



**water & forestry**

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 3***

***Procedures***

**Final**

**August 2006**

## TABLE OF CONTENTS

SECTION	PAGE
1	INTRODUCTION AND CONTEXT ..... 1
1.1	Context..... 1
1.2	Details included in the Guideline Document ..... 1
2	ASSESSMENT ..... 2
2.1	Step 1: Undertake desk study and remote sensing ..... 2
2.2	Step 2: Identify areas for additional work ..... 4
2.3	Step 3: Undertake hydrocensus ..... 5
2.4	Step 4: Siting of monitoring/exploration boreholes..... 7
2.5	Step 5: Drilling and testing of monitoring/existing boreholes ..... 8
2.6	Step 6: Prepare Conceptual Groundwater Model ..... 9
2.7	Step 7: Risk Assessment ..... 10
2.8	Step 8: Spring Capture and Surface/Groundwater Interaction..... 11
2.9	Step 9: Present to stakeholders and obtain input ..... 12
2.10	Step 10: Prepare Numerical/Analytical/Risk-based Groundwater Model..... 13
2.11	Step 11: Prepare Assessment Report..... 14
2.12	Specialist Studies..... 16
3	PLANNING ..... 17
3.1	National Level Planning ..... 17
3.1.1	Step 1: Confirm land use planning and study parameters ..... 17
3.1.2	Step 2: Summarise relevant data and information ..... 18
3.1.3	Step 3: Technical evaluation and costing of options ..... 19
3.1.4	Step 4: Summarise and rank options ..... 20
3.1.5	Step 5: Screening of Options Workshop ..... 21
3.1.6	Step 6: Prepare Planning Report ..... 22
3.1.7	Step 7: Input information to Catchment level assessment and planning..... 23
3.2	Catchment Level Planning ..... 24
3.2.1	Step 1: Summarise required data/ information..... 24
3.2.2	Step 2: Options analysis..... 25
3.2.3	Step 3: Rank options ..... 26
3.2.4	Step 4: Summarise options ..... 27
3.2.5	Step 5: Confirm ranking with stakeholders..... 28
3.2.6	Step 6: Prepare planning report and dolomite strategy ..... 29
3.3	Site-Specific Planning ..... 30
3.3.1	Step 1: Summarise required data/information..... 30
3.3.2	Step 2: Prepare feasibility level design and costs ..... 31
3.3.3	Step 3: Confirm extent of monitoring programme ..... 32
3.3.4	Step 4: Arrange interaction meetings ..... 33
3.3.5	Step 5: Prepare tender drawings and specifications ..... 34
3.3.6	Step 6: Prepare planning report ..... 35
4	NATIONAL LEVEL MANAGEMENT..... 36
4.1.1	Step 1: Develop tools for groundwater resources management ..... 36
4.1.2	Step 2: Review catchment level management reports ..... 37
4.1.3	Step 3: Assist in devising action plans ..... 38

	4.1.4	Step 4: Prepare summary document.....	39
	4.1.5	Step 5: Distribute the summary document .....	40
4.2		Catchment Level Management .....	41
	4.2.1	Step 1: Prepare strategies and management plans .....	41
	4.2.2	Step 2: Monitoring and data management .....	42
	4.2.3	Step 3: Assessment of water use.....	43
	4.2.4	Step 4: Assess aquifer performance and compliance .....	44
	4.2.5	Step 5: Review control and license conditions .....	45
	4.2.6	Step 6: Revise licensing conditions and RQOs.....	46
	4.2.7	Step 7: Design remedial actions.....	47
	4.2.8	Step 8: Review and confirm remedial actions .....	48
	4.2.9	Step 9: Prepare actions plans for catchment level management .....	49
	4.2.10	Step 10: Collate information into management report.....	50
4.3		Site Specific Management .....	51
	4.3.1	Step 1: Set up WSDP, IDP, EMP .....	51
	4.3.2	Step 2: Implement water supply scheme or remedial action(s) .....	52
	4.3.3	Step 3: Install/update and maintain monitoring network.....	53
	4.3.4	Step 4: Operation and maintenance of the system .....	54
	4.3.5	Step 5: Data Management: Gather, store and assess the monitoring data .....	55
	4.3.6	Step 6: Control of water use.....	56
	4.3.7	Step 7: Summarise monitoring data in a site-specific reporting .....	57
5		MANAGING ONGOING STAKEHOLDER RELATIONSHIPS.....	58

## LIST OF TABLES

Table 1: Differences between external company communication and public participation .... 59

Table 2: Procedures to assist Water Managers in managing ongoing stakeholder relations 60

# **1 INTRODUCTION AND CONTEXT**

## **1.1 Context**

Volume 1 provides background details on the context of the Dolomite Guideline within the National Water Act (Act 36 of 1998) and integrated water resources management (IWRM). The Dolomite Guideline is presented as a separate document, 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, and
- Although a wealth of information is available on the assessment, planning and management functions in dolomitic areas, this has not been collated into a single coordinated document. The Dolomite Guideline addresses this need.

## **1.2 Details included in the Guideline Document**

The Dolomite Guideline is aimed primarily at the Water Manager in a Water Management Area (WMA) where assessment, planning and management of water resources in dolomitic areas are required. The guideline will also be useful to other role-players involved in the management of water resources in the catchment. The Guideline is presented in three separate volumes to improve user-friendliness and to assist with easy reference of information. The details included in each volume, 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 on 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 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.

## 2 ASSESSMENT

### 2.1 Step 1: Undertake desk study and remote sensing

Stage	Activity	Volume 2 reference	Done
Input	Collect data relevant to the dolomite aquifers and the scale of the assessment. Sources include:	5.3.1	
	➤ Directorate: Information Management		
	➤ Directorate: Hydrological Services <ul style="list-style-type: none"> <li>○ Sub-Directorate: Groundwater Resources, Assessment and Management</li> </ul>		
	➤ Directorate: Water Resources Planning Systems <ul style="list-style-type: none"> <li>○ Sub-Directorate: Integrated Hydrological Planning</li> </ul>		
	➤ Regional DWAF Office, CMA Office		
	➤ Others		
	Information types include:		
	➤ ISP document(s), WSDP, IDP		
	➤ Hydrogeological reports, borehole logs, test data		
	➤ Published geological maps		
	➤ Published hydrogeological maps and memoirs		
	➤ Monitoring data from national, catchment or site-specific monitoring network (temporal water level data and water quality data)		
	➤ Information on water use/abstraction (concentrating on major abstractors), registered water users, WARMS data, licences issued and conditions		
	➤ Maps and orthophotographs		
➤ Satellite imagery and stereo pair air photography			

Stage	Activity	Volume 2 reference	Done
Methodology	Collate information	.	
	Review and interpret existing data		
	Prepare (preliminary) GIS maps at an appropriate scale indicating: <ul style="list-style-type: none"> <li>➤ Dolomite aquifer extent</li> <li>➤ Position of springs</li> <li>➤ Water course and boreholes</li> <li>➤ Piezometric levels (water levels)</li> <li>➤ Groundwater flow directions</li> <li>➤ Compartmentalisation</li> <li>➤ Groundwater quality, and</li> <li>➤ Impacted or potentially impacted areas</li> </ul>		
	Prepare assessment of water availability and water demand in areas that could be serviced by dolomite groundwater		
	Compile data into and/or update database		
Output	Desk study report to include:		
	➤ Discussion of available data		
	➤ Water balance and water availability		
	➤ GIS maps and database		
	➤ Water demand assessment for areas that could be supplied by dolomite aquifers		
	➤ Delineation of potential dolomite aquifers that could supply the required water demand		
	➤ Identification of dolomite aquifers where further studies are required to confirm resource availability/viability		
	➤ Identification of target aquifers that could satisfy project requirement (bulk water supply, compulsory licensing, etc)		
➤ Discussion of alternatives (e.g. expanding a surface water scheme or conjunctive surface/groundwater use)			

## 2.2 Step 2: Identify areas for additional work

Stage	Activity	Volume 2 reference	Done
Input	Desk study report and supporting information	5.3.2	
Methodology	Review the desk study report:		
	➤ Determine distribution of groundwater availability in the dolomite aquifers		
	➤ Determine current use of dolomite groundwater		
	➤ Undertake discussions/workshops with national, regional and local DWAF offices/CMA		
	➤ Undertake gap analysis		
Output	Confirmation of knowledge gaps		
	Identification of areas requiring further work and prepare work plan as required		

### 2.3 Step 3: Undertake hydrocensus

Stage	Activity	Volume 2 reference	Done
Input	Desk study report/gap analysis	5.3.3	
	Available data concerning distribution of water boreholes		
	Hydrogeological map(s) of dolomite aquifer within the catchment		
Methodology	Select key areas within the dolomite aquifer to undertake the hydrocensus to ensure a more-or-less even distribution of data points compatible with objectives and scale of study		
	Liaise with land owners, obtain permission to visit boreholes, wells or springs		
	Locate selected boreholes, wells or springs. Collect details of:		
	➤ Coordinates (using GPS)		
	➤ Existing equipment		
	➤ Current use		
	➤ Owner		
	➤ Water level		
	➤ Reported or measured depth (if borehole or well)		
	➤ Reported or measured yield (flow if spring)		
	➤ Any available information (e.g. borehole log). (Details on private boreholes are sometimes available from the drilling contractor's invoice)		
➤ Field measurement of pH and EC. Collect sample for full analysis from key selected boreholes/wells/springs to obtain broad overview of groundwater quality. Analyse for at least: pH, TDS, EC, Ca, Mg, Na, K, HCO <sub>3</sub> , SO <sub>4</sub> , Cl, NO <sub>3</sub> , F, Fe, Mn			

Stage	Activity	Volume 2 reference	Done
	Identify potential pollution sources (e.g. waste dumps, mining activities, waste water treatment works, intensive rural settlement, feed lots, irrigation areas)	5.3.3 (cont)	
	Verify existing groundwater use		
	Record all data on standard hydrocensus forms		
	Submit data to relevant department		
Output	Collate all data		
	Prepare/update piezometric (water level) maps of the dolomite aquifer		
	Make recommendations on way forward. These could include:		
	➤ Recommendations for infilling studies		
	➤ Exploratory drilling and testing programme within the identified dolomite aquifer		
	➤ Implementation of, or upgrading of existing, catchment level monitoring network of dolomite aquifer		

## 2.4 Step 4: Siting of monitoring/exploration boreholes

Stage	Activity	Volume 2 reference	Done
Input	Updated desk study report	5.3.4	
	Identity of areas requiring additional data/information		
Methodology	Appoint Hydrogeologist, as required		
	Assess need for and number of monitoring/exploratory boreholes		
	Obtain and interpret remote sensing data: <ul style="list-style-type: none"> <li>➤ Landsat imagery</li> <li>➤ Stereo pair black and white air photography</li> </ul>		
	Identify karst and other features (dykes contact zones, faults, weathering), important for groundwater occurrence		
	Undertake geological appraisal		
	Obtain permission from landowner(s) for access to undertake survey, and to drill and test subsequent boreholes		
	Undertake geophysical survey as necessary to select positions for monitoring/exploratory boreholes. Geophysical survey must comprise a minimum of two techniques, which will include: <ul style="list-style-type: none"> <li>➤ Magnetic</li> <li>➤ Gravity (gravity is a particularly useful technique for detailed siting and aquifer assessment)</li> <li>➤ Electromagnetic</li> <li>➤ Electrical resistivity</li> </ul>		
	Combine desk study, geological and geophysical data to confirm number of monitoring/exploratory boreholes required		
Output	Siting report detailing:		
	➤ Hydrocensus result		
	➤ Area surveyed		
	➤ Techniques employed		
	➤ Location and number of monitoring/exploration boreholes		
	➤ Recommendations for the drilling and testing programme		

## 2.5 Step 5: Drilling and testing of monitoring/existing boreholes

Stage	Activity	Volume 2 reference	Done
Input	Siting report detailing number and location of monitoring/exploration boreholes	5.3.5	
	Technical specifications for drilling and testing	Appendix B1 and B2, Volume 2	
Methodology	Appoint specialist drilling and testing contractor		
	Appoint Hydrogeologist to plan and supervise the work		
	Drill the boreholes according to the technical specifications		
	Measure water strikes and blowing yields; prepare logs		
	Record water levels		
	Undertake testing of the boreholes as required according to the technical specifications		
	Collect water samples from key selected boreholes, wells and springs. Submit to a laboratory for analysis for macro-determinands, as a minimum: pH, TDS, EC, Ca, Mg, Na, K, HCO <sub>3</sub> , SO <sub>4</sub> , Cl, NO <sub>3</sub> , F, Fe, Mn		
Output	Geological and hydrogeological field report containing, as a minimum:		
	➤ A geological and construction log of each borehole drilled		
	➤ A hydrogeological log describing features of importance to the dolomite aquifer (e.g. karst intersections, cavities, fissures, water strike depths, blowing yield)		
	➤ Test results		
	➤ Water levels		
	➤ Water quality		
	Data files for input into database		

## 2.6 Step 6: Prepare Conceptual Groundwater Model

Stage	Activity	Volume 2 reference	Done
Input	Desk study report	5.3.6	
	Field report		
Methodology	Collate all available data		
	Describe the dolomite aquifer in terms of:		
	➤ Aquifer boundaries		
	➤ Lithological composition (e.g. distribution of chert-rich versus chert-poor horizons) which has a bearing on groundwater occurrence		
	➤ Compartments		
	➤ Presence of features of importance to groundwater occurrence and movement (e.g. fractures, karst, cavities, faults)		
	➤ Piezometric levels		
	➤ Distribution of springs, seepage zones and wetlands		
	➤ Location of sinkholes		
	➤ Recharge potential		
	Identify areas of existing abstraction		
	Distribution of land use (e.g. irrigation, mining, waste dumps, urban areas)		
	Identification of impacts (e.g. dewatered or polluted areas)		
Output	Report presenting the conceptual model of the aquifer to be used as planning and management document		

## 2.7 Step 7: Risk Assessment

Stage	Activity	Volume 2 reference	Done
Input	Risk assessment in dolomite Tolmachev, V, (2005), Buttrick, D B et al, (2001) and Buttrick D B and van Schalkwyk, A, (1995)	5.3.7	
	The Department of Public Works (DPW) guideline document PW 344 for risk assessments in land use developments		
Methodology	Identify risks		
	For each risk, identify probability of occurrence and consequence of occurrence		
	Rank risks in terms of probability and consequence		
	Identify mitigation measures		
	Prepare a Risk Management and Mitigation Plan		
Output	Risk Management and Mitigation Plan		

## 2.8 Step 8: Spring Capture and Surface/Groundwater Interaction

Stage	Activity	Volume 2 reference	Done
Input	Desk study report	5.3.8	
	Hydrocensus report		
	Water use information and water demand assessment		
	Reserve determination (as available)		
	Water Quality Objectives (WQO) (as available)		
Methodology	Assess spring status, including:		
	➤ Location, type, flow, size		
	➤ Existing infrastructure at the spring, weirs, canals, protection, etc		
	Map areas of wetlands		
	Map areas of seepage from groundwater into surface drainage and pans		
	Assess water quality		
	Assess vulnerability		
Output	Identification of springs with potential for capture		
	Identification of springs requiring protection (e.g. providing base flow into wetlands where capture could be detrimental)		
	Spring capture design		
	Recommendations for further studies		

**2.9 Step 9: Present to stakeholders and obtain input**

<b>Stage</b>	<b>Activity</b>	<b>Volume 2 reference</b>	<b>Done</b>
Input	Results of assessment of water availability and water requirements	5.3.9	
Methodology	Identify stakeholders		
	Set up focus group meetings and discuss recommendations and options		
Output	Prepare issues report		
	Recommendations on options		

## 2.10 Step 10: Prepare Numerical/Analytical/Risk-based Groundwater Model

Stage	Activity	Volume 2 reference	Done
Input	Desk study report	5.3.10	
	Hydrocensus report		
	Field data, field report		
	Conceptual model		
	Objectives of the modelling process (e.g. regional/catchment or site-specific resource assessment, land use assessment, water quality trends)		
Methodology	Select appropriate modelling technique		
	➤ Analytical (e.g. spread sheet, arithmetic, statistical)		
	➤ Risk based (e.g. Minimum requirements for dolomite land use, Risk Based Corrective Action (RBCA), The South African Groundwater Decision Tool (SAGDT))		
	➤ Numerical – 2D or 3D modelling package (e.g. Modflow or Feflow)		
	Develop, refine and test model		
Output	Modelling predictions		
	Gap analysis		
	Report dealing with the modelling process and results		

## 2.11 Step 11: Prepare Assessment Report

Stage	Activity	Volume 2 reference	Done
Input	Desk study report	5.3.11	
	Field data, results and interpretations		
	Output from stakeholder consultations		
Methodology	Review and integrate data collected		
Output	Prepare assessment report according to generic Table of Contents	Appendix E1 Vol 3	
	Assessment report incorporating all work undertaken in the completed steps, describing the groundwater resources of the dolomite aquifer. The report will include:		
	Hydrogeological maps		
	Borehole logs		
	Test pumping data		
	Distribution of aquifer zones within the dolomite outcrop		
	Delineation of compartments within the dolomite aquifer		
	An assessment of the available dolomite groundwater resources		
	An assessment of the groundwater quality		

Stage	Activity	Volume 2 reference	Done
	Delineation of target areas suitable for future development		
	Delineation of areas of heavy or over-exploitation		
	Discussion of current impacts from existing abstraction or land use (e.g. irrigation, mining)		
	Discussion of surface and groundwater interaction		
	Recommendations for planning and sustainable management of the dolomite aquifer		
	Recommendations for upgrading of existing, or implementation of new, monitoring programme		
	Identification of issues. These could include:		
	<ul style="list-style-type: none"> <li>➤ Over-exploitation</li> <li>➤ Areas impacted by mining dewatering</li> <li>➤ Areas suffering from water shortages</li> <li>➤ Threats to dolomite water quality</li> <li>➤ Cross-boundary issues (catchment, WMA, international)</li> <li>➤ Management and monitoring issues</li> </ul>		

## 2.12 Specialist Studies

Stage	Activity	Volume 2 reference	Done
Input	Definition of specialist study. Examples are:	5.4	
	➤ Surface/groundwater interaction		
	➤ Contribution of dolomitic groundwater to stream, rivers and wetlands		
	➤ Identification of groundwater-dependant ecosystems		
	➤ Direct, indirect and/or unique/keystone ecosystems		
	➤ Determine sensitivity of landscape to fluctuations in water levels – sinkhole formation		
	➤ Assess existing or planned infrastructure that may be affected		
	All available data from previous studies		
Methodology	Define specialist study objectives		
	Appoint specialist service provider		
	Desk study		
	Design field study programme (the details of the study will depend upon the specialist study)		
	Undertake the field programme (i.e. data collection, drilling, testing, water sampling, monitoring, modelling, etc)		
Output	Specialist study report		

### 3 PLANNING

#### 3.1 National Level Planning

##### 3.1.1 Step 1: Confirm land use planning and study parameters

Stage	Activity	Volume 2 reference	Done
Input	Recommendations from relevant level of the assessment study	6.4.1	
	Resource Quality Objectives for the selected catchment(s)		
	Land use planning details		
Methodology	Define and confirm the parameters for the study, including:		
	➤ Likely geographic location		
	➤ Quantity of water required, as well as the assurance of supply (percentage of time that the water is required)		
	➤ Water quality constraints		
	➤ Proposed water use options		
Output	Confirmation of land use planning		
	Confirmation of study parameters		

### 3.1.2 Step 2: Summarise relevant data and information

Stage	Activity	Volume 2 reference	Done
Input	Information from National Level Planning: Step 1	6.4.2	
Methodology	Prepare design criteria report		
	Prepare data summary report containing all relevant information as appendices		
Output	Design criteria report		
	Data summary report		
	Conceptual layouts of the water use options		
	Preliminary cost analyses of the options		

### 3.1.3 Step 3: Technical evaluation and costing of options

Stage	Activity	Volume 2 reference	Done
Input	Confirmation of land use planning	6.4.3	
	Design criteria report		
	Data summary report		
Methodology	Prepare conceptual layout drawings of water use options		
	Assess technical feasibility of water use options, including:		
	➤ Sustainable yield of the source		
	➤ Pump and pipeline requirements		
	➤ Distribution network		
	Determine conceptual level costs for each water use option, from the conceptual layout plans		
	Compare technical and financial aspects for each water use option		
	Prepare conceptual level report		
Output	Report on conceptual level comparison of water use options		

### 3.1.4 Step 4: Summarise and rank options

Stage	Activity	Volume 2 reference	Done
Input	Report on conceptual level comparison of water use options	6.4.4	
	Design criteria report		
	Data summary report		
Methodology	Prepare a summary of the water use options		
	Rank the water use options in a user-friendly format		
Output	Summary report on water use options, with rankings, for presentation to the stakeholders		

### 3.1.5 Step 5: Screening of Options Workshop

Stage	Activity	Volume 2 reference	Done
Input	Report on conceptual level comparison of water use options	6.4.5	
	Records of discussions during assessment phase		
	Summary report on water use options, with rankings		
Methodology	Identify and/or confirm stakeholders		
	Set up workshops and focus group meetings and discuss water use options		
	Prepare issues and comments report		
Output	Issues and comments report		
	Recommendations from the workshops on the preferred options/screening of options		

### 3.1.6 Step 6: Prepare Planning Report

Stage	Activity	Volume 2 reference	Done
Input	Report on conceptual level comparison of water use options	6.4.6	
	Summary report on water use options		
	Issues and comments report		
	Recommendations from the workshops on the preferred options		
Methodology	Collate information and prepare national level planning report		
	Review national level planning report:		
	➤ Within the Department (internal review)		
	➤ With stakeholders (external review and comment)		
	Prepare review and summary report		
	Sign-off national level planning report		
Output	National level planning report		
	Comments documents from review		

### 3.1.7 Step 7: Input information to Catchment level assessment and planning

Stage	Activity	Volume 2 reference	Done
Input	National level planning report	6.4.7	
	Comments documents from review		
Methodology	Liaise with Directorate: Information Management; Sub-Directorate: Groundwater Resources, Assessment and Management		
	Provide relevant data for input into NGS, including:		
	➤ Location and layout of potential water use options		
	➤ Technical and financial feasibility		
Output	Updated NGS		

## 3.2 Catchment Level Planning

### 3.2.1 Step 1: Summarise required data/ information

Stage	Activity	Volume 2 reference	Done
Input	National level planning report	6.5.1	
	Catchment level assessment report		
Methodology	Prepare updated design criteria report		
	Prepare data summary report containing all relevant information as appendices		
Output	Design criteria report		
	Data summary report		

### 3.2.2 Step 2: Options analysis

Stage	Activity	Volume 2 reference	Done
Input	National level planning report	6.5.2	
	Catchment level assessment report		
	Design criteria report		
	Data summary report		
	Conceptual and/or numerical groundwater model		
	Catchment-based resource evaluation models (water resource planning model, water resource yield model, WRSM 2005)		
	Other relevant information within the Department's data management system		
Methodology	Using the conceptual level groundwater model and the resources models, undertake pre-feasibility level design for each water use option, including an assessment of:		
	➤ Social considerations		
	➤ Potential environmental impact		
	➤ Economic and financial viability		
	➤ Technical feasibility		
	➤ Long-term land-use		
	➤ Regulatory considerations		
	Prepare pre-feasibility level drawings of water use options		
	Prepare summary bill of quantity and pre-feasibility level costs for each water use option (25% accuracy)		
Output	Pre-feasibility design report, including costs		
	Pre-feasibility level drawings		

### 3.2.3 Step 3: Rank options

Stage	Activity	Volume 2 reference	Done
Input	Pre-feasibility design report, including costs	6.5.3	
	Pre-feasibility level drawings		
	National level planning report		
	Catchment level assessment report		
Methodology	Rank the water use options being assessed, in order of preference, using one or more of the following methods:		
	➤ Discounted Cash Flow (DCF)		
	➤ Multi-criteria assessment	Fig 19 and Fig 20, Volume 2	
	➤ Internal consultation within the Department (qualitative assessment)		
Output	Report on ranking of water use options		
	Recommendations on options to take to feasibility level design		

**3.2.4 Step 4: Summarise options**

<b>Stage</b>	<b>Activity</b>	<b>Volume 2 reference</b>	<b>Done</b>
Input	Report on ranking of water use options	6.5.4	
	Recommendations on options to take to feasibility level design		
Methodology	Prepare a summary of the water use options		
	Rank the water use options in a user-friendly format		
Output	Summary report on water use options, with rankings, for presentation to the stakeholders		

### 3.2.5 Step 5: Confirm ranking with stakeholders

Stage	Activity	Volume 2 reference	Done
Input	Report on ranking of water use options	6.5.5	
	Summary report		
Methodology	Set up workshops and focus group meetings with stakeholders		
	Discuss water use options, noting comments and issues raised		
	Prepare proceedings of workshops and meetings		
	Prepare comments and issues report		
Output	Proceedings reports		
	Comments and issues report		
	Summary of impact of the discussions on the ranking and design of the water use options		

### 3.2.6 Step 6: Prepare planning report and dolomite strategy

Stage	Activity	Volume 2 reference	Done
Input	Report on ranking of water use options	6.5.6	
	Summary report		
	Comments and issues report		
	Summary of impact of the discussions on the ranking and design of the water use options		
	Summary report giving recommendations		
Methodology	Collate information and prepare Catchment Level Planning Report, including dolomite management strategy		
	Review catchment level planning report		
	Prepare review and summary report		
	Sign-off catchment level planning report		
Output	Catchment level planning report		
	Comments documents from review		

### 3.3 Site-Specific Planning

#### 3.3.1 Step 1: Summarise required data/information

Stage	Activity	Volume 2 reference	Done
Input	Catchment level planning report	6.6.1	
	Summary report		
	Catchment level and site-specific assessment report		
Methodology	Prepare/update design criteria report		
	Prepare data summary report containing all relevant information as appendices		
Output	Updated design criteria report		
	Data summary report		

### 3.3.2 Step 2: Prepare feasibility level design and costs

Stage	Activity	Volume 2 reference	Done
Input	Report on ranking of water use options	6.6.2	
	Summary report		
	Conceptual and/or numerical groundwater model		
Methodology	Undertake feasibility level design, including details on:		
	➤ Borehole configuration and layout		
	➤ Water collection and distribution piping		
	➤ Water storage and pumping network		
	Prepare feasibility level drawings		
	Update bill of quantities and prepare feasibility level costs (to 10% accuracy)		
Output	Summary feasibility level design report, including:		
	➤ Design criteria and details		
	➤ Feasibility level drawings		
	➤ Cost estimates		

### 3.3.3 Step 3: Confirm extent of monitoring programme

Stage	Activity	Volume 2 reference	Done
Input	Report on ranking of water use options	6.6.3	
	Summary report		
	Feasibility level design report		
Methodology	Prepare monitoring programme, including details on:		
	➤ Objectives to be met in the monitoring programme		
	➤ Location of the monitoring points		
	➤ Frequency of monitoring and constituents to monitor		
Output	Monitoring programme		

### 3.3.4 Step 4: Arrange interaction meetings

Stage	Activity	Volume 2 reference	Done
Input	Detailed design report	6.6.4	
	Tender document		
Methodology	Set up workshops and focus group meetings with stake-holders		
	Discuss water use options, noting comments and issues raised		
	Prepare proceedings of workshops and meetings		
	Prepare comments and issues report		
	Finalise plan		
Output	Final water use plan		

### 3.3.5 Step 5: Prepare tender drawings and specifications

Stage	Activity	Volume 2 reference	Done
Input	Catchment level and site-specific assessment report	6.6.5	
	Detailed design report		
Methodology	Prepare drawings to issue to contractors for pricing		
	Prepare detailed Bill of Quantities		
	Prepare construction specifications		
Output	Tender package, including:		
	➤ Tender drawings		
	➤ Tender specifications		
	➤ Bill of Quantities		

### 3.3.6 Step 6: Prepare planning report

Stage	Activity	Volume 2 reference	Done
Input	Detailed design report	6.6.6	
	Comments and issues report		
	Summary of impact of the discussions on the design of the final water use option		
	Summary report giving recommendations		
Methodology	Collate information and prepare Site-specific level Planning report, including dolomite management strategy		
	Review planning report		
	Prepare review and summary report		
	Sign-off planning report		
Output	Final planning report		

## 4 NATIONAL LEVEL MANAGEMENT

### 4.1.1 Step 1: Develop tools for groundwater resources management

Stage	Activity	Volume 2 reference	Done
Input	Monitoring reports	7.3.1	
	Stakeholder issues and concerns		
Methodology	Consider management options to ensure sustainable use of the dolomite aquifers		
	Compare/review monitoring reports against desired management objectives		
	Set guidelines for sustainable use of the dolomite water resources		
Output	Management document detailing desired management objectives, recommendations for intervention		
	Management objectives for water use authorisations and licensing		
	Recommendations for water pricing		
	Recommendations for waste water discharge pricing		

#### 4.1.2 Step 2: Review catchment level management reports

Stage	Activity	Volume 2 reference	Done
Input	Catchment monitoring reports	7.3.2	
	National dolomite aquifer management objectives		
	National dolomite level strategic goals		
Methodology	Compare monitoring data and aquifer behaviour response with aquifer management objectives and strategic goals		
	Determine level of compliance		
	Establish whether intervention is required		
	Identify geographic area where intervention is needed		
Output	Geographic delineation of areas of compliance		
	Geographic delineation of non-compliant areas		

### 4.1.3 Step 3: Assist in devising action plans

Stage	Activity	Volume 2 reference	Done
Input	Compliance audit from step 3 above	7.3.3	
	National dolomite aquifer management objectives		
	National dolomite aquifer strategic goals		
Methodology	<p>Assist in preparing intervention plans for non-compliant areas.</p> <p>These could include:</p> <ul style="list-style-type: none"> <li>➤ Adjustment of licensing conditions</li> <li>➤ Cancellation of licences</li> <li>➤ Introduction of compulsory licences for impacted areas</li> <li>➤ Direct instructions to reduce groundwater abstraction where licences are not in place</li> <li>➤ Expansion of protection zones for springs, wetlands and recharge areas</li> <li>➤ Requirement for tightening/upgrading EMPs for impacting industry or mines</li> <li>➤ Upgrading of EIAs</li> <li>➤ Increased level of monitoring</li> <li>➤ Revision/review of land use planning authorisations</li> </ul>		
Output	Intervention recommendations		

#### 4.1.4 Step 4: Prepare summary document

Stage	Activity	Volume 2 reference	Done
Input	Monitoring reports	7.3.4	
	Management objectives		
	Intervention recommendations from Step 4		
Methodology	Compare performance against RQOs		
	Identify areas of compliance		
	Identify areas of non-compliance		
	Set performance goals for next reporting period		
	Determine strategies for long-term aquifer management		
Output	Strategic management report		
	Strategy for long-term sustainable use of the dolomite aquifers		
	Recommendations for intervention as per output from Step 4		
	Input to the assessment process		

#### 4.1.5 Step 5: Distribute the summary document

Stage	Activity	Volume 2 reference	Done
Input	Strategic assessment report	7.3.5	
	List of recipients		
Methodology	Confirm distribution lists		
	Advertise availability of report		
	Send to Minister		
	Distribute to CMA water managers		
	Distribute to stakeholders		
Output	Strategic dolomite aquifer management document which will include process and management procedures for sustainable management of dolomite aquifers		
	Updated monitoring report as part of the long-term sustainable national dolomite aquifer management programme		

## 4.2 Catchment Level Management

### 4.2.1 Step 1: Prepare strategies and management plans

Stage	Activity	Volume 2 reference	Done
Input	Site-specific monitoring reports	7.4.1	
	Updated control mechanisms		
Methodology	<p>Prepare/review/update dolomite aquifer strategic management plans.</p> <p>This will include:</p> <ul style="list-style-type: none"> <li>➤ Water use authorising</li> <li>➤ Licensing</li> <li>➤ Comparison of use against resources, for the dolomite within the catchment and also for each compartment</li> <li>➤ Identification/delineation of protection zones (springs, wetlands and recharge areas)</li> <li>➤ Setting monitoring frequency guidelines/targets</li> </ul>		
Output	Updated/revised dolomite aquifer management strategy		

**4.2.2 Step 2: Monitoring and data management**

Stage	Activity	Volume 2 reference	Done
Input	Monitoring Programme	7.4.2	
Methodology	Establish monitoring objectives		
	Establish monitoring frequency		
	Establish data to be collected: <ul style="list-style-type: none"> <li>➤ Water levels</li> <li>➤ Water abstraction</li> <li>➤ Water quality</li> <li>➤ Spring flow</li> <li>➤ Rainfall and climatic data</li> </ul>		
	Confirm protocols for recording data		
	Collect water level and abstraction data on standard data sheets		
	Confirm water quality parameters to be analysed; will be dependent upon sampling objectives: <ul style="list-style-type: none"> <li>➤ Potability</li> <li>➤ Pollution control</li> <li>➤ Ecological, etc</li> </ul>		
Output	Data sheets		
	Water quality analyses		

**4.2.3 Step 3: Assessment of water use**

Stage	Activity	Volume 2 reference	Done
Input	Site-specific monitoring reports	7.4.3	
	Updated/revised dolomite aquifer management strategy		
Methodology	Compare site-specific monitoring data with site-specific and catchment level licensing conditions.		
	Identify areas of non-compliance with licensing conditions		
	Identify unlicensed water abstractors/water users		
Output	Identification of areas of compliance with aquifer management strategy		
	Identification of areas of non-compliance		
	Establishment of need for intervention		

#### 4.2.4 Step 4: Assess aquifer performance and compliance

Stage	Activity	Volume 2 reference	Done
Input	Site-specific monitoring reports	7.4.4	
	Updated/revised dolomite aquifer management strategy		
Methodology	Compare site-specific monitoring data with site-specific and catchment level RQOs		
	Assess water abstraction, water level response and water quality trends		
	Determine aquifer behaviour		
Output	Aquifer behaviour		
	Establishment of need for intervention		

**4.2.5 Step 5: Review control and license conditions**

Stage	Activity	Volume 2 reference	Done
Input	Site-specific monitoring reports	7.4.5	
	Identification of areas of compliance with aquifer management strategy		
	Identification of areas of non-compliance		
	Establishment of need for intervention		
Methodology	Review reports and assessment		
	Review control mechanisms and license conditions		
Output	Review report of control mechanisms and license conditions		

#### 4.2.6 Step 6: Revise licensing conditions and RQOs

Stage	Activity	Volume 2 reference	Done
Input	Review report of control mechanisms and license conditions	7.4.6	
	Aquifer behaviour		
	Establishment of need for intervention		
Methodology	Revise control mechanisms, based on the recommendations in the review report		
	Revise license conditions, based on the recommendations in the review report		
Output	Revised control mechanisms and licensing conditions		

**4.2.7 Step 7: Design remedial actions**

Stage	Activity	Volume 2 reference	Done
Input	Identification of areas of non-compliance	7.4.7	
	Establishment of need for intervention		
Methodology	<p>Assess cause of non-compliance in identified areas, for example:</p> <ul style="list-style-type: none"> <li>➤ Declining water levels due to over-abstraction, unlicensed water use, drought</li> <li>➤ Deterioration of water quality due to poor management practices of waste dumps, tailings dams, land use</li> </ul>		
	<p>Design intervention to deal with areas identified as non-compliant; these could include:</p> <ul style="list-style-type: none"> <li>➤ Adjustment of licensing conditions</li> <li>➤ Cancellation of licences</li> <li>➤ Introduction of compulsory licences for impacted areas</li> <li>➤ Direct instructions to reduce groundwater abstraction where licences are not in place</li> <li>➤ Expansion of protection zones for springs, wetlands and recharge areas</li> <li>➤ Requirement for tightening/upgrading EMPs for impacting industry or mines</li> <li>➤ Upgrading of EIAs</li> <li>➤ Increased level of monitoring</li> <li>➤ Revision/review of land use planning authorisations</li> </ul>		
Output	Areas satisfying management strategies and goals. These may be identified as suitable for additional use		
	Intervention plans for remedial action in non-compliant areas		

**4.2.8 Step 8: Review and confirm remedial actions**

Stage	Activity	Volume 2 reference	Done
Input	Intervention plans for remedial action in non-compliant areas	7.4.8	
	Details of stakeholders		
Methodology	Convene focus group meetings/ workshops		
	Discuss monitoring reports and intervention recommendations		
	Obtain consensus on intervention		
	Prepare issues and comments report		
Output	Confirm recommendations of Step 3, updated as necessary to take into account views and response of stakeholders		
	Updated strategic management plan		

#### 4.2.9 Step 9: Prepare actions plans for catchment level management

Stage	Activity	Volume 2 reference	Done
Input	Updated strategic management plan developed in Steps 6 - 8	7.4.9	
	Confirmation of plan from consultation		
Methodology	Prepare detailed action plan for intervention, including:		
	➤ Construction methodology		
	➤ Key success factors		
	➤ Time-frames for implementation		
	➤ Monitoring criteria		
Output	Detailed actions plans		

**4.2.10 Step 10: Collate information into management report**

Stage	Activity	Volume 2 reference	Done
Input	Site-specific monitoring reports	7.4.10	
	Catchment level dolomite aquifer management strategy		
	Compliance assessments (Step 2)		
Methodology	Collate all data from the various monitoring reports		
	Prepare overall aquifer management report. This will include: <ul style="list-style-type: none"> <li>➤ Summary of the catchment management strategy and goals</li> <li>➤ Presentation of water level, water use and water quality trends, and comparison against RQOs</li> <li>➤ Details of new licences issued</li> <li>➤ Details/update of monitoring frequency for all users in the catchment</li> <li>➤ Recommendations for adjusting management objectives to ensure sustainability</li> </ul>		
Output	Management report for distribution to stakeholders and delivery to National Office.		

### 4.3 Site Specific Management

#### 4.3.1 Step 1: Set up WSDP, IDP, EMP

Stage	Activity	Volume 2 reference	Done
Input	Current versions of the WSDP, IDP and EMP	7.5.1	
Methodology	Review the current versions of the WSDP, IDP and EMP		
	Update/amend the groundwater aspects of the WSDP, IDP and EMP documents.		
Output	Updated WSDP, IDP and EMP		

#### 4.3.2 Step 2: Implement water supply scheme or remedial action(s)

Stage	Activity	Volume 2 reference	Done
Input	Agreed project plan	7.5.2	
	Water supply		
	Spring capture		
	Site-specific monitoring		
	Remediation plan (aquifer overexploitation, groundwater pollution, spring or wetland protection, etc)		
Methodology	Undertake required activities. These could include:		
	➤ Siting, drilling and testing of water supply boreholes (refer to procedures outlines in 4 & 5 of assessment)		
	➤ Position production boreholes away from existing boreholes, potential sources of pollution and area vulnerable to flooding		
	➤ Siting, drilling and testing of site-specific monitoring boreholes (refer to procedures outlines in 4 & 5 of assessment)		
	➤ Siting, drilling and testing of site-specific pollution control boreholes (refer to procedures outlines in 4 & 5 of assessment)		
Output	Project completion report		
	Monitoring plan		

### 4.3.3 Step 3: Install/update and maintain monitoring network

Stage	Activity	Volume 2 reference	Done
Input	Agreed monitoring plan	7.5.3	
Methodology	Equipping of boreholes with: <ul style="list-style-type: none"> <li>➤ Production pumps, piezometer tubes and flow meters</li> <li>➤ Piezometer tubes</li> <li>➤ Automatic data loggers</li> </ul>		
	Construction of weirs or flow meters at springs		
	Prepare monitoring plans and administrative requirements		
Output	Ongoing monitoring programme		

#### 4.3.4 Step 4: Operation and maintenance of the system

Stage	Activity	Volume 2 reference	Done
Input	Agreed Monitoring Programme	7.5.4	
Methodology	Assess current status of the monitoring network		
	Identify areas that require maintenance and upgrade		
	Develop annual maintenance plan		
Output	Annual maintenance plan		

#### 4.3.5 Step 5: Data Management: Gather, store and assess the monitoring data

Stage	Activity	Volume 2 reference	Done
Input	Monitoring programme	7.5.5	
Methodology	Establish monitoring objectives		
	Establish monitoring frequency		
	Establish data to be collected: <ul style="list-style-type: none"> <li>➤ Water levels</li> <li>➤ Water abstraction</li> <li>➤ Water quality</li> <li>➤ Spring flow</li> <li>➤ Rainfall and climatic data</li> </ul>		
	Confirm protocols for recording data		
	Collect water level and abstraction data on standard data sheets		
	Confirm water quality parameters to be analysed; will be dependent upon sampling objectives: <ul style="list-style-type: none"> <li>➤ Potability</li> <li>➤ Pollution control</li> <li>➤ Ecological, etc</li> </ul>		
Output	Data sheets		
	Water quality analyses		

#### 4.3.6 Step 6: Control of water use

Stage	Activity	Volume 2 reference	Done
Input	Agreed monitoring plan	7.5.6	
	Information on compliance assessment		
Methodology	Assess level of compliance of water use		
	Develop/revise control mechanisms for water use		
Output	Report on compliance assessment and control of water use		

**4.3.7 Step 7: Summarise monitoring data in a site-specific reporting**

Stage	Activity	Volume 2 reference	Done
Input	Water level, water abstraction and water quality monitoring data	7.5.7	
	Management objectives		
Methodology	Prepare monitoring report		
	Compare water level trends		
	Compare water quality trends		
	Assess need for intervention by comparison with management objectives		
Output	Monthly monitoring report for submission to CMA		

## 5 MANAGING ONGOING STAKEHOLDER RELATIONSHIPS

This section provides detailed procedures to assist the Water Manager in managing ongoing stakeholder relations, particularly after the public participation process has come to an end.

Before considering the details of the procedure to manage ongoing stakeholder relations, it is important to understand the difference between “Company Public Relations” and “Public Participation” (Table 1) (*Greyling T and Pietersen T 2006. Guide to Public Participation in environmental authorisation: Theory and Practice. Golder Associates Africa, Midrand, South Africa*). It is also essential that there is synergy between communication aspects relating to the public participation process for a particular project and communication with external stakeholders by the Public Relations Division of the proponent.

Public participation never promotes the proposed project, but rather presents information relating to the project in an objective way, both negative and positive. Stakeholders will not trust the public participation practitioner to be independent and impartial if they perceive the project to be promoted in any way, nor will they want to share their views. It is essential that Water Managers understand this concept.

It would be fatal for the public participation office to issue a media release encouraging stakeholder comment while, at the same time, the Water Manager’s public relations (PR) division issues a media release boasting about the proposed project as if it were already approved by the authorities.

Experience and the results of public participation process assessments strongly recommend that the company develops, maintains and manages an ongoing stakeholder relationship programme. This will require dedicated staff to provide the wider audience in the project area with information on progress on a regular basis. This communication process will rely heavily on the application of public relations techniques.

However, it remains essential that the synergy is reinforced between communication aspects relating to the public participation process for the project and communication with external stakeholders by the Public Relations Division of the proponent.

The public participation and public relations practitioners should therefore coordinate their activities and act in mutual support of each other. Regular meetings of the project team and the client should take place throughout the duration of the project.

**Table 1: Differences between external company communication and public participation**

<b>Company Communication (PR)</b>	<b>Public Participation</b>
Conducted by company itself	Conducted by independent agency
Ongoing, for the life of the company	Finite with clear start and finish dates, usually around 6-12 months, depending on the project
All aspects of the company	Focussing on a particular project
Usually about existing activities/projects	Usually about a proposed project
Mainly promotional in nature, and awareness creation	Under no circumstances promotional, always by independent agencies (by law)
Aimed at information transfer and distribution of information	Aimed at receiving contributions
Aimed at changing attitudes and mindsets	Aimed at enabling contributions
Promotional material with corporate identity usually in colour, fairly costly to produce	Discussion documents with project identity, seldom in colour, photocopied

Table 2 provides detailed procedures to assist the Water Manager in managing ongoing stakeholder relations, particularly after the public participation process has come to an end.

**Table 2: Procedures to assist Water Managers in managing ongoing stakeholder relations**

Stage	Activity	Volume 2 reference	Done
Input	Evaluation and Monitoring Report of the Public Participation Process	4.4.8	
	Compilation of a communication strategy to provide stakeholders with ongoing feedback on progress using the above report as main reference document		
Methodology	Assess the need for appointing a senior Public Relations Officer (PRO). If the company already has a PRO, it will not be necessary to appoint one		
	The PRO should evaluate the outcome of the Evaluation and Monitoring Report of the Public Participation Process		
	Prepare a situational analysis. Provide a brief outline of the current situation pertaining to communication needs, including key issues, challenges and sensitivities that will require communication		
	Develop a communication strategy that is aligned with the company's overarching communication protocols and existing policies and frameworks. Such a strategy should have the following components:		
	➤ <b>Objectives:</b> The setting of broad objectives of the communication strategy, flowing from the situational analysis		

Stage	Activity	Volume 2 reference	Done
	<ul style="list-style-type: none"> <li>➤ <b>Target audiences:</b> Identify and list various target audiences, with specific objectives for communication with each target audience, including an internal (within the company) target audience. Information about the target audiences can be obtained from the public participation report</li> </ul>		
	<ul style="list-style-type: none"> <li>➤ <b>Key messages:</b> A short list of overarching messages should be developed to be conveyed to all target audiences, and where necessary, specific messages for specific target audiences</li> </ul>		
	<ul style="list-style-type: none"> <li>➤ <b>Channels/methods:</b> Establish communication channels (e.g. media (radio and newspapers), brochures, meetings, complaints register, hotline, information desk, etc) to reach different target audiences</li> </ul>		
	<ul style="list-style-type: none"> <li>➤ <b>Action plan:</b> Compile a broad outline of an action plan indicating who communicates what to which target audiences, how often and how.</li> </ul>		
	<ul style="list-style-type: none"> <li>➤ <b>Crisis communication plan:</b> A broad outline of a crisis communication plan should form part of the communication strategy (e.g. what should be done if sinkholes form in an active urban area)</li> </ul>		
	<ul style="list-style-type: none"> <li>➤ <b>Record-keeping, monitoring and evaluation:</b> Broad recommendations for record-keeping, monitoring and evaluation of the effectiveness of the communication strategy should be developed as part of the communication strategy</li> </ul>		

Stage	Activity	Volume 2 reference	Done
	<p>➤ <b>Budget:</b> The Communication Strategy should provide for budget estimates in broad terms for the first two years of plan implementation. This will assist water managers with overall planning and management</p>		
	<p>When the Communication Plan is in place, the methods of communicating with the target audience for a specific area will fall into place. Similar techniques as those listed in Volume II, section 4 can be used</p>		
	<p>Communication with the target audience should take place regularly, preferably once every two to three months, and can be linked to initiatives by the company (e.g. National Water Week; World Environment Day, etc)</p>		
Output	<p>Action plan of regular communication activities complete with actions, person(s) responsible and deadlines</p>		
	<p>Improved stakeholder relations</p>		
	<p>Trust and credibility for the company involved</p>		