quantity and quality	GW protected, degraded aquifers rehabilitated	a) Identify groundwater bodies which are at risk of over-abstraction or water quality deterioration; b) Estimation of groundwater reserves; c) Determination of the quality of groundwater, as a source of drinking water, for industry, or for irrigation purposes; d) Designate aquifer resource protection areas to safeguard against pollution. e) Demarcate aquifer boundaries to enable setting up effective and				70 million

				decentralised groundwater management institutions f) Establish dedicated water level monitoring, especially for heavily utilised aquifers; g) Ensure that parameters for monitoring are properly selected based on types of pollutants that a specific aquifer is exposed to h) Identify and work towards reversing pollution in groundwater resources using best available technologies that are not disproportionately expensive. i) Use modern approaches (e.g. DRASTIC model) to the assessment of groundwater vulnerability and produce aquifer vulnerability map for Kenya j) Use both regulatory and non-regulatory tools to safeguard the groundwater resources k) Develop, adopt and implement a water resources allocation plan for any groundwater or surface water resources and monitor water use and water quality.				
6.	Lack of IWRM	IWRM incorporated in GW	Promotion of IWRM and practice	a) Assess water quantity and quality in an integrated and holistic manner incl. environmental services; b) Map of groundwater-dependent				65 million

		management		ecosystems and their environmental flow requirements c) Carry out EIA/ESIA on activities incl. including mineral extraction, landfills, waste disposal, etc. on groundwater resources d) Enhance participatory management of water quality and water use l) Improve the classification scheme for Kenya's groundwater resources; m) Mapping strategic aquifers and conjunctive water uses; n) Preparing project designs for aquifer exploitation; o) Harvesting aquifers to increase supply from groundwater; and p) Identify, designate and gazette Groundwater Conservation Areas (GCAs). q) Liaise with NEMA, Local Authorities and other interested parties to encourage the location of new developments in areas where groundwater resources are least vulnerable to contamination r) Establish partnership with the ministry in charge of land use planning s)				
7.	Lack of managed	Identify and adopt	Promotion of new technologies and	a) Identifying potential sites and aquifers for managed aquifer				45

	recharge	managed recharge where applicable	practices to enhance water storage in the ground for present and future uses	recharge (MAR) b) Carry out studies of aquifer characteristics; c) Determine opportunities for recharge.				million
8.	Limited knowledge of groundwater response to climate change	Groundwater -climate change linkages studied and well understood	GW-CC to be incorporated in planning and development of water resources	a) Determine the likely impact of climate change on resource availability b) Devise and implement Disaster Risk Reduction and Management strategies and plans including Early Warning Systems (EWS), preparedness, and institutional arrangements to mitigate against increase frequency of droughts that incorporate groundwater c) Harmonise sectoral approaches for drought mitigation d) Strengthen the knowledge on linkages between groundwater resources and climate change e) Build stock capacity for drought preparedness f) Establish an explicit plan for groundwater restriction during droughts.				100 million
9.	Transboundary aquifers not well known,	TA well known, characterised	Implement appropriate new policies and institutions to ensure	a) Identify and demarcate TAs; b) Collect information; c) Promote information sharing and				24 million

	characterised nor managed	and managed by countries sharing	seamless management of TA	adopt international good practices; d) Expand transboundary water unit to Department				
10.	Weak/disjointed legal/institutional frameworks	Strong, cohesive legal/institutional frameworks	Strengthen legal/institutional frameworks	a) Review the policy, legal and institutional frameworks that exist in order to rectify any deficiency in law with respect to groundwater management. b) Establish committee of stakeholders to guide IWRM incl. GW; c) Determine cross sectoral linkages; d) Formulate a joint policy on land, water and forests e) Establish a fast track regulation of water rights. f) Establish a coordinating framework for cross-sectoral issues. g) Develop and implement water resources allocation plan for any groundwater or surface water resources h) Review the mandate and role of WRMA as a regulator in the industry;				15 million
11.	Limited capacity in GW issues	Develop human and technical capacity for GW	Capacity building programmes and GW centres of excellence strengthened	a) Build capacity for women to undertake roles in which they are currently under-represented b) Improve understanding of practitioners and water users of				18 million

		management		groundwater science c) Develop guides, modules such as CoPs, Guides for development and operation of Aquifer Management Plans (AMPs); d) Prepare training packages for practitioners as well as WRUAs. e) Increase the number of the sub-regional WRMA offices for effectiveness f) Review and update training of hydrogeologists and hydrologists g) Registering and regulation of groundwater practitioners should devolve to the WRMA; h) Introduce a bill in Parliament to streamline training, registration and activities of groundwater professionals.				
12.	Limited financing of GW	Sufficient financing for GW programmes / management	Government to increase exchequer allocation and establish new revenue streams and ensure transparent financial management of groundwater revenues	a) Lobby with stakeholders including Committees of Parliament to increase allocation b) Explore climate change funds c) Investigate and establish Trust Funds and Endowments d) Carry out a study and implement results of PES study				19 million

13.	Lack of stakeholder involvement	Stakeholder awareness and involvement in GW improved	Attempt a structured approach in engaging stakeholders	a) Awareness programmes so that water users and the general public have a clear understanding and awareness of the need for groundwater protection b) Report groundwater quality status in the NWRMS or annual report to the public. c) Implement constitutional requirements for gender mainstreaming; d) Increase public awareness on gender issues; e) Increasing awareness to the Water Resources Management Rules; f) Develop a network for community management and technical skills development for natural resources management				45 million