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Department:  
Water Affairs & Forestry  
REPUBLIC OF SOUTH AFRICA

***A Guideline for the Assessment, Planning  
and Management of Groundwater  
Resources within Dolomitic Areas in  
South Africa***

***Volume 1***

***Conceptual Introduction***

**Final**

**August 2006**

**Title:** A GUIDELINE FOR THE ASSESSMENT, PLANNING AND MANAGEMENT OF GROUNDWATER RESOURCES WITHIN DOLOMITIC AREAS IN SOUTH AFRICA

**Authors:** Graham Hubert, Frank Wimberely and Toni Pietersen

**Project Name:** GUIDELINE DEVELOPMENT STUDY: GEOHYDROLOGY ASSESSMENT, PLANNING AND MANAGEMENT FOR DOLOMITIC AREAS

**Status of Report:** Final

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## ACRONYMS

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<b>ARD</b>	Acid Rock Drainage
<b>BM</b>	Benchmarking
<b>BPG</b>	Best Practice Guidelines
<b>BWS</b>	Bulk Water Supplier
<b>CMA</b>	Catchments Management Agency
<b>CMS</b>	Catchment Management Strategy
<b>EC</b>	Electrical Conductivity
<b>EIA</b>	Environmental Impact Assessment
<b>EMP</b>	Environmental Management Plan
<b>GMP</b>	Good Management Practices
<b>ICM</b>	Integrated Catchment Management
<b>IDP</b>	Integrated Development Plan
<b>ISP</b>	Internal Strategic Perspective
<b>IWRMP</b>	Integrated Water Resources Management Plan
<b>IWRM</b>	Integrated Water Resources Management
<b>Km<sup>2</sup></b>	Square Kilometer
<b>l/s</b>	Litres per second
<b>ma</b>	Million annum
<b>mamsl</b>	Metres above mean sea level
<b>MI/d</b>	Megalitres per day
<b>m</b>	Metre
<b>mm</b>	Millimetre
<b>mm/a</b>	Millimetres per annum
<b>mS/m</b>	Millesiemens per metre
<b>m<sup>3</sup></b>	Cubic metre
<b>MAP</b>	Mean Annual Precipitation
<b>MPRDA</b>	Mining and Petroleum Resources Development Act (Act No. 73 of 1994)
<b>NEMA</b>	National Environmental Management Act (Act No. 107 of 1998)
<b>NWA</b>	National Water Act (Act No. 36 of 1998)
<b>NWRS</b>	National Water Resource Strategy
<b>NWC/WDMS</b>	National Water Conservation/Water Demand Management Strategy
<b>PPM</b>	Parts per million
<b>RDM</b>	Resource Directed Measures
<b>RQO</b>	Resource Quality Objective
<b>RWQO</b>	Resource Water Quality Objective
<b>TDS</b>	Total Dissolved Solids
<b>WMA</b>	Water Management Area

<b>WSA</b>	Water Services Act (Act No. 108 of 1997)
<b>WMI</b>	Water Management Institution
<b>WMP</b>	Water Management Plan
<b>WSDP</b>	Water Services Development Plan
<b>WSI</b>	Water Services Institution
<b>WSP</b>	Water Service Provider
<b>WUAu</b>	Water Use Authority
<b>WUA</b>	Water User Association

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## GLOSSARY OF TERMS

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### **AQUICLUDE**

A bed, formation or group of formations essentially impervious to water.

### **AQUIFER**

A geological formation which has structures or textures that hold water or permit appreciable water movement through them. National Water Act (Act No. 36 of 1998)

### **BOREHOLE**

Includes a well, excavation, or any other artificially constructed or improved underground cavity which can be used for the purpose of intercepting, collecting or storing water in or removing water from an aquifer; observing and collecting data and information on water in an aquifer; or recharging an aquifer. Source: National Water Act (Act No. 36 of 1998).

### **BOUNDARY**

An aquifer-system boundary represented by a rock mass (e.g. an intruding dolerite dyke) that is not a source of water, and resulting in the formation of compartments in dolomite aquifers.

### **CONFINING LAYER**

A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers; it may lie above or below the aquifer.

### **DOLOMITE AQUIFER**

See "Karst"

### **DRAWDOWN**

The lowering of the water table or piezometric surface caused by the extraction of groundwater by pumping a borehole(s).

### **GROUNDWATER**

All water occurring in the saturated zone. The water table marks the upper surface of groundwater systems.

### **GROUNDWATER DIVIDE or GROUNDWATER WATERSHED**

The boundary between two adjacent groundwater catchments. The divide is represented by a high in the water table or piezometric surface.

## **GROUNDWATER FLOW**

The movement of water through openings in sediment and rock; occurs in the zone of saturation in the direction of the hydraulic gradient.

## **HYDRAULIC CONDUCTIVITY**

Measure of the ease with which water will pass through the earth's material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (m/d).

## **HYDRAULIC GRADIENT**

The rate of change in the total hydraulic head per unit distance of flow in a given direction . The slope of the water table or piezometric surface.

## **INFILTRATION**

The downward movement of water from the atmosphere into the ground.

## **KARST (KARSTIC)**

The type of geomorphological terrain underlain by carbonate rocks where significant solution of the rock has occurred due to flowing groundwater.

## **MONITORING**

The regular or routine collection of groundwater data (e.g. water levels, water quality and water use) to provide a record of the aquifer response over time.

## **PHREATIC SURFACE**

The surface at which the water level is in contact with the atmosphere: the water table.

## **POROSITY**

The ratio of the volume of void space to the total volume of the rock or earth material.

## **PIEZOMETRIC SURFACE**

An imaginary or hypothetical surface of the piezometric pressure or hydraulic head throughout all or part of a confined or semi-confined aquifer; analogous to the water table of an unconfined aquifer.

## **OBSERVATION BOREHOLE**

A non-pumping borehole used to observe the elevation of the water table or piezometric surface. An observation borehole is generally of larger diameter than a piezometer.

## **PRODUCTION BOREHOLE**

A borehole specifically designed to be pumped as a source of water supply.

## **CONE OF DEPRESSION**

The cone-shaped area around a borehole that results from the lowering of the water table or piezometric surface by abstraction.

## **RECHARGE**

The addition of water to the saturated zone, either by the downward percolation of precipitation or surface water and/or the lateral migration of groundwater from adjacent aquifers.

## **RECHARGE BOREHOLE**

A borehole specifically designed so that water can be pumped into an aquifer in order to recharge the ground-water reservoir.

## **RECOVERY**

The rate at which the water level in a borehole rises after the pump has been shut off. It is the inverse of drawdown.

## **SATURATED ZONE**

That part of the earth's crust beneath the regional water table or piezometric surface in which all voids, large and small, are filled with water under pressure greater than atmospheric.

## **SPECIFIC CAPACITY**

A measure of borehole performance and is calculated by dividing the yield of the borehole by drawdown induced by abstraction. Specific capacity should be described on the basis of the number of hours of pumping prior to the time the drawdown measurement is made. It will generally decrease with time as the drawdown increases.

## **STORATIVITY**

The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

## **SPECIFIC YIELD**

The ratio of the volume of water that drains by gravity to that of the total volume of the saturated porous medium. Always in an unconfined aquifer.

## **TRANSMISSIVITY**

The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer. (Units:  $\text{m}^3/\text{day}/\text{m}$  or  $\text{m}^2/\text{day}$ ).

## **UNSATURATED ZONE (also termed VADOSE ZONE)**

The zone between the land surface and water table which may include the capillary fringe. Water in this zone is generally under less than atmospheric pressure, and the voids may contain water, air or other gases.

## **WATERSHED**

The boundary between adjacent surface water catchments. It is represented by a topographically high area relative to surrounding areas.

## **WATER TABLE**

The upper surface of the saturated zone of an unconfined aquifer at which pore pressure is equal to that of the atmosphere.

## EXECUTIVE SUMMARY

The National Water Act (Act 36 of 1998) (NWA) was promulgated to provide for reform of the law relating to water resources, recognising that water is a scarce and unevenly distributed national resource that belongs to all people. The NWA provides the Department of Water Affairs and Forestry (the Department) with a mandate to protect, use, develop, conserve, manage and control South Africa's water resources in an integrated manner (NWRS, 2004).

The dolomite aquifers of South Africa represent important water resources that are relied on by many users for their water use. The development and protection of the aquifers' groundwater resources are currently being undertaken in response to local pressures and decisions, potentially taking cognisance of the NWA but without the benefit of standard procedures. The Department therefore identified the need to develop a guideline document (termed the Dolomite Guideline) that can be followed and adhered to when undertaking *assessment, planning and management* of the water resources within the dolomitic areas of the country.

The Dolomite Guideline will assist in the sustainable development, protection and management of the groundwater resources and will assist in achieving the overall goal of integrated water resources management (IWRM) within the Department. Although the assessment, planning and management of water resources in dolomitic areas are seen as important functions within the overall scope of IWRM, the Dolomite Guideline is presented as a separate document, and it addresses the need to collate all available information into a single co-ordinated document.

The importance of assessment, planning and management of the water resources in the dolomitic areas are highlighted by the following:

- No such guideline currently exists to guide the Water Planners/Manager and Service Provider in the procedures required for the assessment, planning and management of the groundwater resources in dolomitic areas
- The groundwater in the dolomitic areas represents an important water resource as part of conjunctive use for bulk and local water use, as well as for extensive irrigation. In some areas, groundwater from dolomite aquifers represents the sole source of water or is a critical resource in times of drought. In these areas or circumstances, the dolomite aquifers would be considered to be of strategic importance
- Overall planning and management of dolomite aquifers are essential to ensure sustainable development. Individual private use often takes no account of the impact of this use on the total resource

- Past experiences have indicated that a lack of effective assessment, planning and management can result in significant detrimental impacts on the dolomite resource. For example, unmanaged and uncontrolled abstraction and/or dewatering of the dolomite aquifers can lead to sinkhole formation, representing a local safety risk
- Potential groundwater yields from karst formations can be significantly higher than yields from other rock formations. High borehole yields are therefore often available from dolomite aquifers and they can typically give the appearance of virtually unlimited water resources. However, these same characteristics that allow high borehole yields can also be responsible for sudden failure of the resource
- Due to the physical characteristics of the host rock, water resources in dolomitic areas are particularly vulnerable to over-exploitation, unsustainable practices and pollution. This vulnerability aggravates the potential impact of land use on the dolomitic groundwater resources, and
- The direct interaction between dolomitic groundwater and adjacent ecosystems makes these ecosystems particularly vulnerable to pollution and abstraction impacts, to the same degree as the dolomite aquifers themselves. Protection of the dolomite aquifers will therefore lead to the protection of these ecosystems.

The Dolomite Guideline is presented in three separate volumes to improve user-friendliness. The details included in each of the volumes, and their proposed use, are:

- **Volume 1:** Provides a conceptual overview of the Dolomite Guideline in terms of the purpose of the guideline, the location of the dolomite resources, the regulatory framework, principles and approaches, and the institutional arrangements. **Volume 1** can be used by role-players who seek to gain an initial insight into the assessment, planning and management of water resources in dolomitic areas
- **Volume 2:** Provides details of the process and related activities that should be followed during the assessment, planning and management functions. This volume is aimed at the role-players who require a detailed understanding of the processes to be followed during assessment, planning and management, to enable the overall management, integration and control of these processes, and
- **Volume 3:** Provides detailed procedures, in the form of check-lists with guiding notes, for carrying out the assessment, planning and management functions. This volume is aimed at those role-players tasked with the operational aspects of these functions.

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# 1 INTRODUCTION AND CONTEXT

## 1.1 Context

The National Water Act (Act 36 of 1998) (NWA) was promulgated to provide for reform of the law relating to water resources, recognising that water is a scarce and unevenly-distributed national resource that belongs to all people. The NWA provides the Department of Water Affairs and Forestry (the Department) with a mandate to protect, use, develop, conserve, manage and control South Africa's water resources in an integrated manner (NWA, 1998).

The dolomitic aquifers of South Africa represent important water resources that are relied on by many. Water users include the ecology (wetland areas around springs and surface water flow originating from the dolomite groundwater), urban and rural dwellers (located both within the dolomitic areas and downstream of dolomite outcrops), irrigation and livestock farmers, industry and mining.

Development and protection of the groundwater resources of the dolomite aquifers is currently being undertaken in response to local pressures and decisions, potentially taking cognisance of the NWA but without the benefit of standard procedures. The Department therefore identified the need for the development of a guideline document (termed the Dolomite Guideline) that can be followed and adhered to when undertaking *assessment, planning and management* of the water resources within the dolomitic areas of the country. This document will assist in sustainable development, protection and management of the groundwater resources, and will assist in achieving the overall goal of integrated water resources management (IWRM) within the Department.

The Dolomite Guideline is aligned to, and integrated with, other guidelines prepared by the Department, which together aim to address the overall objectives of IWRM. The Dolomite Guideline is presented as a separate document, albeit within the context of IWRM, because:

- The assessment, planning and management of water resources in dolomitic areas are seen as important functions within the overall scope of IWRM. Of equal importance is the interaction between surface and groundwater and the contribution of groundwater to baseflow in many instances, and
- Although a significant amount of information is available on the assessment, planning and management functions in dolomitic areas, this has not been collated into a single co-ordinated document. The Dolomite Guideline addresses this need.

## **1.2 Importance of assessment, planning and management**

The assessment function is required to enable and inform the planning and management functions. Information of sufficient accuracy is currently unavailable to ensure integrated water resource management. Assessment also provides a better understanding of the local interactions between people and the water resource and provides details on current impacts and the use/abuse of the resource. The integration of the assessment, planning and management functions is important because:

- These functions are linked in the management of the water resources in dolomitic areas. Thus, if assessment is undertaken poorly, then the planning will also be poor. In turn, poor planning can lead to the adoption of unsuitable options and hence the unsustainable use of the resource
- Given the linked nature of the functions, poor assessment, leading to poor planning can result in the inefficient use of the Department's assessment, planning and management budgets.

## **1.3 Importance of developing the dolomite guideline**

The overall rationale and motivation for developing a guideline for the assessment, planning and management of water resources in the dolomitic areas include the following factors:

- No such guideline currently exists to guide the Water Manager/Service Provider in the procedures required for the assessment, planning and management of the groundwater resources in dolomitic areas
- The groundwater in the dolomitic areas represents an important water resource as part of conjunctive use for bulk and local use, as well as for extensive irrigation. In some areas, groundwater from dolomite aquifers represents the sole source of water use or is a critical resource in times of drought. In these areas or circumstances, the dolomite aquifers would be considered to be of strategic importance
- Overall planning and management of dolomite aquifers are essential to ensure sustainable development. Individual private abstractions often take no account of the impact of these abstractions on the total resource
- Past experiences have indicated that a lack of effective assessment, planning and management of the resource can result in significant detrimental impacts on the dolomite resource. For example, unmanaged and uncontrolled abstraction and/or dewatering of the dolomite aquifers can lead to sinkhole formation, representing a local safety risk

- Potential groundwater yields from karst formations can be significantly higher than yields from other rock formations. High borehole yields are therefore often available from dolomite aquifers and they can typically give the appearance of virtually unlimited water resources. However, these same characteristics that allow high borehole yields can also be responsible for sudden failure of the resource
- Due to the physical characteristics of the host rock, water resources in dolomitic areas are particularly vulnerable to over-exploitation, unsustainable practices and pollution. This vulnerability aggravates the potential impact of land use on the dolomitic groundwater resources
- The direct interaction between dolomitic groundwater and adjacent ecosystems makes these ecosystems particularly vulnerable to pollution and abstraction impacts, to the same degree as the dolomite aquifers themselves. Protection of the dolomite aquifers will therefore lead to the protection of these ecosystems, and

#### **1.4 Use of the Dolomite Guideline**

The Dolomite Guideline is aimed primarily at the Water Manager/Planner and Service Provider in a Water Management Area (WMA) who will be responsible for the assessment, planning and management of the dolomitic resources in the area. The responsible person will thus make comprehensive use of Volumes 2 and 3 of the Dolomite Guideline to enable him/her to undertake these functions. The Guideline is presented in three separate volumes to improve user-friendliness. The details included in each volume, and the proposed use, are:

- **Volume 1:** Provides a conceptual overview of the Dolomite Guideline in terms of the purpose of the guideline, the location of the dolomite resources, the regulatory framework, principles and approaches, and the institutional arrangements. **Volume 1** can be used by role-players who seek to gain an initial insight into the assessment, planning and management of water resources in dolomitic areas
- **Volume 2:** Provides details of the process and related activities that should be followed during the assessment, planning and management functions. This volume is aimed at the role-players who require a detailed understanding of the processes to be followed during assessment, planning and management, to enable the overall management, integration and control of these processes, and
- **Volume 3:** Provides detailed procedures, in the form of check-lists with guiding notes, for carrying out the assessment, planning and management functions. This volume is aimed at those role-players tasked with the operational aspects of these functions.

Various other stakeholders may have different uses for the Dolomite Guideline, depending on their specific organisational positions, work areas and responsibilities. In particular:

- Personnel at management level within the Department's Head Office, Regional Office and within the CMA are likely to make use of **Volume 1** to obtain an overview of the nature and applicability of the Dolomite Guideline
- Water Resource Management personnel involved in assessment, planning and management for the sustainable use of water resources will make use of Volumes 2 and 3, and
- Water User Associations, Dolomite Committees, Water Service Providers, task teams and water users themselves will find Volumes 2 and 3 useful, especially the technical specifications in the appendices.

## **2 PURPOSE OF THE DOLOMITE GUIDELINE**

The purpose of the Dolomite Guideline can be described briefly as follows:

- To provide assistance and guidance to all role-players involved in the assessment, planning and management of water resources within the dolomitic areas of South Africa, and
- To ensure that all role-players in the management of water resources in the dolomitic areas of the country have clear guidance on the processes to follow.

The Dolomite Guideline will therefore assist in ensuring that the water management function in these areas is streamlined and meets the objectives of both the Department and other role-players.

## **3 GOALS OF THE DOLOMITE GUIDELINE**

The goals of the Dolomite Guideline are presented in terms of strategic, operational and other goals in **Table 1**. Key success factors are also provided for each of the Guideline goals.

**Table 1: Goals of the Dolomite Guideline**

<b>Level</b>	<b>Goals</b>	<b>Role-players involved in meeting the goals</b>	<b>Key success factors</b>
Strategic	Provide guidance for sustainable development and management of the resource	<ul style="list-style-type: none"> <li>• DWAF Head Office</li> <li>• DWAF Regional Office</li> <li>• CMA management</li> <li>• Other national departments</li> </ul>	<ul style="list-style-type: none"> <li>• Increased understanding and appreciation of sustainable development and management of the resource</li> <li>• Improved development and management techniques</li> </ul>
	Assist in ensuring equitable access to the resource		
Management	Enable optimum management, protection and use of the resource to ensure sustainable development	<ul style="list-style-type: none"> <li>• DWAF Regional Offices</li> <li>• CMA management</li> <li>• Water User Associations</li> <li>• Water Forums and reference groups</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable use of the resource</li> </ul>
	Integrated water resources management		
Operational	Provide information that will feed into the Department's planning process	<ul style="list-style-type: none"> <li>• CMA operational level</li> <li>• Water User Associations</li> <li>• District and local municipalities</li> <li>• Water Boards</li> <li>• Individual users (e.g. irrigation farmers, mines and industrial enterprises)</li> </ul>	<ul style="list-style-type: none"> <li>• Operational guidelines that are:               <ul style="list-style-type: none"> <li>• Clear, concise and user-friendly</li> <li>• Contain sufficient details to be used as a primary information reference by role-players</li> </ul> </li> </ul>
	Ensure the sustainable use of the resource according to guidance given.		
Other	Integration with existing and new initiatives within the Department	<ul style="list-style-type: none"> <li>• DWAF Head Office</li> </ul>	<ul style="list-style-type: none"> <li>• Inclusion of links to other relevant initiatives</li> </ul>

## 4 OVERVIEW OF THE DOLOMITE RESOURCES IN SOUTH AFRICA

Dolomite is predominantly distributed in the northern and central regions of the country. Dolomite covers less than 2.3 percent of the total surface area of South Africa and is best described graphically (**Figure 1**). **Table 2** summarises the location of the country's dolomite resources, including Province, water management area (WMA) and the impacts and uses in each area. Additional details on the dolomitic areas and related water resources are provided in Volume 2 of the Dolomite Guideline.

Karst aquifers, specifically occurring in dolomite and limestone, represent an important water resource within South Africa. Dolomite aquifers store large volumes of water, support numerous springs and provide abundant resources for abstraction for urban and rural water supply, agriculture and irrigation, industry and mining. Karst aquifers have unique physical properties, such as solution cavities, high permeability, compartmentalisation and the ability to recharge rapidly, that distinguish these aquifers from primary, crystalline or fractured rock aquifers. Hence their assessment, planning and management must recognise this uniqueness and the associated challenges.

The dolomite in the central regions of South Africa, the host rock of the karst aquifers, was deposited in a shallow sea some 2.5 billion years ago. They represent some of the oldest carbonate rocks in the world. This sequence of carbonates, which is approximately 2km thick, took 100 million years to accumulate and comprises chert-rich and chert-poor layers, limestone, breccias and minor amounts of fine-grained shale. Minor occurrences of more recent limestone also occur in the Western Cape. These are included in the Guideline, as they have similar water-bearing characteristics. Calcrete, however, is excluded from the Guideline.

## 5 OVERVIEW OF THE REGULATORY AND POLICY FRAMEWORK

It is not intended in this section of the Dolomite Guideline to provide comprehensive details of the various acts, policies and strategy documents that make up the regulatory framework of the water sector in South Africa. It is assumed that role-players using the Guideline have sufficiently detailed knowledge of the regulatory framework to understand where and how the Guideline fits in. **Table 3** provides an overall summary of the regulatory and policy framework for South Africa. It should be noted, however, that this summary does not represent an exhaustive list of all acts, policies and strategies, but rather a summary of those relevant to the assessment, planning and management of water resources in dolomitic areas.

Other useful references relating to the assessment, planning and management of water resources in dolomitic areas are provided in the bibliography at the end of this volume of the Dolomite Guideline.

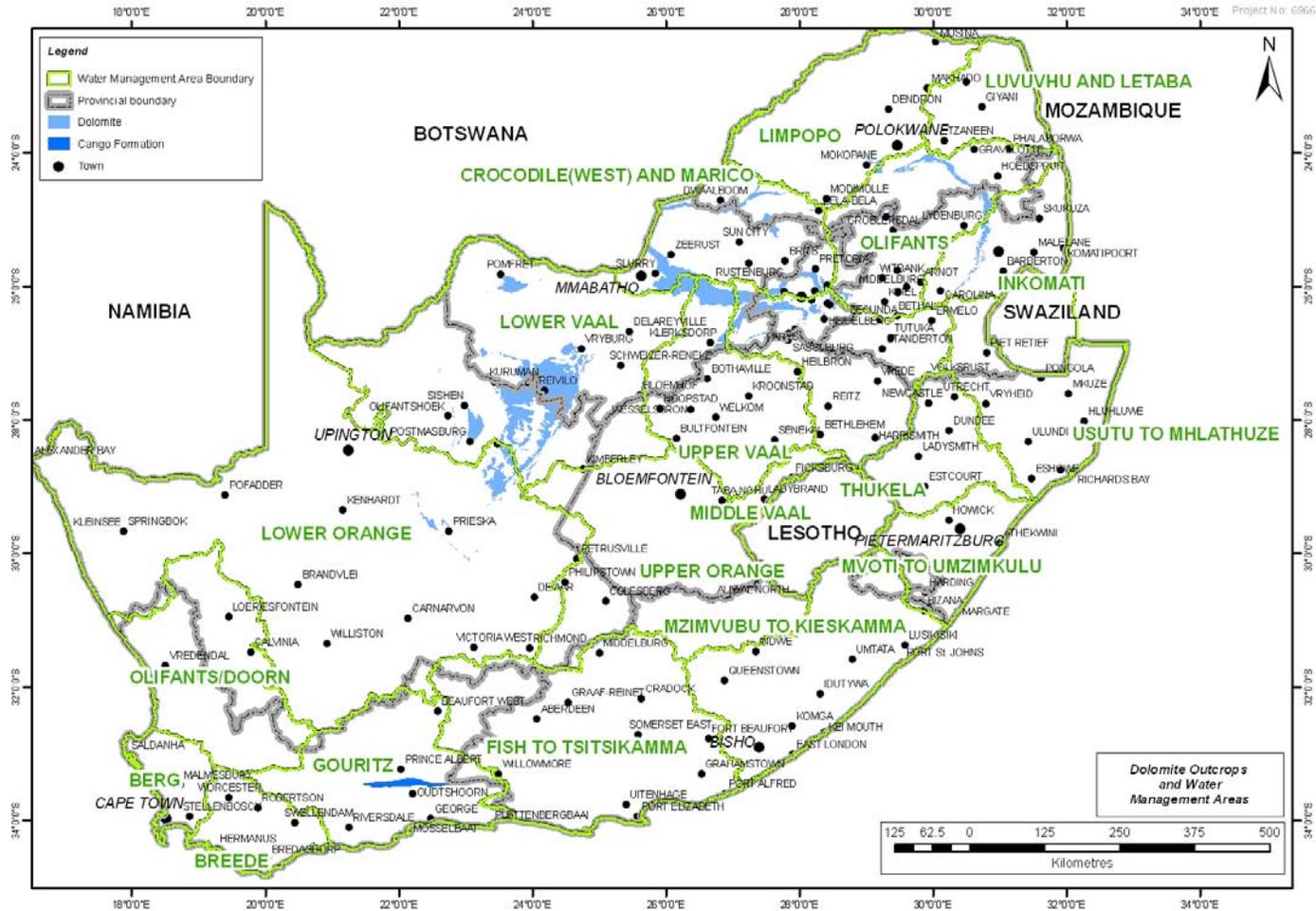


Figure 1: Location of dolomite aquifers in South Africa

**Table 2: Summary of the location, use and associated impacts of the dolomite resources**

Province	WMA No.	WMA	Types of use	Types of impact
North West and Limpopo	3	Crocodile (West) and Marico	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Bulk supply to Mafikeng and Zeerust</li> <li>• Urban water supply – Mafikeng, Lichtenberg and Zeerust</li> <li>• Large-scale irrigation in the, Grootpan and Itsoseng/Lichtenburg compartments</li> <li>• Bulk water supply in the Pretoria area (eastern section)</li> </ul>	<ul style="list-style-type: none"> <li>• Groundwater qualities generally good</li> <li>• Minor occurrences of pollution within communal land areas</li> <li>• Risk of pollution</li> <li>• Over-exploitation in certain compartments</li> </ul>
Limpopo and Mpumalanga	4	Olifants	<ul style="list-style-type: none"> <li>• Largely undeveloped area</li> <li>• Agriculture in the Zebedelia area</li> <li>• Mining and forestry</li> <li>• Bulk water supply, especially rural areas</li> <li>• Aquifer plays an important role in river flow (e.g. Lethaba and Blyde Rivers)</li> </ul>	<ul style="list-style-type: none"> <li>• Over-exploitation in association with intense citrus agriculture in the Zebedelia area near Mokopane (Potgietersrus)</li> <li>• Extensive exploitation in Delmas area</li> <li>• Pollution risk from mining and agricultural activities (Ohrigstad valley), aquifer re-watering (acid mine drainage)</li> <li>• Risk of pollution from waste disposal sites (e.g. Pilgrim's Rest waste disposal site is situated in a dolomitic area)</li> </ul>
Mpumalanga	5	Inkomati	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Aquifer plays an important role in river flow (e.g. Elands and Crocodile Rivers)</li> <li>• Forestry</li> <li>• Mining</li> </ul>	<ul style="list-style-type: none"> <li>• Forestry and irrigation</li> <li>• Irrigation of effluent from production of paper products at Ngodwana</li> <li>• Risk of pollution</li> <li>• Potential for acid mine drainage</li> </ul>
Gauteng, Free State, Mpumalanga and North West	8	Upper Vaal	<ul style="list-style-type: none"> <li>• Mining</li> <li>• Bulk water supply through Rand Water</li> <li>• Agriculture and forestry</li> <li>• Large-scale irrigation</li> </ul>	<ul style="list-style-type: none"> <li>• Aquifer dewatered in the Carletonville area</li> <li>• Pollution from the Witwatersrand goldfields</li> <li>• Impact of re-watering of the dolomites after mining in the area ceases</li> </ul>
Free State and North West	9	Middle Vaal	<ul style="list-style-type: none"> <li>• Mining and agriculture</li> <li>• Large-scale irrigation in the Schoonspruit and Grootpan compartments</li> </ul>	<ul style="list-style-type: none"> <li>• Risk of pollution from gold mining in the KOSH area</li> <li>• Impact of re-watering of the dolomites after mining in the area ceases</li> <li>• Decline of water levels due to irrigation abstraction</li> </ul>
Northern Cape and North West	10	Lower Vaal	<ul style="list-style-type: none"> <li>• Area largely undeveloped</li> <li>• Domestic use and stock watering is widespread but of negligible quantities</li> <li>• Large-scale irrigation schemes (e.g. Tosca, Kuruman)</li> <li>• Large-scale irrigation in the Itsoseng/Lichtenburg compartment</li> <li>• Mining: Sishen and other mines</li> <li>• Municipal water use to Vryburg and Kuruman</li> </ul>	<ul style="list-style-type: none"> <li>• Localised impacts associated with pit dewatering and groundwater abstraction as part of mining operations</li> <li>• Irrigation abstraction – over-use led to restrictions</li> <li>• Point source pollution threat to health in rural areas</li> </ul>
Northern Cape	14	Lower Orange	<ul style="list-style-type: none"> <li>• Area largely undeveloped</li> <li>• Domestic use and stock watering is widespread but of negligible quantities</li> <li>• Mining at Postmasburg</li> </ul>	<ul style="list-style-type: none"> <li>• Dewatering by mines in the Postmasburg area</li> </ul>
Western Cape	16	Gouritz	<ul style="list-style-type: none"> <li>• Little known about the importance of the resources associated with the limestone of the Kango formation</li> <li>• Environmental and socio-economic benefits</li> <li>• Yields less than karst aquifers associated with dolomite</li> </ul>	<ul style="list-style-type: none"> <li>• Impacts are not well known</li> </ul>

**Table 3: Summary of the regulatory and policy framework in South Africa**

National Department	Act/Policy/Strategy	Act No.	Key details/principles
Water Affairs and Forestry	National Water Act	36 of 1998	<ul style="list-style-type: none"> <li>• Promulgated to provide for reform of the law relating to water resources</li> <li>• Recognises that water is a scarce and unevenly distributed national resource belonging to all people</li> <li>• Provides mandate to protect, use, develop, conserve, manage and control the water resources in an integrated manner</li> <li>• Key principles:               <ul style="list-style-type: none"> <li>○ Ultimate aim: Sustainable use of water for the benefit of all users</li> <li>○ Protection of water quality is necessary to ensure sustainability</li> <li>○ Integrated management is required, with delegation to regional or catchment level where appropriate</li> </ul> </li> </ul>
	Water Services Act	108 of 1997	<ul style="list-style-type: none"> <li>• Key principles:               <ul style="list-style-type: none"> <li>○ Rights of access to basic water use and sanitation</li> <li>○ Duty of government, through co-governance, to ensure efficient, equitable and sustainable water use services</li> <li>○ All spheres of government to work towards this objective</li> </ul> </li> <li>• Goals:               <ul style="list-style-type: none"> <li>○ Provide for rights of access to basic water use and sanitation</li> <li>○ Set and provide the national standards and norms</li> <li>○ Provide framework and details for developing Water Services Development Plans (WSDP)</li> <li>○ Provides the regulatory framework for water services institutions</li> <li>○ Provide the mechanisms for the establishment and dis-establishment of water boards</li> <li>○ Monitoring of water services</li> <li>○ Financial assistance to institutions</li> <li>○ General powers of the Minister</li> <li>○ Information-gathering in national information system</li> </ul> </li> </ul>

National Department	Act/Policy/Strategy	Act No.	Key details/principles
Water Affairs and Forestry	National Water Policy for South Africa	1997	<ul style="list-style-type: none"> <li>• Key proposals:                             <ul style="list-style-type: none"> <li>○ Formalise water as an indivisible national asset</li> <li>○ Only water required to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right</li> <li>○ Riparian system of allocation is abolished</li> <li>○ Pricing to include full financial costs (infrastructure and catchment management activities)</li> <li>○ Pricing may be waived to promote equitable access to water for disadvantaged groups</li> <li>○ Major water users to develop water use, conservation and protection policy</li> <li>○ Management of water through the Catchment Management Agency (CMA)</li> </ul> </li> <li>• Goal:                             <ul style="list-style-type: none"> <li>○ Some water, for all, growing prosperity and equity</li> </ul> </li> </ul>
	National Water Resource Strategy	2004	<ul style="list-style-type: none"> <li>• Details how the Department plans to give effect to the principles and policies in the NWA</li> <li>• Key sections:                             <ul style="list-style-type: none"> <li>○ Objective: manage water resources in an integrated way to ensure equitable, sustainable social and economic transformation and development</li> <li>○ Progressive decentralisation: Head Office as policy-maker, regulator and monitor; CMAs will take on operator responsibilities</li> <li>○ Description of aggregated estimates of present water availability and requirements</li> <li>○ Details on strategies, objectives, plans, guidelines and procedures required to implement the NWA</li> <li>○ Broad overview of methods to build capacity</li> <li>○ Indicative programme of capital development</li> </ul> </li> </ul>
	Integrated Catchment Management (ICM)	2004	<ul style="list-style-type: none"> <li>• Central Government role in ICM:                             <ul style="list-style-type: none"> <li>○ Leadership, aimed at facilitating and coordinating the development and transfer of skills set</li> <li>○ Institutional arrangements required for effective inter-government collaboration</li> <li>○ Landowners and communities to be seen as competent partners</li> <li>○ Lead agent to assist in developing skills, where lacking</li> </ul> </li> </ul>

National Department	Act/Policy/Strategy	Act No.	Key details/principles
Environment and Tourism	National Environmental Management Act (NEMA)	107 of 1998	<ul style="list-style-type: none"> <li>• Promulgated to give legal effect to the principles of sustainability</li> <li>• Purpose: <ul style="list-style-type: none"> <li>○ Give effect to the vertical application of Section 24 of the Constitution, guaranteeing the right to all people of a healthy and safe environment</li> <li>○ Create an enabling framework for cooperative governance in environmental matters</li> <li>○ Establish a legislative framework for environmental management principles and integrated environmental management</li> </ul> </li> <li>• Legislation for compulsory Environmental Impact Assessments (EIA), promulgated in terms of Sections 21, 22, and 26 of the Environmental Conservation Act</li> <li>• Objectives: <ul style="list-style-type: none"> <li>○ Thorough and uniform control of the environmental impact of development projects</li> <li>○ Promote a sustainable development</li> <li>○ Ensure that social and economic interests are taken into account</li> <li>○ Regulate the process and reports required</li> </ul> </li> </ul>
Minerals and Energy	Minerals and Petroleum Resources Development Act (MPRDA)	73 of 1989	<ul style="list-style-type: none"> <li>• This Act requires the provision of an Environmental Management Programme (EMP) for all mining activities and an Environmental Impact Assessment (EIA) for proposed new mines</li> <li>• These programmes and reports regulate environmental management and protection for all mining activities, including the management and protection of water resources</li> </ul>

## 6 PRINCIPLES AND APPROACHES

The guidelines, operational procedures and detailed practices included in the Dolomite Guideline are aligned to the principles and approaches included in the various acts, policies and strategies that are summarised in **Table 3**.

Some of the key principles adopted are:

- **Equity:** Fairness to people and communities who do not have equal access to natural resources and/or to social and economic goods.
- **Participation:** All interested and affected parties have a right to participate in the management of water resources; participation includes meaningful, timely and representative consultation with interested and affected parties in order to contribute to effective and informed decision-making.
- **Freedom of information:** Openness and transparency in decision-making and information dissemination.
- **Sustainable development:** Promotion of actions and practices that focus on conservation and sustainable use of the water resource, such that future generations have access to the resource and that it meets their needs.
- **Stewardship:** All water users are required to ensure and strive for the same water quantity and quality goals at agreed risk levels.
- **Flexibility:** In undertaking the management of the dolomite water resource, the regulator has the flexibility to consider the application of different alternatives and approaches, provided that each of these is capable of meeting the desired objectives and requirements of the NWA.
- **Continual improvement:** The policies, strategies and guidelines developed by the Department focus on encouraging continual improvement in the water resource management actions and practices of both government and the regulated community.
- **Delegated responsibility:** The Department focuses on placing responsibility for achieving the goals and objectives of the NWA at the lowest (most local) level possible while maintaining effective performance.

The procedures and practices in the Dolomite Guideline are also based on the following key approaches:

- **Precautionary approach:** The regulatory system adopts a risk-averse and cautious approach to water management, recognising that the water resource is vulnerable to threats from pollution and that there are certain constraints to the current knowledge base. Active measures are therefore required to be taken to avert or minimise the potential risk of undesirable impacts on the water resource. The implications of the precautionary approach include:
  - Avoiding potential risks to the water resource, wherever possible
  - Minimising risks to the water resource by being conservative in all decision-making steps on water resource management, and
  - Encouraging conservation and sustainable use of the water resource to reduce the need to develop new resources.
  
- **Prevention approach:** The Department's strategies on water resource management include a hierarchy of control measures that will govern such management, including, in order of priority:
  - Waste elimination, substitution, recycling, re-use and disposal, effected through the adoption of Best Practice guidelines and cleaner technology, and
  - Control, through the water use authorisation process, either of developments taking place, or of the use of procedures, processes, activities or substances that produce discharges or emissions of water containing waste where there is an unacceptably high risk to the water resource.
  
- **Differentiated approach:** This approach recognises that applying the same degree of management input to all water resources can be both inefficient and wasteful. South Africa's water management policy and strategy do not aim to prevent impacts to the water resource at all costs, since this could hinder much needed social and economic development. The approach rather calls for a differentiated level of management effort in order not only to use the available resources most effectively but also to meet the water resource objectives.
  
- **Integration:** Integration ensures uniformity and consistency of approach between departments, eliminates duplication, ensures cooperation, rationalises resources and ensures the consideration of all media. Integration aims to ensure effective enforcement of regulations through a coordinated regulatory and enforcement interface with the regulated community.
  
- **Risk-based approach:** This approach recognises the need for a link between the level of control required to manage resource development and the risks posed on the resource by that development. A lower level of control can be motivated if it can be demonstrated that the risks posed by the development are within acceptable limits, and *vice versa*. The risk-based approach allows for the identification of areas of risk and impact mitigation in these risk areas in order to achieve focussed and effective water resource management actions.

## 7 INSTITUTIONAL ARRANGEMENTS

### 7.1 Description of the role-players

The various role-players involved in the assessment, planning and management of water resources in the dolomitic areas are:

- National institutions: Department of Water Affairs and Forestry (Head Office) and Department of Environmental Affairs and Tourism
- Regional institutions:
  - Department of Water Affairs and Forestry (Regional Offices)
  - Catchment Management Agencies (CMAs)
  - Dolomite Aquifer Management Committees
  - Department of Agriculture
  - Provincial Environmental Offices
- Local institutions:
  - Dolomite Committee(s)
  - Water User Associations (WUAs)
  - District and local municipalities
  - Water Boards
  - Water forums and reference groups (groups of forums)
  - Ward Councillors and Ward Committees, and
  - Specific task teams or technical committees.

### 7.2 Roles and responsibilities

**Table 4** summarises the roles and responsibilities of the institutions at the various levels of government and society. The table also describes the opportunities and challenges facing the various institutional bodies in the assessment, planning and management of water resources in the dolomitic areas.

**Table 4: Institutional roles, responsibilities, opportunities and challenges**

Level	Institution	Roles and responsibilities	Opportunities	Challenges
National	Department: Water Affairs and Forestry (National Office)	<ul style="list-style-type: none"> <li>• Responsibility to “protect, use, develop, conserve, manage and control water resources in a sustainable manner, for the benefit of all”</li> <li>• Develop policies, strategies and guidelines for effective resource management</li> <li>• Organisational approach:               <ul style="list-style-type: none"> <li>○ Centralised planning and policy-making</li> <li>○ Support function to Regional Offices</li> <li>○ Decentralised implementation, regional and catchment level</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Integration of resource management functions at a high level</li> </ul>	<ul style="list-style-type: none"> <li>• Ensuring Strategic goals are met</li> <li>• Participation of stakeholders in initiatives</li> <li>• Developing relevant useful tools for implementation of policies &amp; strategies</li> </ul>
	Department of Environment and Tourism	<ul style="list-style-type: none"> <li>• Protection, conservation and maintenance of terrestrial and aquatic ecosystems and water resources</li> </ul>	<ul style="list-style-type: none"> <li>• Protection of the national water resource</li> </ul>	<ul style="list-style-type: none"> <li>• Integration of stakeholders</li> </ul>
Regional	Department: Water Affairs and Forestry (Regional Offices)	<ul style="list-style-type: none"> <li>• Delegated responsibility of water resource management</li> <li>• Implementing agents for the Department of water resources policy and strategy</li> <li>• Audit of CMA with its related functions and responsibilities</li> </ul>	<p>Pivotal role in decentralised water resources management, having greater knowledge of the dolomitic water resource issues at regional level</p> <p>Opportunities from decentralised strategy:</p> <ul style="list-style-type: none"> <li>• Enhanced groundwater management</li> <li>• Increased participation</li> </ul>	<p>Limited geohydrological capacity and skills in Regional Offices to take on the decentralised responsibilities:</p> <ul style="list-style-type: none"> <li>• Institutional capacity</li> <li>• Historic neglect of groundwater in overall water management</li> <li>• Lack of clear integrated management structure</li> </ul>

Level	Institution	Roles and responsibilities	Opportunities	Challenges
	Catchment Management Agency (CMA)	<ul style="list-style-type: none"> <li>Responsible for the day-to-day management of water resources in dolomitic areas</li> <li>Delegated responsibility for some water management activities, including water use allocation</li> <li>Delegation managed and monitored against a specific catchment management strategy for each WMA</li> </ul>	<ul style="list-style-type: none"> <li>Pivotal role in the day-to-day management of water related issues in the WMA</li> <li>Opportunities from decentralised strategy</li> </ul>	<ul style="list-style-type: none"> <li>WMAs defined according to surface water systems</li> <li>Aquifers extend over a number of WMAs, leading to complex trans-boundary management issues</li> </ul>
	Environmental section of the Department of Agriculture and Land Affairs	<ul style="list-style-type: none"> <li>Protection, conservation and maintenance of terrestrial and aquatic ecosystems and water resources</li> </ul>	<ul style="list-style-type: none"> <li>Protection of the national water resource</li> </ul>	<ul style="list-style-type: none"> <li>Integration of stakeholders</li> </ul>
	Dolomite Aquifer Management Committee	<ul style="list-style-type: none"> <li>Responsible for cross-boundary coordination where the aquifer spans more than one WMA</li> </ul>	<ul style="list-style-type: none"> <li>Pivotal institutional role for the coordination of the management of the water resources</li> </ul>	<ul style="list-style-type: none"> <li>Institutional capacity</li> <li>Knowledge base – user defined</li> </ul>
Site-specific	Dolomite Committee	<ul style="list-style-type: none"> <li>Responsible for day-to-day management of the water resources in the dolomite aquifer within the WMA or local catchment</li> </ul>	<ul style="list-style-type: none"> <li>Key role in ensuring optimum sustainable development</li> </ul>	<ul style="list-style-type: none"> <li>Licensing</li> <li>Resource assessment</li> <li>Management of the available resources</li> </ul>
	Water User Association	<ul style="list-style-type: none"> <li>Responsible for the management of the water resources being utilised, including those of the dolomite aquifer</li> </ul>	<ul style="list-style-type: none"> <li>Key role in the institutional structure for the management and use of water</li> <li>Major users of water</li> </ul>	<ul style="list-style-type: none"> <li>Lack of capacity and financial resources</li> <li>Lack of clarity in terms of divisions of roles and responsibilities</li> </ul>

Level	Institution	Roles and responsibilities	Opportunities	Challenges
	District and Local Municipalities	<ul style="list-style-type: none"> <li>• Planning and developing water services and infrastructure to ensure acceptable minimum levels of provision to their constituents</li> <li>• Management of local water source</li> </ul>	<ul style="list-style-type: none"> <li>• Key role in the institutional structure for the management and use of water</li> <li>• Major users of water</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of capacity and financial resources</li> <li>• Lack of clarity in terms of divisions of roles and responsibilities</li> </ul>
	Water Boards	<ul style="list-style-type: none"> <li>• Organs of state established to provide water services to other water services institutions</li> </ul>	<ul style="list-style-type: none"> <li>• Strategic and operational management input</li> </ul>	<ul style="list-style-type: none"> <li>• Future role unclear: Economic viability of Water Boards as opposed to Local and District Councils in providing the service is being debated</li> </ul>
	Water forums and reference groups	<ul style="list-style-type: none"> <li>• Monitoring and management of water resource development schemes</li> </ul>	<ul style="list-style-type: none"> <li>• Local water resource management</li> </ul>	<ul style="list-style-type: none"> <li>• Representation on water institutions</li> </ul>
	Ward Councillors and Ward Committees	<ul style="list-style-type: none"> <li>• Representation of communities' needs</li> <li>• Local management of water schemes</li> <li>• Set up and operate water management committees</li> </ul>	Local water resource management	Representation on water institutions
	Task teams	<ul style="list-style-type: none"> <li>• Responsible for specific projects of a short-term nature, relating to assessment, planning and management of water resources</li> </ul>	<ul style="list-style-type: none"> <li>• Focussed input to water management issues</li> </ul>	<ul style="list-style-type: none"> <li>• Retention of institutional memory</li> </ul>

### 7.3 Structure and the integration of functions

**Figure 2** indicates the proposed institutional framework for the assessment, planning and management of water resources in dolomitic areas. This framework is underpinned by the formation of a Dolomite Aquifer Management Committee (DAMC) in areas where the dolomite aquifer(s) span(s) more than one WMA and Dolomite Committees for addressing site-specific issues.

#### Dolomite Aquifer Management Committee (DAMC)

The DAMC will be an advisory body (not legislated) set up by the various role-players in the catchments to provide strategic input to the assessment, planning and management of the water resources in the dolomitic areas.

The primary representation on each of the established DAMCs will be from the various CMAs within which the dolomitic area is located. Other representation will be from the Department's National Office, Regional Office/CMA, Water User Associations, Water Boards, District and Local Municipalities, as well as other relevant government Departments with an interest in the specific area. The representatives should be sufficiently or appropriately informed and knowledgeable about the area. The DAMC will:

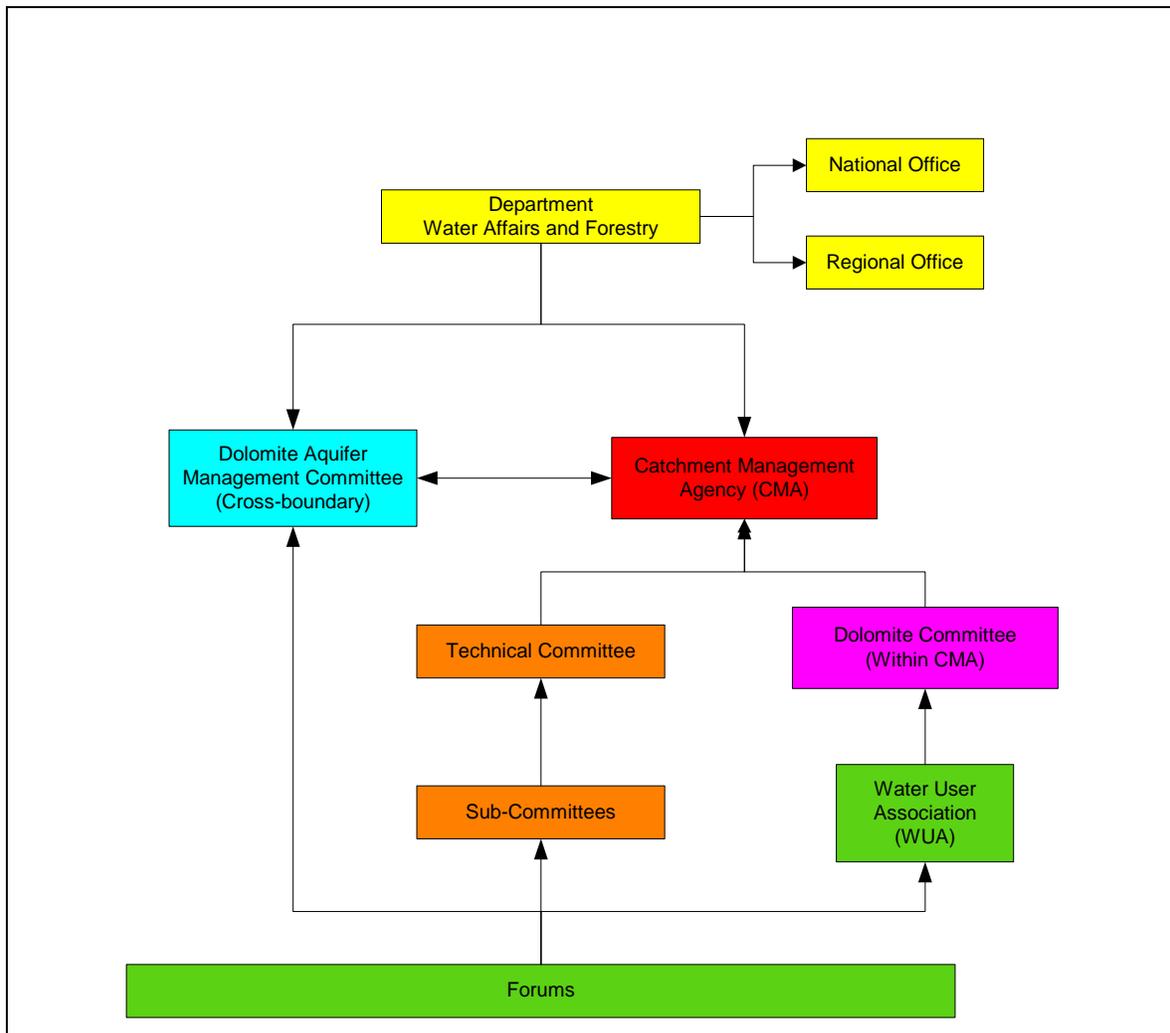
- Ensure the integration of the different functional groups for the assessment, planning and management of the water resources in the specific dolomitic area
- Provide all necessary strategic and operational input to ensure that the use of the aquifers in the dolomitic area is planned and managed on a sustainable basis. Ensure cooperative governance with other spheres of government, for example, in respect to land-based activities and zoning within the dolomite aquifer areas
- Assess the cumulative impacts of water use, different compartments and stakeholder groups on the integrity of the dolomitic resource and devise action plans to mitigate this impact, if required, and
- Receive assistance and input on the assessment, planning and management of the water resources from Dolomite Committees and task teams.

#### Dolomite Committee

The Dolomite Committee will be a legal entity, set up by the Catchment Management Agency (CMA) in accordance with Section 82(5) of the National Water Act and will:

- Be delegated powers from the CMA for the day-to-day management of the water resources in the dolomitic areas,

- Be responsible for management functions, such as water use control, resource assessment and management of the available resources, and report to the CMA on a regular basis on the effectiveness of management of the water resources. Correspondence, reports and minutes of the Dolomite Committee activities should also be provided to the CMA and Department’s Regional Office, and
- Integrate the management functions between a Water User Association (if a WUA is in place in the dolomitic area) and other stakeholders in the area.



**Figure 2: Proposed institutional framework**

#### 7.4 Reporting and auditing functions

Regular (monthly) operational reporting will primarily be from the Dolomite Committee to the CMA. These reports will be collated and summarised into quarterly reports to be submitted to the CMA and DAMC. The CMA will then provide an audit function of the effectiveness of management of the dolomite water resources.

## **8 PUBLIC PARTICIPATION**

Public participation in this project will serve as a vehicle to provide assistance and guidance both to the Water Manager and all other role-players involved in the assessment, planning and management of water resources within the country's dolomitic areas. If conducted effectively, public participation will contribute to informed and integrated decision-making aimed at achieving sustainable development.

### **8.1 What is Public Participation?**

Public participation is the involvement of all parties who may potentially have an interest in a development or project, or be affected by it. It entails a wide range of activities, ranging from providing information, through consultation to direct involvement of the public in aspects of the decision-making process.

The Department of Water Affairs and Forestry's Generic Guidelines for Public Participation (September 2001) defines public participation as the *"ongoing interaction between role-players that is aimed at improving decision-making during the planning, design, implementation and evaluation of the Department's development projects and processes. It requires the involvement of all stakeholders, including groups that are often marginalised, such as women and the youth. Decision-makers have to consider the views of stakeholders during the decision-making process."*

### **8.2 Benefits of public participation**

In its submission to the World Summit on Sustainable Development, the International Association for Public Participation (IAP2) described the benefits of public participation:

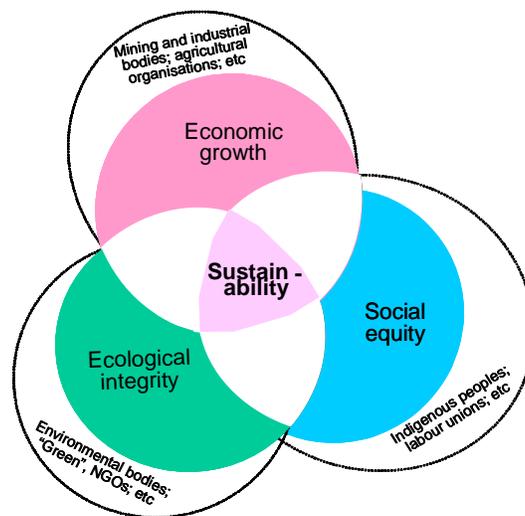
- Builds public understanding of the need for a proposed policy, programme, plan or project and leads to better and more durable decisions
- Creates trust in decision-makers and their processes, leading to stable policies and enduring decisions
- Provides an early warning of issues that require mitigation
- Builds public ownership and a stronger stake in initiatives leading to participants carrying out their responsibilities during implementation – they do not want to be seen letting their co-participants down
- Identifies local customs or institutions that could be barriers to implementation, with opportunities to adapt the activity before the implementation begins

- Creates opportunities for stakeholders to discuss their differences directly, often leading to creative new solutions
- Manages single-issue viewpoints through an interactive process which allows a broad range of balancing perspectives and values
- Enriches decision-making through a diversity of opinion and the local and traditional knowledge and collective wisdom of a range of stakeholders, and
- Builds “legitimacy” for decisions that allows them to withstand changes in government or company policy and leadership.

### 8.3 Public participation’s role in achieving sustainable development

The greatest benefit of public participation is its contribution to achieving sustainability. For a project, policy or programme to be sustainable, it has to take into consideration all three dimensions of sustainability, namely, economic growth, social equity and ecological integrity.

These three dimensions are seldom in balance as there are always trade-offs based on local needs and circumstances, and the point of sustainability differs from project to project. Public participation assists decision-makers to establish the point of sustainability for each project. It contributes essential local knowledge and wisdom to project assessment, planning and design, and management, and clarifies the degree to which stakeholders are willing to accept, or live with, the trade-offs (**Figure 3**). Thus, public participation assists decision-makers to make informed and integrated decisions about the sustainability of a proposed project, policy, programme or plan.



**Figure 3: Contributions to sustainability**

Public participation therefore assists in achieving sustainable development through stakeholders deliberating the trade-offs between ecological integrity, social equity and economic growth.