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A GUIDELINE TO THE WATER QUALITY MANAGEMENT COMPONENT OF A CATCHMENT MANAGEMENT STRATEGY

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PREFACE

Reform of South African water resource management has been a key focus of the Department of Water Affairs and Forestry (DWAF) for a number of years. This reform process has already seen a number of highlights, prime amongst which was the formulation of a new National Water Policy in 1997 and promulgation of a new water statute, the National Water Act (Act No. 36 of 1998). These developments established, *inter alia*, a formal process of integrated water resource management according to 19 water management areas (WMAs). At the national scale, this process of integrated management is now structured by a National Water Resource Strategy (NWRS), while evolving Catchment Management Strategies (CMS) provide an integrated management framework at the catchment scale.

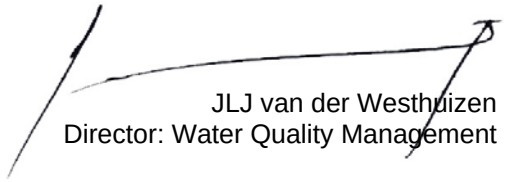
Sound strategies for catchment management require relevant information about the *water-related* natural attributes, infrastructure developments, human and ecological needs, human impacts, issues and economic development in a catchment. The process of collating, processing and interpreting such information in a water-related context is now generally called a "catchment assessment study". Although various forms of catchment assessments (sometimes called "situation analyses" or "basin studies") have been common-place in South African water resource planning for some time, a number of diverse approaches have been followed which have not necessarily been of comparable standard and consistency. Furthermore, the particular mix of information needs that statutory strategy development invokes, brings new challenges in the field of water resource decision support.

In such a new and evolving management environment, consistency and acceptable standards of both strategy development and supporting information might easily suffer. Therefore, a clear need has arisen for guiding procedures to support the processes and decisions involved. (It should also be noted that Section 10(1) of the National Water Act enables the establishment of such "guidelines" for the preparation of catchment management strategies.) DWAF has responded to this need by initiating processes to develop a range of guideline documents in the integrated water resource management and catchment management fields. This document is one of a trio of inter-related documents specifically aimed at the domain of *water quality management*:

- *A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy*
- *A Guideline to the Water Quality Component of a Catchment Management Strategy*
- *A Guide to Conduct Water Quality Catchment Assessment Studies.*

The development of these documents was informed by interviews with knowledgeable professionals operating in the water resource management field, as well as by the proceedings and outcomes of two dedicated Technical Workshops. The development process was guided by a Steering Committee under my chairmanship and with the support of the Director: Catchment Management. A series of three Training Workshops, using an early draft of these documents, were also conducted with Regional Office staff in three different regions of the country. Valuable comments and insights, contributed by the Training Workshop participants, were incorporated in the documents.

Comments from those using these three documents in the future will assist their revision and ongoing improvement. The documents will also be used for continuing capacity-building and training and for conceptual and technical support to the unfolding implementation of the National Water Act.



JLJ van der Westhuizen
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Reports forming part of this Sub-Series:

Sub-Series No.	Report Title
MS 8.1	A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy
MS 8.2	**A Guideline to the Water Quality Management Component of a Catchment Management Strategy (this document)**
MS 8.3	A Guide to Conduct Water Quality Catchment Assessment Studies: In Support of the Water Quality Management Component of a Catchment Management Strategy

Other relevant Department of Water Affairs and Forestry (DWAF) Reports:

- Republic of South Africa (RSA) Department of Water Affairs and Forestry, 2001. Integrated Water Resource Management Series, Sub-Series No. MS 6.1, *Guidelines on the Establishment and Management of Catchments Forums: in support of Integrated Water Resource Management*. Pretoria.

- RSA Department of Water Affairs and Forestry, 2001. Integrated Water Resource Management Series, *Generic Framework for Catchment Management Strategies* (Draft). Pretoria.

- RSA Department of Water Affairs and Forestry, 1999. DWAF Report No. WQP 0.1. *A Framework for Implementing Non-Point Source Management under the National Water Act.* Pretoria.

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ACRONYMS

CMA	- catchment management agency
CMS	- catchment management strategy
DEAT	- Department of Environmental Affairs and Tourism
DWAF	- Department of Water Affairs and Forestry
DWAF HO	- DWAF: Head Office
DWAF RO	- DWAF: Regional Office
NPS	- non-point source
IWRM	- integrated water resources management
ISD	- institutional and social development
NWA	- National Water Act (Act No. 36 of 1998)
NWRS	- national water resource strategy
RDM	- resource directed measures
RQO	- resource quality objectives
RSA	- Republic of South Africa
RWQO	- resource water quality objectives
SMO	- source management objectives
WMA	- water management area
WMI	- water management institution
WQ	- water quality
WQCAS	- water quality catchment assessment study
WQM	- water quality management
WSI	- water services institution
WRM	- water resources management
WSA	- water services authority
WSP	- water services provider
WUA	- water user association

EXECUTIVE SUMMARY

Background

Reform of South African water resource management has been a key focus of the Department of Water Affairs and Forestry (DWAF) for a number of years. This reform process has already seen a number of highlights, prime amongst which was the formulation of a new National Water Policy in 1997 and promulgation of a new water statute, the National Water Act (Act No. 36 of 1998). These developments established, *inter alia*, a formal process of integrated water resource management according to 19 water management areas (WMAs). At the national scale, the process of integrated management is now structured by a National Water Resource Strategy (NWRS), while evolving Catchment Management Strategies (CMS) provide a management framework at the regional and catchment scale. Resource directed measures (RDMs) comprising a Resource Management Classification system, implementation of a "Reserve" and the setting of Resource Quality Objectives (RQOs) underpin this framework. The "Reserve" is that quantity and quality of water required for basic human needs, as well as that quantity and quality required to sustain aquatic ecosystems. RQOs are time-related management goals reflecting a path leading to an agreed future state for the catchment, as specified by the Resource Management Class.

Important components of these new approaches are the over-arching requirements to ensure sustainable use of water resources and the equitable use[1] of the resource for the "optimum social and economic benefit" of the country. Coupled with these are the need for a transparent and participative approach to water resources management and the redress of inequitable access to water resources caused by past policies.

These policy principles must underlie the approach to water resource management on a catchment basis. Catchment water quality management is a component of the water resource management process, and as such is subject to these policy principles.

Sound strategies for catchment management require relevant information about water-related conditions, issues and developments in a catchment. The process of collating, processing and interpreting such information is now generally called a "Catchment Assessment Study". Although various forms of catchment assessments (sometimes called "situation analyses" or "basin studies") have been common-place in South African water resource planning for some time, a number of diverse approaches have been followed which have not necessarily been of comparable standard. Furthermore, the particular mix of information needs that statutory strategy development invokes, brings new challenges in the field of water resource decision support.

In such a new and evolving management environment, consistency and acceptable standards of both strategy development and supporting information might easily suffer. Therefore, a clear need has arisen for guiding procedures to support the processes and decisions involved. (It should also be noted that Section 10(1) of the National Water Act enables the establishment of such "guidelines" for the preparation of catchment management strategies.) DWAF has responded to this need by initiating development of a number of guideline documents. This document is one of a trio of inter-related documents specifically aimed at the domain of water quality management, that have been developed by the Directorate: Water Quality Management:

[1] Most importantly, "Use" as defined in the National Water Act includes *inter alia* the consumptive use of the resource, as well as use of the resource to assimilate water that contains waste.

- *A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy.*
- *A Guideline to the Water Quality Component of a Catchment Management Strategy (this document).*
- *A Guide to Conduct Water Quality Catchment Assessment Studies.*

Why Does this Document Address Only Water *Quality*?

Water resource management occurs within a highly integrated environment, where water quality, water quantity and the aquatic ecosystem are all interlinked and interdependent. This integration is achieved at a national level by the National Water Resource Strategy (NWRS), and by Catchment Management Strategies (CMS) at a catchment or water management area (WMA) level. These strategies link together the management elements required by the water quality, water quantity and aquatic ecosystem components of the water resource into a coherent approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

However, while it is important to integrate the management of these components, the complexities of the water environment usually require that they be addressed by different parts of the same water management institution (for example the different directorates of DWAF). Pragmatism therefore dictates that water quality, water quantity and the aquatic ecosystem are also likely to be managed somewhat independently at a catchment level. It is nevertheless still important to integrate these components in some way. This document provides guidelines and procedures for integrating the *water quality management component* to yield IWRM at a catchment level. It should be noted that the approaches developed are largely generic, and should also be appropriate for the *quantity and aquatic ecology* components of IWRM.

Purpose of this *Guideline to the Water Quality Component of a Catchment Management Strategy*

This document is aimed at DWAF officials, Catchment Management Agencies (CMAs) and water management institutions (or their professional service providers) who are engaged in the ongoing development and revision of a CMS, or in giving effect to the CMS. The document provides a framework and particular guidelines for integrating water quality management into catchment water resource management by addressing the following issues:

- Identifying the stakeholders' needs with respect to water quality
- Developing resource water quality objectives or targets for water quality management.
- Formulating source management objectives to realise these resource water quality objectives.
- Developing a WMA-wide water quality management framework and programme.
- Developing sector-specific user plans to realise these source management objectives.
- Developing source-specific authorisation requirements or directives to realise these plans.
- Developing "in-resource" remediation and reservoir/ system operation plans to help realise resource water quality objectives

- Outlining procedures for local actions to give effect to these plans.
- Outlining the procedures for auditing compliance to these plans.

The Water Quality Management Component of the CMS[2]

Operational management of water quality takes place at a localised level and therefore water quality management plans, decisions and actions are generally focused at a sub-catchment scale. However, these have implications for downstream users (and upstream impactors), which requires WQM alignment between sub-catchments within a WMA (and even between WMAs).

Catchment water quality management must give effect to the requirements of the Resource Directed Measures and the NWRS. Together these establish the water quality, water quantity and aquatic ecosystem attributes that are required to ensure a given level of protection for the resource, to meet basic human needs, and to meet the requirements of strategically important water users. The process of developing a CMS may also identify stakeholders' needs with respect to use of the water resource over and above these requirements.

The framework proposed below is based on identifying the stakeholders' needs with respect to use of the water resource over and above these requirements. This is attained through following an iterative and incremental process that answers four generic questions, as outlined below:

What are the goals for water quality management?

(a) Establish resource water quality objectives to meet user requirements and for use of the resource to dispose of water that contains waste, based on the needs expressed by the stakeholders.

How must water quality loads change to achieve the goals?

(b) Determine source management objectives to meet RWQOs, in accordance with these needs.

How will this be managed across the WMA?

(c) Formulate a WMA-wide *water quality management framework-plan* that indicates the management priorities, requirements, CMS linkages, sectoral responsibilities and programme to achieve these objectives.

How, where, by whom and when will this be implemented?

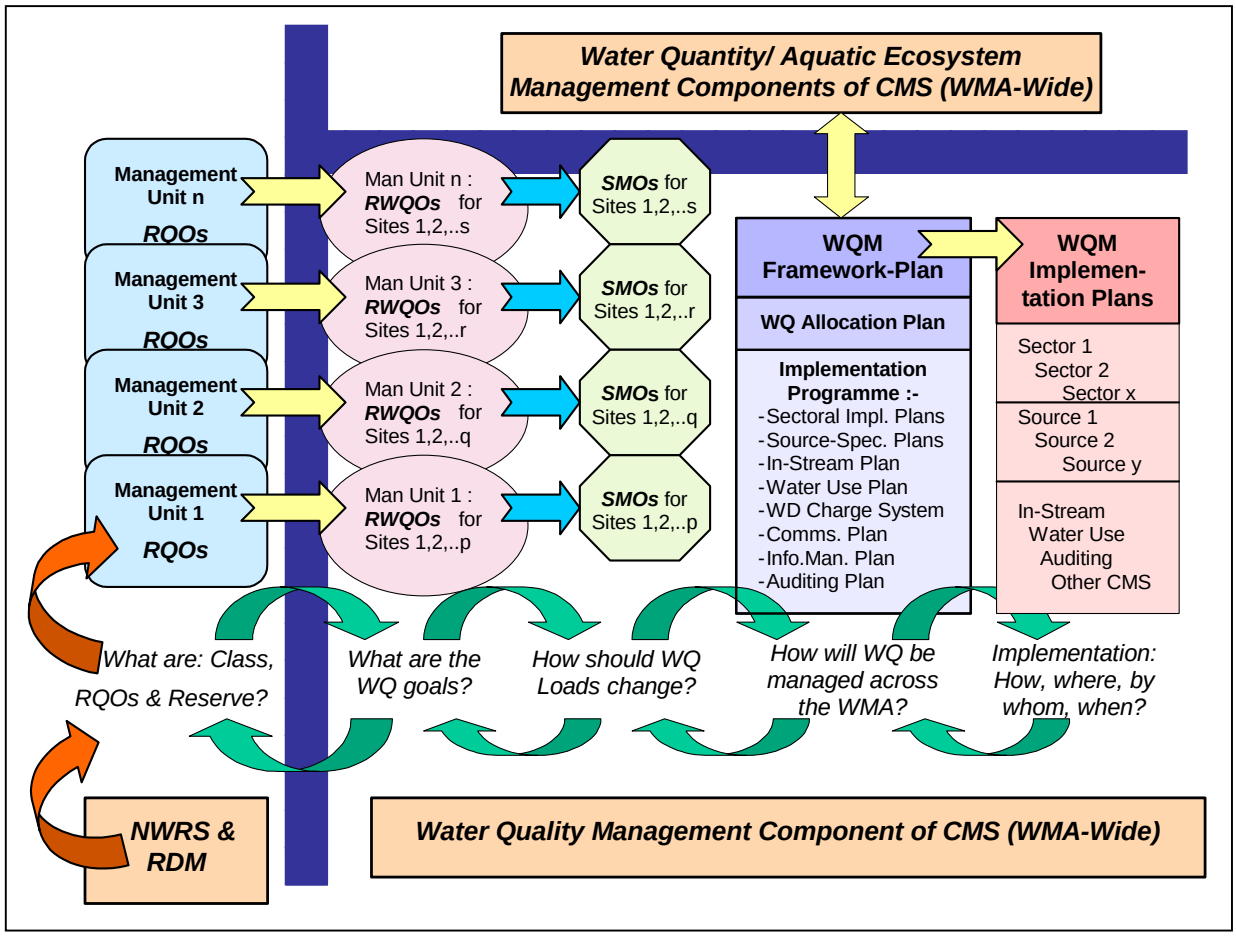
(d) Develop individual *water quality management implementation plans*, which may be source-, issue- or sector-specific, or even, multi-sectoral, to give effect to the water quality management framework-plan.

Together, the outputs from the above steps make up the water quality management component of the CMS. As such, they will be revised and updated on 5-yearly basis to accommodate the ongoing development of the catchment. The process is aimed at securing

[2] The WQM Component of the CMS must be informed by the data, results, findings and management options produced by a Water Quality Catchment Assessment Study (WQCAS). A sister-document to this Guideline, *A Guide to Conduct Water Quality Catchment Assessment Studies* (Sub-Series 8.3) presents the procedures that make up a WQCAS.

a gradual and phased realisation of the stakeholders' requirements for the water resource and the public trust responsibility of DWAF.

The conceptual diagram presented below shows how these four stages allow for the gradual realisation of stakeholders' goals - according to sub-catchment boundaries identified as "*Management Units*" - by harnessing the collective resources available at a local level. An outline of the four stages and their outputs is presented below:



What are the goals for water quality management?

- *Resource Water Quality Objectives* reflect stakeholders' needs with respect to use of the water resources of the catchment. They include the objectives outlined in the NWRS and by RDM, but express stakeholders' needs over and above those outlined by these statutory measures. These objectives outline stakeholders' needs with respect to water quality, as well as their needs with respect to the disposal of water that contains waste to the resource. The process of determining these objectives is a consultative, consensus-seeking process, which may be incorporated into the process of developing RQOs, where the Classification and CMS processes are aligned.

How must water quality loads change to achieve the goals?

- *Source Management Objectives* provide the focus for the actions required to give effect to the *Resource Water Quality Objectives*. As such, they outline the changes in pollution loads required to meet the immediate (5-year) Resource Water Quality Objectives. Source Management Objectives are not source type- or sector-specific, but outline waste

load targets on a catchment or sub-catchment basis. This is primarily a technical-scientific process, which iterates with the determination of the *Resource Water Quality Objectives*, and with the W*ater Quality Management Framework-Plan*.

How will this be managed across the WMA?

- The *Water Quality Management Framework-Plan* outlines the arrangements for water quality management across the whole WMA, and as such represents the heart of the water quality management component of the CMS. It should specify the desired future water quality use load allocation per sector, the *strategic* approaches and plans for water quality management, the linkages to other components of the CMS important to water quality management, and the sectoral responsibility and programme for formulating and implementing Water Quality Management Implementation Plans required to meet the *Resource Water Quality Objectives.*

How, where, by whom and when will this be implemented?

- A *Water Quality Management Implementation Plan* specifies the management actions, responsibilities, resources and timeframes to mitigate or remediate the existing or future water quality impacts associated with priority sectors/ sources within a particular (sub-) catchment area, in order to give effect to the water quality use load allocation specified in the W*ater Quality Management Framework-Plan*. A Plan may be sector- or issue-oriented, or even, sub-catchment/ Management Unit-focused, and may include statutory and/or non-statutory approaches that are more stringent than the general requirements for these sources.
- *Source-specific interventions* indicate the requirements (actions, resources and timeframes) for mitigating or remediating the water quality impacts from a specific source, under a water use authorisation, a cooperative agreement or a directive under the NWA, or under relevant sections of environmental statutes. They will generally be applied to specific concerns that have a significant impact on the water quality of a water resource, and may be linked to a W*ater Quality Management Implementation Plan*.

These four stages provide a logical sequence to move from the objectives for water resource management throughout a WMA to the actions required at a localised level to achieve these objectives. The first three steps provide the basis for the WMA-wide water quality management component of the CMS, while the last step provides the basis for the local sub-catchment scale components of the CMS.

Layout of the Guideline

The layout of the Guideline is identical for each of the above stages and is structured according to following components:

- A detailed description of the stage.
- What steps must be taken to undertake the stage?
- What special considerations apply?
- What catchment assessment study support may be required?
- Who should be involved in undertaking the stage?

The Guideline closes with a conceptual template for the water quality component of a Catchment Management Strategy, representing the combination of all the individual elements described in the document.

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1. INTRODUCTION

1.1 Background to this Guideline

Reform of South African water resource management has been a key focus of the Department of Water Affairs and Forestry (DWAF) for a number of years. In such a new and evolving management environment, consistency and acceptable standards of both strategy development and supporting information might easily suffer. Therefore, a clear need has arisen for guiding procedures to support the processes and decisions involved. DWAF has responded to this need by initiating processes to develop a range of guideline documents in the integrated water resource management and catchment management fields. This Guideline is one of a trio of inter-related documents specifically aimed at the domain of *water quality management*:

- *A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy* (Water Quality Management Series, Sub-Series No. MS 8.1)
- *A Guideline to the Water Quality Component of a Catchment Management Strategy* (Water Quality Management Series, Sub-Series No. MS 8.2)
- *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of a Catchment Management Strategy* (Water Quality Management Series, Sub-Series No. MS 8.3).

1.2 Why is only Water *Quality* Management addressed in this Document?

Water resources management occurs within a highly integrated environment, where water quality, water quantity and aquatic ecosystems are all interlinked and interdependent. The National Water Act (Act No. 36 of 1998) (NWA) makes provision for this by promoting *integrated* water resources management (IWRM). This is done both at a national level by the national water resource strategy (NWRS), and by catchment management strategies (CMS) at a catchment/ water management area/ regional level. These strategies draw together the water quality, water quantity and aquatic ecosystem components of the water resource into a coherent management approach that aims to secure the beneficial, equitable and sustainable use of the water resource.

However, while it is important to integrate the management of these components, the complexities of the water environment usually demand that they be addressed by different parts of the same water management institution (for example the different directorates of DWAF). Pragmatism therefore dictates that water quality, water quantity and the aquatic ecosystem are also likely to be managed somewhat independently at a catchment level. It is nevertheless still important to integrate these components in appropriate ways. This document provides guidelines and procedures for integrating the *water quality management component* into IWRM at catchment and regional levels. However, the approaches developed are largely generic, and should be appropriate to the “quantity” and the “aquatic ecosystem” components of IWRM.

1.3 Purpose of this Document

This document is aimed at DWAF and Water Management Institutions, particularly Catchment Management Agencies (CMAs) (or their professional service providers), who are engaged in the ongoing development or revision of a CMS, or in giving effect to the CMS. The document provides guidelines for integrating water quality management into catchment water resource management through the following steps:

- Identifying the stakeholders' needs with respect to water quality.
- Developing resource water quality objectives or targets for water quality management.
- Formulating source management objectives to realise these resource water quality objectives.
- Developing a framework and a programme for WMA-wide water quality management.
- Developing sector-specific user plans to realise the source management objectives.
- Developing source-specific authorisation requirements or directives to realise these plans.
- Developing "in-resource" remediation and reservoir/ system operation plans to help realise catchment water quality objectives.
- Outlining procedures for local actions to give effect to these plans.
- Outlining the procedures for monitoring and auditing compliance to these plans and to institute corrective steps and management review.

1.4 Way Forward

This Guideline is a first edition that has been developed in the absence of a comprehensive Catchment Management Strategy process being conducted. Furthermore, it only represents the water quality management component of the CMS.

The Guideline will be tested in pilot applications, after which it will be revised according to the lessons learned.

A similar guideline may be formulated for the *quantity* and *aquatic ecosystem* components of the CMS, so that the various elements of resource quality may be addressed simultaneously in the interest of IWRM.

Note

This Edition of this Guideline does not cover the details of the water quality management component of the CMS as far as it relates to the *coastal marine environment.*

2 TOWARDS CATCHMENT WATER QUALITY MANAGEMENT

This Chapter proposes a generic structure for developing the Water Quality Management Component of a Catchment Management Strategy within the context outlined in the previous Chapter. This structure also provides the basis for a "Roadmap" for this Guideline document.

2.1 What roles do the National Water Resource Strategy and Resource Directed Measures play in Catchment Water Quality Management?

According to the National Water Act, the CMS, and, therefore, the development of its water quality component, must give effect to the NWRS and to the resource directed measures (RDMs). Together these two processes establish *baseline* resource objectives for each catchment or water resource, and, as such, shape the formulation of more localised water quality objectives at any particular site in a catchment, or may serve as a point of departure for such local objectives.

The NWRS outlines the strategic objectives with respect to water resource management in the nineteen WMAs. As such it presents estimates of present and future water requirements in each WMA, makes provision for the transfer of water from water-rich catchments to water-poor catchments, and provides broad-brush assessments of the water quality issues in each WMA. Nationally, strategic water users (for example power generation) are allocated priority use by the NWRS. Similarly, certain international water quality and quantity obligations with respect to rivers that cross the Republic of South Africa's (RSA's) borders are spelt out in the NWRS.

RDMs are aimed at securing different levels of protection *via* a Water Resource Management Classification System, that outlines those characteristics that are required for different Resource Management "Classes", as well as the source directed controls appropriate to each Class. These characteristics are expressed as *resource quality objectives* (RQOs), which include water quality and quantity requirements, as well as characteristics for the aquatic ecosystem. RQOs are an outcome of the *catchment visioning* process that determines the Resource Management Classification of the whole catchment/WMA. RQOs are statutory entities and, after being drafted, are published for comment, after which they are formalised by being Gazetted. RDMs also make provision for the determination of a *Reserve* for water resources. This Reserve represents that quality and quantity of water required to ensure the sustainability of aquatic ecosystems, and to meet basic human needs. The Reserve is the only water use by right, and must be given effect through the CMS.

However, while stakeholder participation is required for the Classification process, there is a risk to classifying the water resource outside of the Catchment Management process. This risk is realised where stakeholders may not be aware of the implications for both downstream and upstream users of classifying the resource without a catchment-wide perspective. This may result in unrealistic RQOs that cannot feasibly be satisfied by the Catchment Management process; therefore, it is advisable that water resource Classification be conducted in parallel with the determination of the RQOs.

Note

The national Water Resource Management Classification System is still under development, and will still be subjected to a stakeholder review process. There is consequently still some uncertainly as to the exact nature of the Classification system. This section has therefore been based on the statutory requirements of this system as outlined in the National Water Act.

2.2 Why Develop a Common Framework for Catchment Management?

The NWA is not only based on securing the beneficial, equitable and sustainable use of the resource, but also on the need to ensure stakeholder participation in this process. The NWA therefore devolves management of the water resource to a regional and catchment level *via* CMAs. These Agencies must include stakeholders in both the ongoing development of the CMS, and in giving effect to the Strategy. The reason for this is straight-forward - local communities or water user sectors are more likely to be able to identify their needs with respect to use of the resource, and to ensure local actions to realise these requirements. Furthermore, the NWA specifically requires public consultation for the development of strategies and the application thereof.

However, water flows over long distances within the catchment, and may even be transferred from one catchment to another. Local use of the water resource therefore affects users across the whole catchment, and potentially in neighbouring catchments. This makes it difficult to realise the benefits of local management of the water resource without a common framework within which to balance local actions with their catchment-wide and regional implications. The framework for the water quality management component of the CMS following below is proposed as a means for reconciling the often-diverging needs of water users within a common goal for the water resources of the catchment and of the WMA.

2.3 How Large must a Catchment be to justify IWRM-based Catchment Management?

In terms of IWRM needs, a catchment may be any size, from a few square kilometers, to something like the Orange-Vaal River catchment, which dominates the larger portion of Southern Africa and is shared by three countries. IWRM may occur at any of these scales, from small common-interest groups aiming to protect a short stretch of river or local groundwater, to the national or even international goals of the NWRS. Economies of scale, nevertheless, dictate that CMAs, which must be economically viable, will have to operate at fairly large scales, *i.e*. the WMA scale. Furthermore, RQOs are set at a relatively coarse spatial resolution.

However, given the frequent lack of human resources, and the requirements for participative management in the NWA, the CMS cannot ignore catchment management efforts that occur at a finer scale, *e.g*. at sub-catchment or river reach scales. Be this as it may, management efforts that occur at finer scales must be compatible with the overall objectives of the CMS. The framework outlined below (and the rest of this Guideline document, therefore) enable integration of water quality management efforts that occur at different scales into the formulation of the water quality component of the CMS.

1.4 The Water Quality Management Component of the CMS

As stated in Section 2.1, catchment water quality management must be informed by the requirements of the "Catchment Vision", Water Resource Management Class, RQOs, the Reserve, and the NWRS. Together these establish the water quality, water quantity and aquatic ecosystem attributes that are required to ensure a given level of protection for the resource, to meet basic human needs, and to meet the requirements of water users. The framework proposed below is based on identifying the stakeholders' needs with respect to use of the water resource over and above these requirements. This is attained through following an iterative and incremental process that answers four generic questions, as outlined below:

What are the goals for water quality management?

a. Establish *resource water quality objectives* to meet user requirements and for use of the resource to dispose of water containing waste, based on the needs expressed by the stakeholders.

How must water quality loads change to achieve the goals?

b. Determine *source management objectives* to meet these needs.

How will this be managed across the WMA?

c. Formulate a *water quality management framework-plan* that indicates the WMA-wide management priorities, requirements, CMS linkages, sectoral responsibilities and programmes to achieve these objectives.

How, where, by whom and when will this be implemented?

d. Develop individual *water quality management implementation plans*, which may be source-, issue- or sector-specific, or even, multi-sectoral, to give effect to the water quality management framework-plan.

Together, these make up the water quality management component of the CMS. They will be revised and updated on a five-yearly basis to accommodate ongoing development in the WMA, and are aimed at securing a gradual and phased realisation of the stakeholders' goals for individual catchments in the WMA. These four steps may occur at any scale, and the results could be fed into the formulation of the wider CMS. In these cases, the CMS would have to ensure the compatibility of these processes with allied upstream and downstream processes and approaches. How this could be done, is outlined in the following chapters.

Figure 1 shows conceptually how these four steps allow for the gradual realisation of the stakeholders' goals - according to key individual sub-catchments, or spatial *"Management Units"* (see Text-Box in Section 3.3) - in the WMA, by harnessing the collective resources available at a local level.

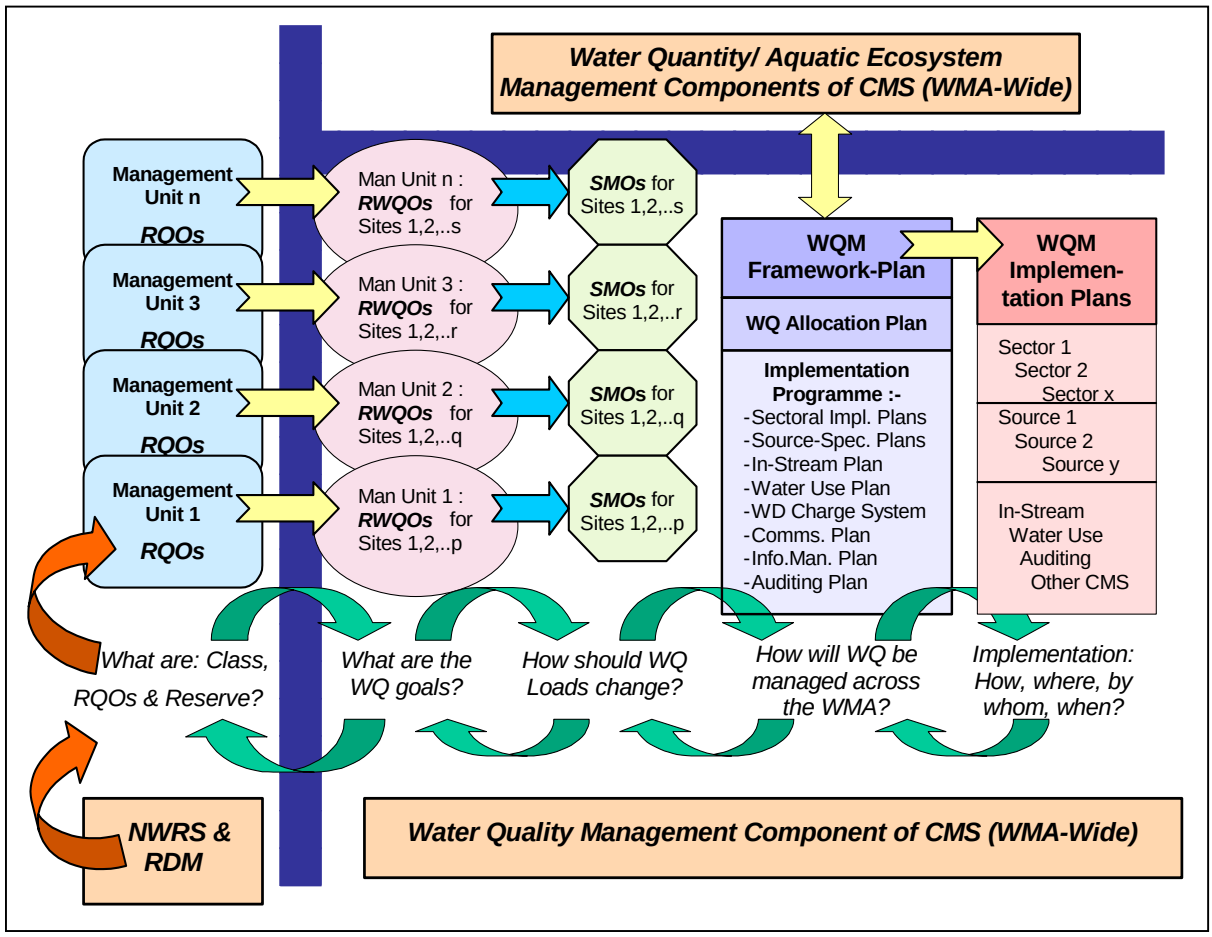


Figure 1: Conceptual Framework for Catchment Water Quality Management

2.5 A Roadmap for this Guideline

Chapters 3 to 7 provide detailed step-wise procedures and guidelines to formulate the water quality management component of a CMS within the framework outlined above. Chapter 8 then outlines a template for the water quality management component of the CMS, based on the individual elements outlined in the previous chapters.

The full procedure is captured in the "Roadmap" in Figure 2, which also highlights the inputs required for, and outputs of, the Catchment Water Quality Management process. This Roadmap therefore also serves as a quick-reference guide to the procedures outlined in this Guideline. It also shows the link of the water quality catchment assessment (WQCAS) with the establishment of the water quality component of the CMS.

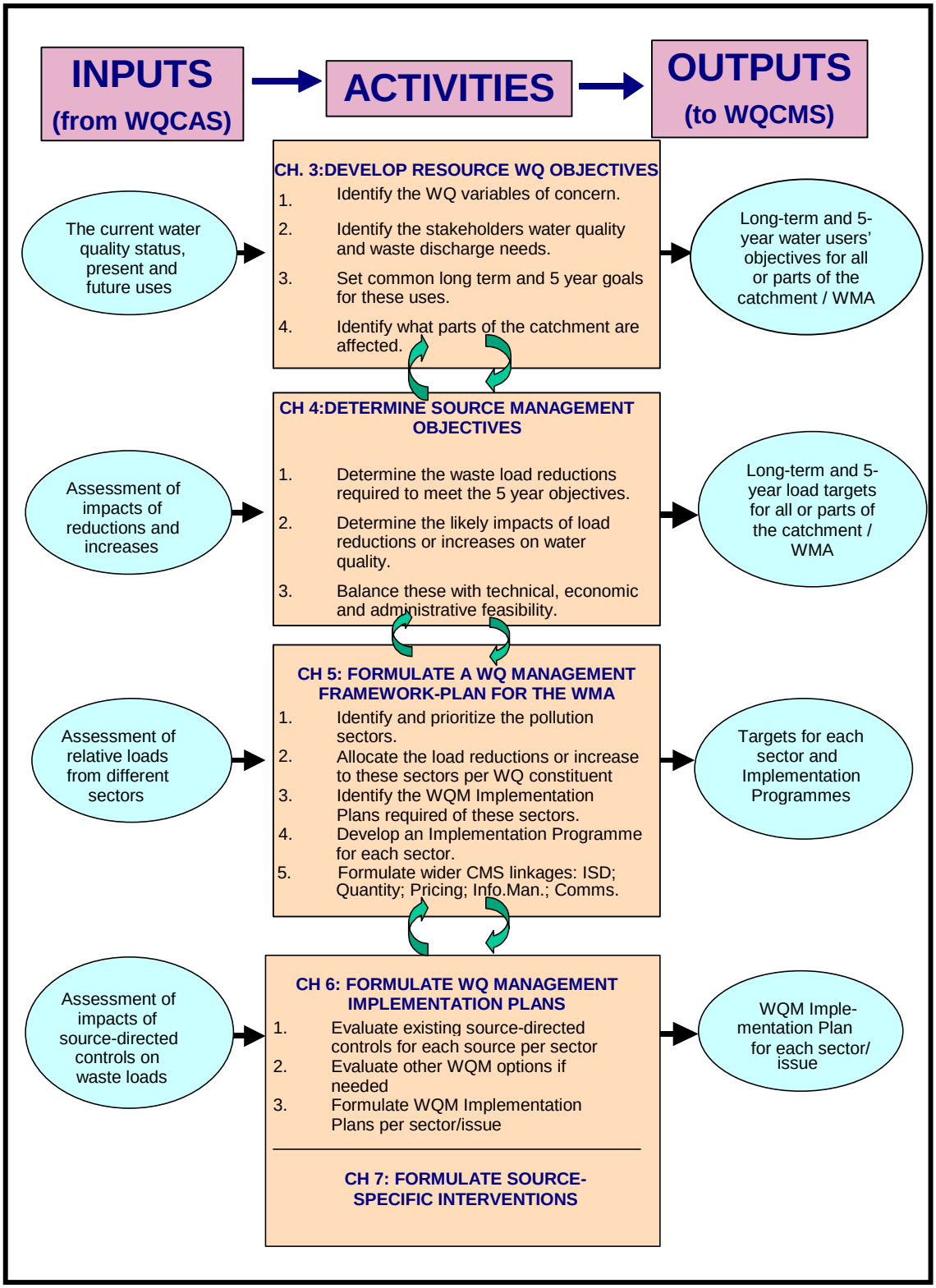
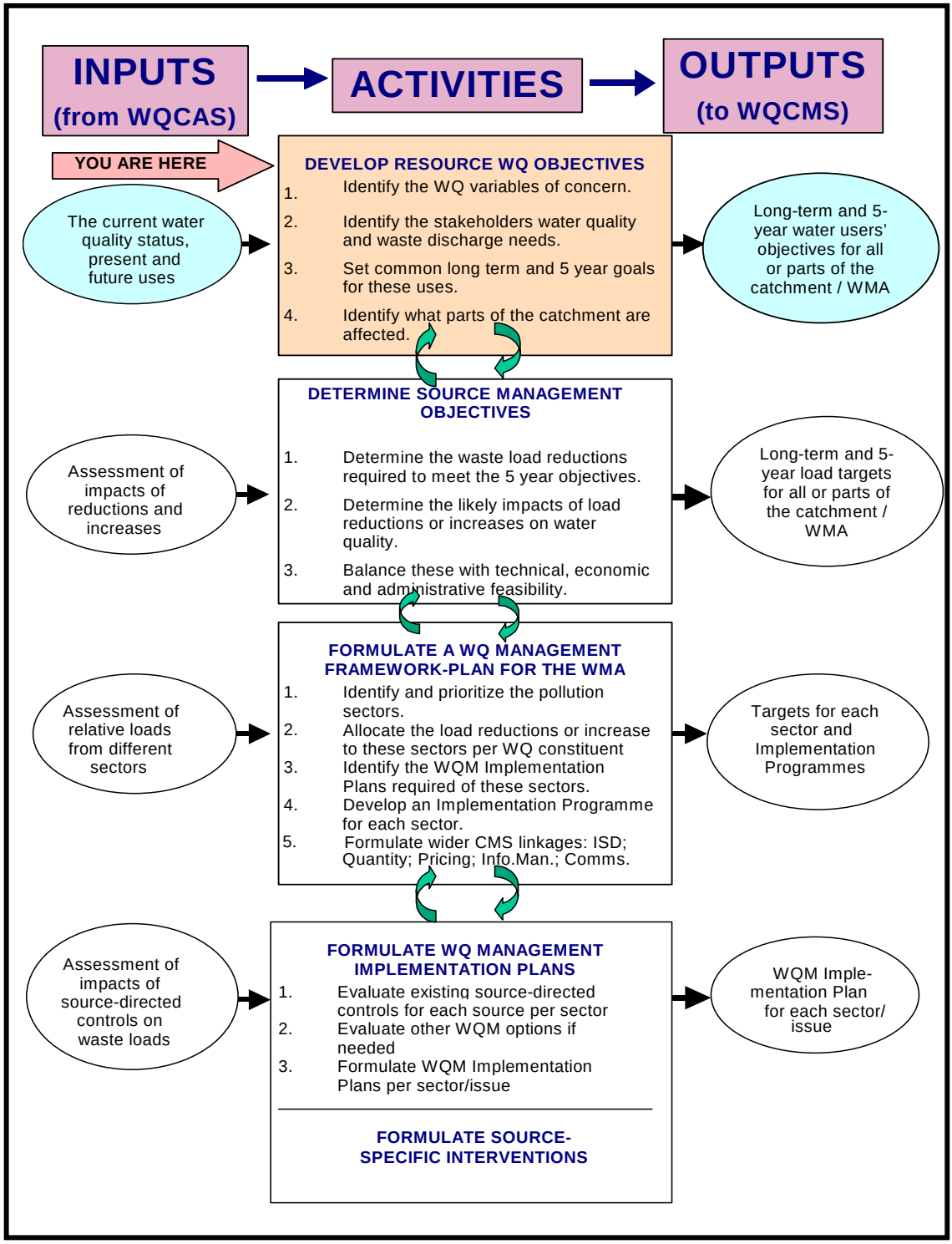


Figure 2: Roadmap for this Guideline

3 DEVELOP RESOURCE WATER QUALITY OBJECTIVES

Resource water quality objectives (RWQOs) reflect stakeholders' needs with respect to use of the water resources of the catchment. They include the statutory resource quality objectives (RQOs) outlined in the national water resources strategy (NWRS) and by resource directed measures (RDM), but express stakeholders' needs over and above those outlined by these processes. The RWQOs both outline stakeholders' needs with respect to water quality, as well as their needs with respect to the disposal of water containing waste to the resource. The process of determining RWQOs is consultative, but requires strong technical support.



3.1 What are Resource Water Quality Objectives?

RWQOs reflect the water users' and other stakeholders' needs with respect to the in-stream or in-aquifer water quality of the catchment *over and above those outlined in the NWRS and by the gazetted RQOs*, and include stakeholders' needs with respect to the disposal of water that contains waste to the resource. Together these two needs shape the goals for water quality management in the catchment, and will be among the key determinants of the CMS.

However, as a wide range of substances can impact on the quality of the water, RWQOs must only focus on the priority water quality concerns in the catchment. Similarly, RWQOs would not be applicable to the whole of the WMA, but would refer to specific sites (e.g. an irrigation water abstraction point), or the outflow point of a *Management Unit* (See section 3.3) or a key sub-catchment (*e.g*. the catchment of an impoundment). The overall RWQOs for the WMA could therefore include a range of water quality constituents, and may, for example, focus on eutrophication-related issues in one area, and on salinity in another. Similarly, RWQOs may be expressed by given interest groups; for example, to restore the natural riparian vegetation along a given river reach within a 15-year period. RWQOs are part of the CMS, and would consequently be reaffirmed, reviewed or updated on a 5-yearly basis.

Summary Characteristics of RWQOs

- RWQOs must give effect to the Catchment Vision, Resource Management Classes and the water quality component of gazetted RQOs as part of the RDMs.
- RWQOs are spatially-temporally incremental in-stream (or in-aquifer) water quality "targets", and could be derived from the *SA Water Quality Guidelines* (DWAF, 1996 – See Footnote 4 for reference). The *SA Water Quality Guidelines* provide narrative descriptions of acceptability of water quality associated with different concentration ranges for a wide range of substances for different water user requirements..
- RWQOs are aimed to satisfy the water quality needs of downstream water users and other stakeholders, including the need to dispose of water that contains waste, and marine coastal waters.
- RWQOs may be set identical to the water quality component of gazetted RQOs as part of RDM, but are more often set at a finer resolution than RQOs, to enable localised water resource management; thus, for every one RQO set, more than one set of upstream RWQOs may be formulated, in recognition of the relevant characteristics of individual upstream sub-catchments.
- RWQOs dictate the tolerable level of impact collectively produced by upstream water users.
- RWQOs may be set at any level better than that minimum level which would promote sustainability of resource use, and which would give effect to the gazetted RQOs.

RWQOs have several possible components:

- A narrative description of the required water quality. *For example: The water must be suitable for a lifetime of irrigation of all vegetable crops without yield loss.*
- A description of the site or area where these will apply. *For example: At the Brits Irrigation Board abstraction point.*
- A maximum allowable concentration, or a range of concentrations, or a statistical expression of the concentration. *For example: The 90-percentile for electrical conductivity must be less than 40 mS/m.*
- A description of the goal for the next 5 years. *For example: In 5 years' time the 90-percentile must be below 50mS/m.*
- A description of the current water quality status. *For example: currently the 90-percentile is 60mS/m*.
- A narrative description of the point/non-point source need to use assimilative capacity in the resource to dispose of water that contains waste for this sector. *For example: Saline irrigation return flow may return the irrigated salts in 10% of the applied irrigation water.*

3.2 Why Develop Resource Water Quality Objectives?

Catchment Water Quality Management is a highly complex task. The water quality, water quantity and aquatic ecosystem components of the resource are all interdependent and linked by a complex set of biological, physical and chemical interactions. Water quality changes continuously as water that contains waste is added to the river, which is then further modified as the river flows downstream, and as its estuary is influenced by the ocean tides. Water quality may also be affected by abstractions, which decrease the capacity of the resource, both the river and its estuary, to assimilate waste. Water in rivers may be impounded, which then realises a whole new set of biological, physical and chemical interactions, while groundwater, or water in tidal estuaries, may be subjected to an altogether different set of biological, physical and chemical interactions.

However, Catchment Management must give expression to the constitutional obligations for subsidiarity. This is realised where local needs are identified, and where local action achieves these goals. Recommendations from the Rio-Copenhagen-Dublin-Onandagou process and Agenda 21 place special obligations on signatory countries (which includes South Africa) to devolve water resources management to the lowest practicable level. The National Water Act (NWA) requires that stakeholders be involved in the water resources management process. However, water (particularly in South Africa) flows from one area to another over long distances, and may even be transferred from one catchment to another. Management of local water resources, and stakeholders' needs, may therefore impact on users far removed from the immediate problems.

The complexities of Catchment Management, as well as the apparent paradox of subsidiarity of IWRM within large WMAs, demand that the development of the water quality management component of a CMS be largely a technical process. This process must, nevertheless, be rooted in stakeholder participation, such that the technical process serve the needs of the stakeholders and in a manner which allows them to meaningfully contribute to the process. The operation of Forums (usually at a sub-catchment scale) that enable direct representation of stakeholders in the local Catchment Management processes has become indispensable[3]. The need to devolve decision-making to lower levels also means that stakeholders must identify their needs for use of the water resource, and must as far as possible implement local or sector-specific actions to realise these needs. The stakeholders' water quality needs, and their needs to use the resource to dispose of water that contains waste, must therefore be translated into *technically and economically feasible resource water quality objectives* (RWQOs) at localised scales, which can then direct the technical process. In addition, clearly defined and negotiated common RWQOs promote local action to realise catchment-wide needs.

The formulation of RWQOs for water quality management therefore provides:

- the opportunity for stakeholders to express their localised needs with respect to the quality of the water they require for use.
- the opportunity for stakeholders to outline their localised needs to use the resource to dispose of water containing waste (both in terms of point and non-point sources).
- a focus for the technical process of formulating the water quality management component of the CMS.
- a common, feasible and balanced approach to water quality management across the WMA.
- a framework within which local WQM actions can contribute to a common goal.

[3] See *Guidelines on the Establishment and Management of Catchment Forums*, DWAF IWRM Series, Sub-Series MS 6.1, 2001.

3.3 Including Scale Considerations in the formulation of RWQOs

As outlined in the previous chapter, Catchment Management activities may occur at both regional and localised scales. The spatial resolution of RQOs determines that such localised activities have to be managed according to relatively coarsely-defined sub-catchments, which can be seen to represent spatial *Management Units* for the purposes of Catchment Management. Selection of locations for RWQO determination needs to heed the definition of such Management Unit boundaries. The Text-Box below outlines the nature of Management Units.

Discretisation of Catchments as Spatial Management Units for WQM

Output Component 19 of the sister-document to this Guideline, *A Guide to Conduct Water Quality Catchment Assessment Studies* (Sub-Series 8.3), provides the following motivation for discretising the WMA into spatial Management Units for the purposes of WQM:

The NWA states that the CMS "...may be established in a phased and progressive manner and in separate components over time.." [s8(3)(a)]. This statement refers not only to variable timing of aspects of the CMS, but also to spatial distinctions in the establishment of the CMS, i.e. that at any stage the CMS implementation may focus more intensely on some portions of a catchment/ WMA and less so on others. These flexibilities are necessary to accommodate four "reality checks":

- *issues and problems are usually more acute in some sub-catchments compared with others; therefore, greater urgency resides with those "stressed or threatened" areas and they offer higher returns on management investment.*
- *WQM capacity is not limitless, therefore, the urgent problems should be tackled first*
- *the sub-catchments upstream of some river reaches require higher investment of management focus because they are primary water supply points*
- *information may be too inadequate in some catchment portions to warrant detailed interventions.*

These four factors dictate that the degree of spatial detail (fineness of scale) of RQOs and the resulting WQM challenges, and, therefore, the required spatial and temporal resolution of the WQM Implementation Plans, may vary among sub-catchments. From a pragmatic perspective, it would also make sense to treat certain sub-catchments as management "units", each with their own information base and WQM Implementation Plan.

As far as possible, each RQO site in a river should represent the "outflow" point of a Management Unit

It should also be noted that the concept of catchment management is not new to South Africa, and since the early 1990s, a number of Catchment Forums have been initiated across the country. These initiatives typically reflect the stakeholders' *local* needs with respect to the use of the water resource, and in many cases these local bodies have already formulated some "objectives" for their part of the catchment. It is therefore important that the process of formulating RWQOs recognises these localised existing initiatives and contributes or builds onto these processes.

However, it is equally important that these objectives be integrated into the wider catchment perspective. In this respect, the focus of the Catchment Forum or stakeholder group can be important. For example, the objectives established by environmental interest groups for the protection of the riparian zone may be localised, and will not affect downstream or upstream users much. However, irrigation interest groups are significantly affected by upstream users, and in turn impact on the downstream use of the resource. In general terms, objectives for conservative substances are likely to have more larger-scale implications, while those for non-conservatives may be more localised.

3.4 How are Resource Water Quality Objectives Developed?

RWQOs must serve to "operationalise" the water quality components of gazetted RQOs. Therefore, RWQOs may be based on stakeholders' water quality requirements, as well as their needs to dispose of waste in water, at levels more stringent than mandated by the RQOs and at a spatial resolution finer than that of the RQOs. However, some of these needs may be incompatible, or may not be technically or economically feasible within the catchment context. The establishment of RWQOs is therefore an iterative process of assessing the implications of the objectives on other water users, and revising the objectives according to these implications, against the back-drop of the gazetted RQOs. It should be noted that RWQOs may not be set at any level worse than that minimum level which would promote long-term sustainable development, and which would give effect to the gazetted RQOs. The formulation and refinement of RWQOs is, consequently, both a stakeholder-focused and a technical process, and can be described by the following steps:

Step 1: *Determine the water quality variables and catchment areas of concern - a technical process.*

As it is impractical to determine RWQOs for every water quality variable, the water quality variables of concern must be identified. This can be done by comparing the water quality data that are available to the *SA Water Quality Guidelines*[4] . Additional variables of concern may be identified from the land use data. GIS-based systems provide the ideal tool for this form of assessment, as they not only help identify potential water quality problems, but also the parts of the catchment where these occur. The following steps are based on determining RWQOs for these variables of concern.

Step 2: *Assist the stakeholders and water user sectors to identify their water quality requirements, and the requirements for the use of the water to dispose of waste - a stakeholder consultation process.*

Stakeholders or water user sectors must consider their water quality requirements on two sets of grounds:

- in terms of the outcome of the catchment "visioning" process which should give rise to the gazetted RQOs
- in terms of the impact of water quality on their livelihoods, or their general quality of life.

This process will have to be assisted by providing a description of the current water quality status of the resource, and the potential for improved water quality. The *SA Water Quality Guidelines* (see Footnote 4) and this Guideline's sister-document, *Guide to Conduct Water Quality Catchment Assessment Studies,* provide a basis for this process. This might result in an idealistic vision of the desired water quality, which would have to be balanced with the concomitant impacts of the land use on water quality. (Almost all water use activities generate either point or non-point source pollution, *i.e.* one may not insist on ideal water quality, when one's own activity contributes to the deterioration in water quality.) This, therefore, leads to both the acceptance of the need to use the water resource to dispose of water that contains waste (including its non-point source forms), and to the formulation of more realistic water quality requirements.

[4] DWAF, 1996. *South African Water Quality Guidelines* (Second Edition). Volumes 1 – 8.

Step 3: *Compare these water quality requirements with the present water quality status: a technical process.*

This process can have three potential results:

a) The water quality is significantly better than that required by the stakeholders (*i.e*. an "unstressed" situation). In this case, the stakeholders' water quality requirements can be adopted as RWQOs. (It must be noted that the Minister is under no obligation to fully allocate the available capacity of the resource to assimilate waste, since the NWA requires that special provision be made for future water use, strategic water use, inter-basin transfers and international obligations.)

b) The water quality is close to that required by the stakeholders (*i.e*. a "threatened" situation). In this case, the need for development in the catchment (and hence the increased use of the resource) would have to be balanced with the expected impacts on water quality. It may be necessary to either revise the water quality requirements, or the need to discharge water that contains waste in these cases. (This does not imply no further development, but that new developments would mean more stringent discharge standards to maintain total loads).

c) The water quality is worse than that required by the stakeholders (*i.e*. a "stressed" situation). In this case, an iterative process of assessing the implications of these requirements on other stakeholders would have to be initiated.

Step 4: *Define Management Unit boundaries: a technical process*

The spatial resolution of gazetted RQOs, the set of findings from Step 3 for all points of comparison in the WMA and relevant information from the Water Quantity and Aquatic Ecosystem Component of the CMS are used to identify particular sub-catchments as spatial Management Units for the purposes of Catchment Management (see Text-Box in Section 3.3). Usually, this step would be performed as part of the Water Quality Catchment Assessment Study[5] (WQCAS), or a similar assessment study for water quantity and aquatic ecosystems. This is one of many indications of how closely the WQCAS overlaps with the WQM component of the CMS.

Step 5: *Iterate between the stakeholders' requirements and the implications for other users: a facilitated process - consultations with stakeholders driven by technical staff.*

In a threatened or stressed situation it will become necessary to balance the conflicting demands for use of the water resource. This is an iterative process driven by the need to ensure the beneficial, equitable and sustainable use of the water resource. It serves to balance the water quality needs of the users, with the use of the water resource to assimilate water containing waste. As outlined above, this may be done on a localised basis for water quality variables which are rapidly assimilated (e.g. microbiological contamination), or on a sub-catchment basis for variables with somewhat wider impacts (e.g. nutrient contamination). Conservative water quality variables (e.g. salts) may require the iteration to be done on a catchment-wide basis, and may have to consider the implications of importing salts *via* inter-basin transfers from donor catchments.

This process is a facilitated dialogue that specifically aims to bring conflicting demands (or requirements) for use of the resource to the table. It is informed by the technical process, and aims to highlight different stakeholders' standpoints. This builds a greater

[5] See *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of the Catchment Management Strategy* (Department of Water Affairs and Forestry, Water Quality Management Series, Sub-Series No. MS 8.3).

understanding of the integrated nature of the water resource among stakeholders, and may result in the formulation of more realistic and balanced requirements. The result may either be a revision of the water quality requirements, or the re-assessment of the use of the water resource to dispose of water that contains waste.

Note

- It should be borne in mind that the preceding catchment "visioning" process, which ultimately yields the gazetted RQOs, would recognise the degree of existing or potential stress in the catchment, albeit at a coarser scale, which, in turn, should exercise a moderating influence on stakeholders' requirements at finer scales.
- It is likely that, in practice, much of the stakeholder participation during CMS development remains focused on the catchment visioning and RQO determination stages, so that the RWQO determination stage may have relatively light public participation requirements and ends up being mostly a technical process. If that is the case, then public participation, in the case of RWQOs, may be pre-dominantly in the domain of awareness-creation and capacity-building.

Step 6: *Determine the long-term RWQOs and get stakeholders' comments: a pre-dominantly technical consultation process.*

Steps 1 to 5 are aimed at determining *realistic* requirements for each of the stakeholders or water user sectors. This step (6) aims at collating these into a set of *economically and technically feasible* RWQOs. These objectives need not represent the immediate, or even 5-year, goals of the CMS, but could represent medium- to long-term (10- to15-year) goals for catchment water quality management, *i.e.* the RWQOs elaborate the water quality component of the stakeholders' "Vision" for the resource. Stakeholders in the catchment must be given the opportunity to comment on these before they are finalised.

This step may be supported by modelling outputs from the Water Quality Catchment Assessment Study (WQCAS) to evaluate the implications of future developments and water quality management actions on catchment water quality. (It should nevertheless be remembered that modelling-based assessments are resource intensive and are not always necessary). Once finalised, the RWQOs determine the future status of the sub-catchments, or different parts of the resource, including groundwater. As in step 3, these may result in unstressed sub-catchments or resources, or threatened sub-catchments and resources, or stressed sub-catchments and resources.

Step 7: *Determine the shorter-term interim RWQOs: a technical process.*

While Step 6 outlines longer-term objectives for a catchment, the CMS is based on a 5-year timeframe. It is therefore necessary to determine interim (or 5-year) RWQOs for the CMS. These should aim to bring about the gradual and phased realisation of the long-term RWQOs. The steps in this process are determined by the status of the resource. Interim objectives for unstressed resources may be based on development scenarios for the catchments. In threatened resources, interim objectives may be aimed at maintaining the current state of the resource, while in stressed sub-catchments interim objectives would outline the first step in improving the water quality. The extent of this step is determined by the pollution sources, and their potential for/ ease of management.

3.5 What must be Considered?

The formulation of viable RWQOs is perhaps one of the most important steps in the catchment water quality management process. RWQOs that have the support of the stakeholders will secure their participation in the ongoing process. It also sets the goals that drive the technical process of formulating Source Management Objectives (see Chapter 4), the use-allocation strategies, and the sector-specific plans. It is therefore critical to ensure that this process produces viable goals that stakeholders can support.

The following general considerations are, therefore, offered to further guide the process:

- This process focuses on stakeholders' requirements over and above those expressed by the RDM and NWRS. These already secure sustainable and strategic use of the resource at larger scales. This process must therefore focus on securing the beneficial and equitable use of the resource on a sub-catchment basis.
- This process has the potential to formulate "pie-in-the-sky" objectives. In this regard, it is important to test the objectives against beneficial and equitable use, and the economic and social implications on the catchment/WMA as a whole.
- The objectives should initially concentrate on the burning water quality issues, and on the stressed resources. Catchment Management is a progressive and phased process, and there will be opportunities to revise, update and expand the RWQOs.
- While the process of determining the RWQOs includes stakeholders, it need not be consensus-driven, but should strive to determine common objectives wherever possible. Ultimately, the water resource managers, *i.e.* DWAF or the CMAs, formulate these objectives based on stakeholders' input, and bear the ultimate responsibility for the management process that must ensure the meeting of these objectives.

Note

- The technical protocol for definition of an RWQO still requires research and development, as well as consideration in DWAF's policy development to ensure consistent execution across different WMAs.
- The NWA makes provision for the prohibition of land-based activities that may impact water quality [S.13(3)(g)]. In the setting of RWQOs this and other source-directed control measures need to be considered.
- RWQOs is one component of the "operationalising" of the Resource Management Class, RQOs and the Reserve. Currently, DWAF's policy-framework for this process of operationalising of statutory measures is not very advanced. This is an area of policy development that requires increased attention.

3.6 What Catchment Assessment Support is required?

The formulation of the RWQOs should be largely supported by a water quality catchment assessment study (WQCAS), including an assessment of the major point and non-point sources of pollution in the catchment. However, there will be some degree of iteration between these assessments and the formulation of the RWQOs. For example, initial water quality assessments would be based on the *SA Water Quality Guidelines* (see Footnote 4), but the water quality assessments must be based on the RWQOs once these have been established.

Similarly, initial assessments of the sources of pollution would be broad-brush assessments of all potential sources, but once the RWQOs have been established, pollution source assessments would be based on the critical pollution sources. The WQCAS should therefore run in parallel with the process of formulating the RWQOs. These assessments therefore provide the ongoing support to stakeholders in this process.

Water Quality Catchment Assessment Study (WQCAS) Outputs Required

The following Outputs are required from the WQCAS, as described in *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of a CMS.*

- Output 0: Summary of existing understanding, knowledge and past studies
- Output 1: Catchment description
- Output 2: Requirements of the NWRS and RDM
- Output 3: Water use and conservation
- Output 4: Overview of adequacy of water availability
- Output 5: Water quality requirements and constituents of concern
- Output 6: Water quality for streamflow, reservoirs, estuaries, wetlands and groundwater
- Output 12: Stakeholder details and participation processes
- Output 14: Record of water quality issues and their origins
- Output 16: Vision for water quality management
- Output 19: Management units and assessment spatial and temporal resolution

3.7 Who should be Involved?

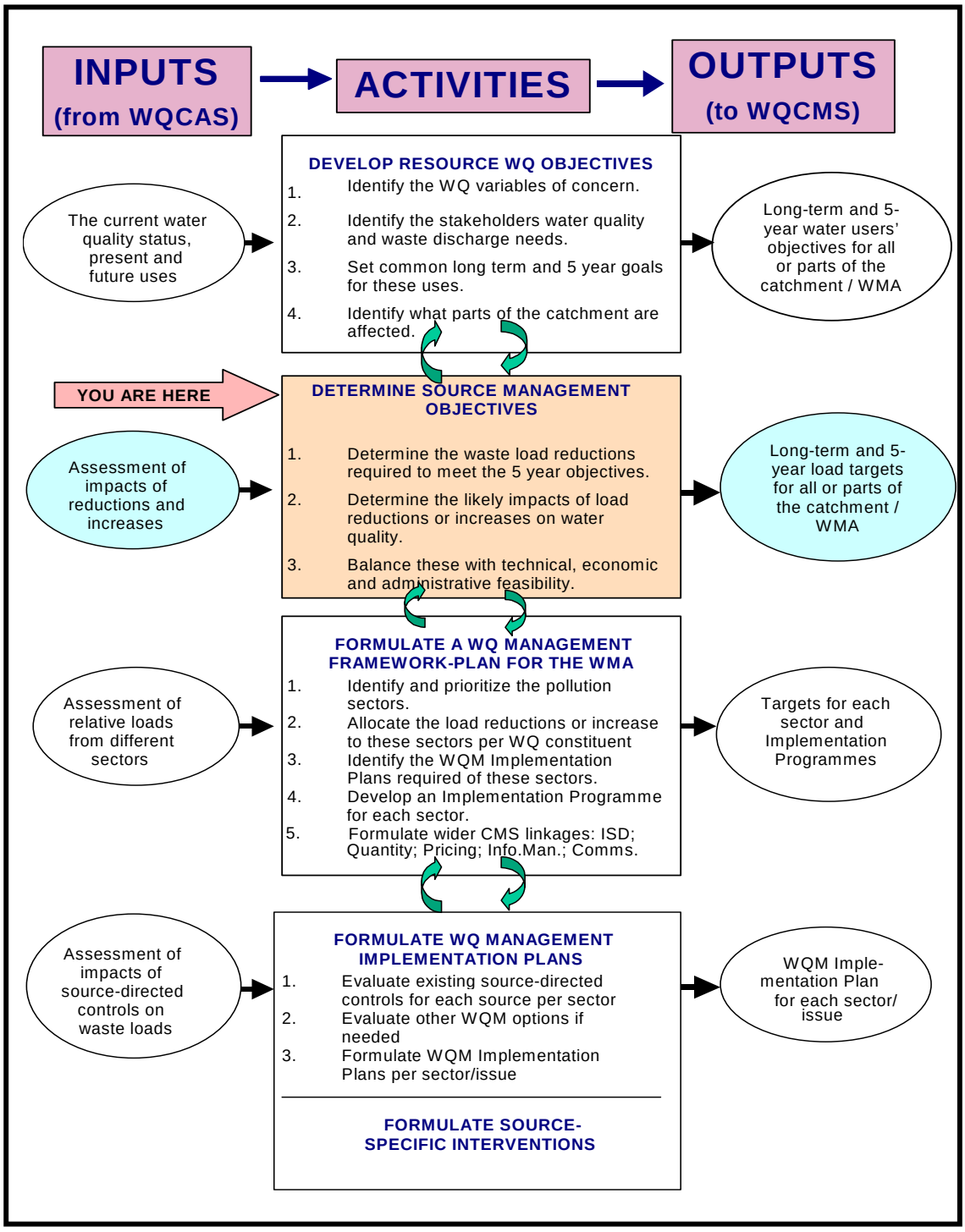
The first consideration with respect to stakeholder participation in this process is that all stakeholders are afforded the opportunity to comment on the RQOs (including its water quality component) once notice of the CMS has been published in the Gazette. However, it is impracticable to involve all stakeholders in the formulation of the RWQOs. Stakeholder involvement should, therefore, be based on the spatial extent of individual water quality problems, and should include both the impactors and the stakeholders affected by the impacts. Localised problems, such as microbiological contamination, may therefore only include local stakeholders, while catchment-wide problems, such as salinity, may involve a wider range of stakeholders (see Section 3.3).

Given that the process is iterative, and is based on facilitated dialogue between the different needs for water use, smaller groups of stakeholders are more likely to be successful. Smaller groups can actively participate in the debate, and may have to receive specific capacity-building in this regard. These stakeholders would typically only be those directly affected by the RWQOs, and different small groups could address different sets of objectives. This would typically be done in a workshop environment.

Be this as it may, there must be wider information dissemination with regard to the process, and the RWQOs that are distilled from this process. This could be in the form of newsletters that inform a wide group of stakeholders of the results of the stepwise process outlined in Section 3.4.

4 FORMULATE SOURCE MANAGEMENT OBJECTIVES

Source management objectives (SMOs) provide the focus for the actions required to give effect to the *RWQO*s. They outline the incremental waste load reductions (in stressed catchments), waste load maintenance (in threatened catchments), or waste load increases (in unstressed catchments) required to meet the interim (5-year) RWQOs. *Source management objectives* are not source- or sector-specific, but outline incremental waste load targets on a sub-catchment basis. This is primarily a technical process, which iterates with the determination of the *RWQO*s, and with the W*ater Quality Management Framework-Plan* for the whole WMA.



4.1 What are Source Management Objectives?

Source management objectives (SMOs) outline the incremental waste load targets for the WMA at the sites where RWQOs have been set. They outline *what* needs to be done to realise the interim RWQOs, but not *who* or *how* this will be done. SMOs, therefore, specify the incremental waste load reductions (in stressed sub-catchments), or increases (in unstressed sub-catchments) required to realise stakeholders' requirements for use of the water resource in each sub-catchment. SMOs may also indicate that total incremental waste loads should be maintained in the face of increasing development in the catchment (in threatened sub-catchments).

SMOs are set for each of the interim RWQO sites in the WMA (see Section 3.5), and aim to realise these objectives within a 5-year timeframe. The SMOs are not source- or sector-specific, but are determined by DWAF or the CMA on a sub-catchment basis, as well as at the WMA scale, in the case of neighbouring WMAs that share a resource.

4.2 How are Source Management Objectives determined?

SMOs are determined by balancing waste load targets with the technical, economic and administrative practicalities of achieving these targets. This is an extension of the process of determining RWQOs, and forms the link to the Water Quality Management Framework-Plan, which indicates a WMA-wide Implementation Programme for sectoral plans, to give effect to the waste load targets. SMOs are determined in an iterative process of testing what needs to be done to give effect to the interim RQOs, against the feasibility of achieving these goals.

In order to ensure administrative simplicity, SMOs are set for the whole WMA, and incrementally for whole catchments, sub-catchments, or river reaches (*e.g.* a phosphorus load reduction target for the catchment of a eutrophic impoundment), according to the "Management Unit" concept, but not for individual sources within these catchments. (The WMA scale is considered, because it has to be feasible for a CMA to require from neighbouring CMAs that a specific set of SMOs be maintained on their common border.) SMOs are also set for each of the critical water quality issues identified in the WQCAS. This process sets common targets for all the sources within each catchment, and hence promotes the formulation of catchment-wide sector-specific actions to achieve these targets within the Water Quality Use Allocation Plan and sectoral Implementation Plans described in Chapters 5 and 6.

This approach, therefore, allocates waste load targets to parts of catchments. These incremental sub-catchment waste load targets are then re-allocated to specific sectors or sources within the Water Quality Use Allocation Plan, described as one of the components of the Water Quality Management (WQM) Framework-Plan in Chapter 5. As these Water Quality Use Allocation Plans are developed in close co-operation with stakeholders from the relevant sources and sectors, this process forces the stakeholders to think within the wider catchment perspective when allocating targets for specific sectors. This avoids many of the problems associated with the source-specific receiving water quality objectives approach[6]. However, where the total waste loads in a catchment are dominated by "single" sources, source-specific SMOs may be specified.

[6] The Receiving Water Quality Objectives approach, advocated in the 1980's, was aimed at determining source-specific pollution (or waste) loads for each discharger. This approach proved to be resource-intensive and difficult to implement. It was also difficult to allocate waste loads to the different sources within the catchment. This approach carries the inherent danger of ultimately leading to a resource that is only marginally fit for use and does not promote sustainability.

In addition, the process of determining SMOs need not be based on quantifiable cause-effect relationships. SMOs can be based on simple heuristic understandings of the likely effects and feasibility of specific load reductions (or increases), or on previous modelling studies of the likely effects of given changes in loading.

4.3 What must be Considered?

The feasibility of achieving the SMOs is determined by the type of pollution source, and the waste load reduction required. The most important issues to consider when establishing the SMOs for each part of the catchment/ WMA are therefore:

- The difference between the current state and the RWQO.
- The type and number of sources that contribute to the water quality problems.
- The expected growth in these pollution sources, in number and waste load.
- The pollution control technology available to the pollution sources and sectors.
- The local capacity in Water Management Institutions required to achieve the SMOs.

The following paragraphs provide more detail on how to establish SMOs within these considerations:

The difference between the current state and the RWQO:

The difference between the current state and the RWQOs indicates the overall reduction or increase in waste loads that should be considered.

In stressed catchments, RWQOs will differ significantly from the current state, and considerable load reductions may be required to realise the RWQOs. Many of the water resources in these catchments are also likely to have a lower Resource Management Class, and hence less stringent source-directed controls. It is, therefore, possible that additional catchment-specific standards and management practices will be required to meet the RWQOs. In these cases, the economic and technical feasibility of SMOs will have to be carefully weighed against the likely impacts of the load reductions on water quality. The management emphasis will be on assessing the overall load reductions required to realise the RWQOs. This may require detailed assessments of the likely effects of waste load reductions on downstream water quality, and is likely to be resource-intensive.

In threatened catchments, SMOs are likely to specify that there should be no overall increase in waste loads. This need not prevent further development of the catchment, but rather indicates that development in the catchment has to be balanced by reductions in waste loads elsewhere in the catchment. The management emphasis in these cases will, therefore, be on allocating waste loads to different sectors according to the Water Quality Management Framework-Plan. This is likely to require the least investment in assessing the impacts on downstream water quality, and formulation of the SMOs will be the least resource-intensive.

In unstressed catchments, SMOs will specify the possible increases in waste loads that may be accommodated without threatening the RWQOs. However, this is not a free licence to increase waste loads, and proposed increases in waste loads should only be considered if there are clear social and economic benefits to the catchment as a whole. In these cases, the WQM Framework-Plan (and Water Quality Use Allocation Plan) would have to allocate these increases to the various sectors based on the principles of beneficial and equitable

use of the resource[7], taking account of the principles of sustainable development. This process must consider the natural growth in the catchment, as well as any proposed developments that may occur. The management emphasis in these cases will be on assessing what increases can be considered without risking the RWQOs. This may have to be supported by assessments of the likely impacts of waste load increases on downstream water quality, and must include assessments of the increases in waste loads that are associated with the planned developments in the catchment.

The type and number of sources that contribute to the water quality problems:

The type and number of waste sources that contribute to the current waste loads provide clues as to the feasibility of waste load reductions. In general terms, where a few large sources contribute to the overall waste loads, significant load reductions are more feasible, and where a great many smaller pollution source contribute to the problems, reductions in waste loads may be more difficult. Smaller individual sources are also less likely to be able to afford costly capital investments in pollution control technology. However, this largely depends on the type of sources in the catchment. It is generally more difficult to manage the water quality impacts from non-point sources, than from point sources. The formulation of SMOs is therefore also informed by the point and non-point source components of the WQCAS, which should indicate who is contributing to the overall waste loads.

The pollution control technology available to the pollution sources and sectors:

The type of sources that contribute to the overall loads may also impact on the feasibility of waste load reductions. Cost-effective pollution control technology is available for many source types, but is not necessarily seeing wide use in South Africa. Similarly, "cleaner-production" approaches, which often realise savings for the industry while reducing overall waste loads, have not taken root within the South African context. Significant load reductions are therefore possible in many sector types, without significant economic implications for the individual sources.

The capacity of the local implementing agent:

This is particularly important where RWQOs, and subsequent SMOs, pose the need to address localised problems, for example, where the SMO requires implementation of an existing water quality management protocol for "dense settlements". In these cases the viability of the SMO has to be carefully weighed against the capacity of the stakeholders to implement the protocol. This capacity may be determined by the technical or skills required, the financial resources required, and the institutional arrangements required to implement the protocol. In cases where the capacity is very limited, the CMS may have to give consideration to building this capacity.

[7] In unstressed catchments, SMOs will always indicate that additional waste loads can be accommodated, but these may not always be allocated simply as there is no economic and social benefit to the catchment as a whole. In other words, the "Precautionary Principle" applies.

Note

- The technical procedures and conventions for quantifying an SMO still require considerable research and development – e.g. whether it is a "low-flow"-related load only, or seasonal, or ....etc.
- The quantification of SMOs is achieved through the WQCAS, in which the impacts on the SMOs of inter-catchment transfer schemes, strategic water use and the in-stream fate of pollutants require recognition.
- The feasibility of developing a Resource-Directed Life-Cycle Assessment methodology to trace pollutants back to their source, requires further attention in DWAF's policy-support planning. This methodology would assist decisions about the feasibility of pollution load reductions.

4.4 What Catchment Assessment Support is required?

The above paragraphs have outlined the type of assessment support required to establish SMOs. Assessment techniques that support the formulation of SMOs are those which:

- indicate the likely effects of pollution load increases or decreases on downstream water quality, and
- indicate the number and type of sources contributing to the overall pollution loads.
- highlight the protocols required to address specific pollution problems.

Assessment techniques that indicate the effects of pollution loads on water quality are likely to be the most important tools in the formulation of the SMOs. These tools indicate what decreases in loads are required to realise the RWQOs, or what increases in loads can be accommodated without threatening the RWQOs. These assessment techniques may range from complex water quality process models for non-conservative variables, to simple mass balance models for conservative substances. Simple heuristic models based on previous studies may also prove to be valuable tools. In general, these assessment techniques should not focus on processes that lead to pollution, but rather on the impacts of pollution loads on water quality.

Catchment-wide point and non-point source assessment techniques are also important in the formulation of SMOs, as they indicate which sources are contributing to current pollution loads. These models may be quantitative or qualitative, and contribute to assessing the feasibility of pollution load reductions (see Section 4.3).

Water Quality Catchment Assessment Study (WQCAS) Outputs Required

The following additional Outputs are required from the WQCAS, as described in *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of a CMS.* (NB: It is assumed that the Outputs listed as "Required" for Chapter 3 are already available.)

- Output 9: Configured and calibrated water quality predictive tools/ models
- Output 10: Reconciliation: catchment sources and water quality patterns
- Output 17: Plans and projections of future water demands and catchment development
- Output 18: Predicted future water quality at sites of management focus

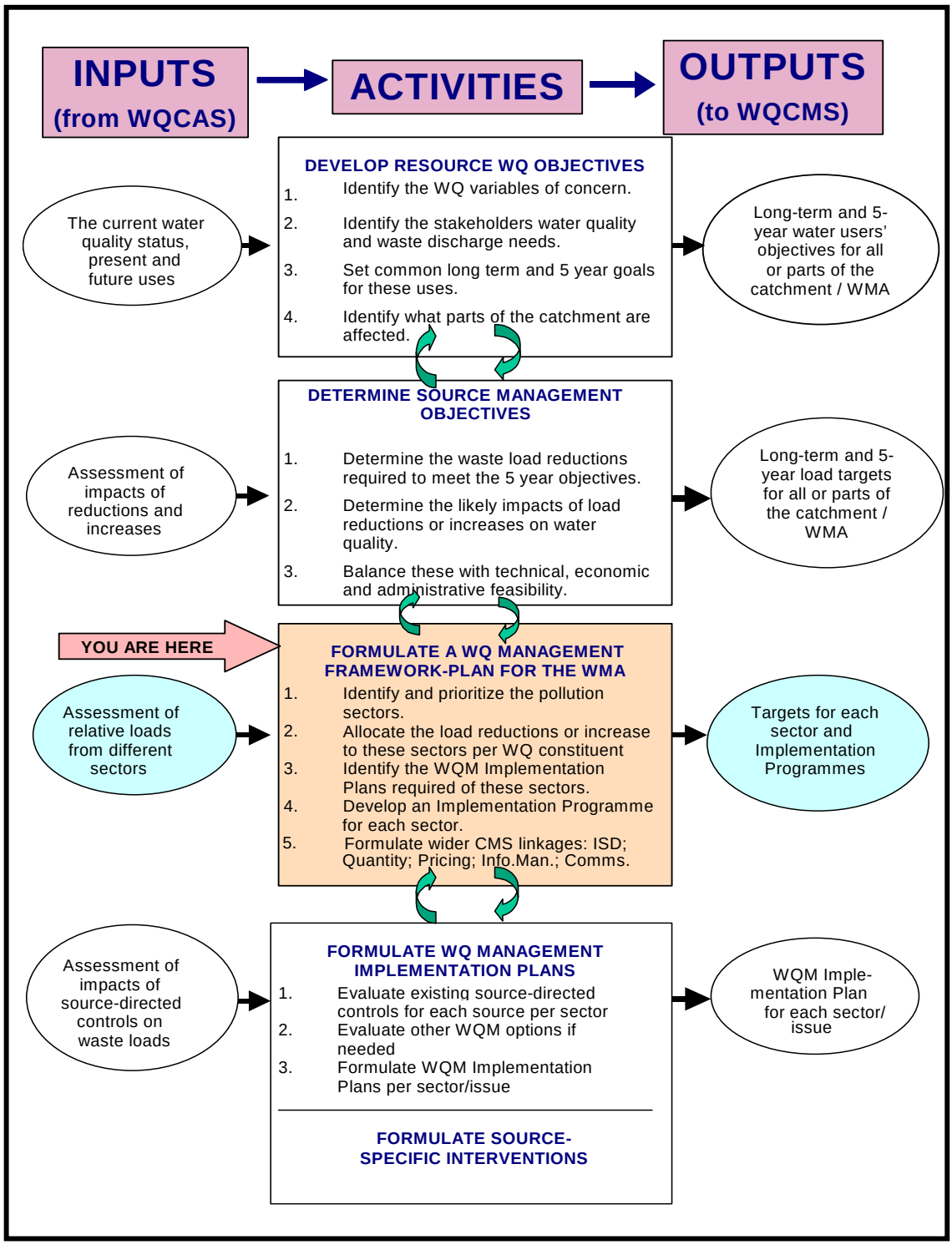
4.5 Who Should be Involved?

The formulation of SMOs is largely a technical process of determining the load reductions or increases that are required to realise the RWQOs. However, the SMOs must be technically and economically viable. This means that the representatives of individual sources and sectors that contribute to the water quality problems must be involved in the process. Participation of these sources/sectors focuses as follows:

- on the iteration between the SMOs and the Water Quality Management Framework-Plan,
- on soliciting comment from the sources who will be expected to give effect to these SMOs about the overall reductions in pollution loads.

5 FORMULATE A WATER QUALITY MANAGEMENT FRAMEWORK-PLAN

The *Water Quality Management Framework-Plan* outlines all the elements of water quality management at WMA-wide scale. It should specify the *strategic* approaches for water quality management, the linkages to other components of the CMS, the sectoral responsibility for implementing the water quality management required to satisfy the RWQOs, an Implementation Programme and auditing, correcting and reviewing arrangements. The WQM Framework-Plan, as documented, comprises the water quality part of the Gazetted CMS.



5.1 What is a Water Quality Management Framework-Plan?

The Water Quality Management (WQM) Framework-Plan assembles the elements of the *WMA-wide* strategy for water quality management. It has to ensure that the SMOs and, hence, the interim (5-year) RWQOs are achieved for identified critical water quality constituents inside the key "*Management Unit*" sub-catchments in the WMA, by setting out a WQM Implementation Programme for relevant sectors/ sources and an integrated set of linkages to other components of the CMS. It includes a Water Quality Use Allocation Plan, in alignment with the Water Allocation Plan required as part of the CMS by the NWA [Section 9(e)]. When the CMS is eventually Gazetted, the WQM Framework-Plan, as documented, will comprise the water quality part of the CMS.

What are the Elements of a WQM Framework-Plan?

Any or all of the following elements may be required:

i) Matrix of principles, criteria, NWRS requirements and RDM details according to which WQM is exercised across the particular WMA, including the monitoring and auditing principles and criteria.

ii) Inventory of RWQOs and SMOs for the WMA on a Management Unit basis (supported by GIS).

iii) Water Quality Use Allocation Plan for the WMA on a Management Unit basis.

iv) Inventory of WQM approaches – both technical and non-technical (*e.g.* authorisation; cooperation; direct intervention; advocacy; capacity-building; protocols) - according to sector- or source-types.

v) Inventory of required *Sectoral* WQM Implementation Plans with specification of sectoral responsibilities (could be multi-sectoral).

vi) Inventory of required *Source-Specific* WQM Implementation Plans with specification of stakeholder responsibility (could be multi-source, but of a localised area or single user).

vii) Inventory of *Management Unit-* or *Sub-Catchment-Focused* WQM Plans (if any).

viii) Inventory of required *In-Stream* WQM Plans (if any).

ix) Inventory of required *Water Use* WQM Plans (if any).

x) Inventory of required linkages to other components of the CMS and Outlines of the composition of the WQM part of each of these other CMS components.

xi) WMA-wide Implementation Programme for WQM Plans of any or all of the following: *Sectoral; Source-Specific; Sub-Catchment-Focused; In-Stream; Water Use; "Other CMS".*

xii) Plan for Monitoring, Evaluation, Auditing, Correction and Review of WQM across the whole WMA.

The WQM Framework-Plan, through the Water Quality Use Allocation Plan, allocates the available incremental water quality load, defined by the SMOs, to different water user sectors on a template of "Management Units". The WQ Use Allocation Plan further dictates which sectors need to develop sectoral or source-specific WQM Implementation Plans to achieve these loads. This should address both point sources and non-point sources. In doing this, it should indicate the types of management approaches that should be adopted for each sector- or source-type, including:

- statutory authorisation requirements, such as compulsory licensing with more stringent conditions, for point source discharges, or non-point source activities defined as water use under Section 21 of the NWA;
- specific direct structural or operational management interventions to address a particular problem;
- cooperative governance initiatives with other government departments and spheres of government, such as Department of Agriculture, Department of Environmental Affairs and Tourism, etc;
- capacity-building and awareness-building programmes to change the water use behaviour of users and improve the management/operation of key activities; and/or

- specific requirements of existing pollution control protocols, for instance a "dense settlements", or a "groundwater protection" protocol.

Furthermore, the WQM Framework-Plan should indicate the need to develop In-Stream WQM Plans (where internal loading is significant, or where river/ reservoir rehabilitation is required) or Water Use WQM Plans[8] (where the water quality of abstracted water is not fit for a particular use).

In general, the WQM Framework-Plan incorporates a suite of interventions for source-types that have been identified as "critical" through the stakeholder participation process, matching the approaches to the characteristics of each source-type. For example, cooperative governance and awareness-building approaches may be most appropriate for dry-land agricultural activities, while statutory licensing and associated control practices may be specified for irrigated agriculture.

The WQM Framework-Plan must specify the sector/ source WQM Implementation Plans that need to be formulated on a Management Unit basis and a Programme for their development/ implementation, including the sectoral responsibilities for developing these Plans. The requirements and arrangements for WQM monitoring, auditing and review are also outlined.

Note

The WQM Framework-Plan must, in principle, cover the whole WMA, while individual WQM Implementation Plans may cover only particular Management Units, or groups thereof, *e.g*. Management Units that make up a particular catchment. Also, the respective WQM issues under focus in particular Management Units may differ from each other.

5.2 What is the Relationship of the WQM Framework-Plan to other Components of the CMS?

The WQM Framework-Plan is a key element of the total CMS. It must highlight the inter-relationships between the WQM Implementation Plans for sectors/ sources on the basis of Management Units and the linkages with the *other Components* of the CMS, some of which are described in the draft document, *Generic Framework for Catchment Management Strategies* (DWAF, 2001), but which are further expanded upon as follows:

- NWRS and RDM (Class, Reserve and RQOs) Intervention Component Strategy
- Water Quantity Management Component of the CMS, including a Water Quantity Management Framework-Plan and Water Quantity Use Allocation Plan
- Aquatic Ecosystem Management Component of the CMS, including an Aquatic Ecosystem Management Framework-Plan
- Water Resource Augmentation Component Strategy
- Water Resource Operating Component Strategy
- Water Demand Management Component Strategy
- Water Pricing Component Strategy
- Institutional Development and Cooperative Governance Component Strategy
- Communications/ Awareness-Building Component Strategy
- Land Use Planning/ Management Component Strategy

[8] A Water Use WQM Plan includes options to either treat the water before use, or use alternative sources.

- Information Management and Monitoring Component Strategy
- Auditing and Review Component Strategy

Each of these Component Strategies of the CMS has either a WQM sub-component (*e.g.* the WQM part of the Communications/ Awareness Component Strategy), or has technical cross-linkages to a WQM consideration (e.g. the role of "freshening releases" in determining water quality management aspects of the Water Resource Operating Component Strategy).

5.3 How is a WQM Framework-Plan Developed?

The Text-Box in Section 5.1 illustrates that the WQM Framework-Plan may have numerous elements, but, of these, the Water Quality Use Allocation Plan is central to the specification of many of the other components. It is therefore necessary to consider the Allocation Plan more closely. The Water Quality Use Allocation Plan represents the partitioning of the total allocable load for a specific "critical" water quality constituent in each (sub-) catchment of the WMA into the individual loads available for a sector and/or a source. This must focus on the sources with the greatest contribution to the load, and must reflect the NWRS. Care must be taken not to make these sector allocations impracticably specific, but rather to use broad sectoral categories. Where an approach selected to effect the SMOs has been specified as the need to implement a given pollution management protocol, the Water Quality Use Allocation Plan would prioritise the sources for implementation; e.g. the prioritisation of settlements in the catchment/WMA for implementation of a "dense settlements" pollution prevention protocol.

The following steps are proposed in the development of a WQM Framework-Plan:

***Step 0**:* *Formalise the principles, criteria, NWRS requirements and RDM details according to which WQM is exercised in this WMA*

WQM needs to unfold within a cohesive structure of principles and criteria (including those for monitoring and auditing of WQM) that meet the general support of stakeholders, and with recognition of the requirements of the NWRS and the RDM specifications. The catchment visioning process that underlies the RDM outcomes, as well as the WQCAS, will have yielded such principles and criteria with stakeholder input, but particular attention needs to be given to the criteria governing monitoring, auditing, corrective action and review. This Step serves to record and order all these details as a safety-net for sustainable WQM.

***Step 1**:* *Prioritise the sectors/ sources/ activities that require management in each Management Unit sub-catchment*

The range of sources that contribute to the pollution load in a Management Unit must be prioritised for management purposes, *i.e.* where to allocate attention and resources. All source types (or particular sources) with significant contributions (*e.g.* greater than 10% of the load) should be considered as priorities.

Those source-types, or sub-catchments, with the greatest total impact on a water quality concern, should be a priority for management. However, those sources with the highest relative impact (*e.g.* loading per unit area or per capita) should also have a higher priority for management, because the interventions may be more effective in these areas. Similarly, the potential future impacts of these sources should be a major consideration, because these impacts may be more easily mitigated before they are manifested.

The manageability of a source indicates whether the impacts from that source may be controlled and, therefore, the prioritisation should consider:

- *background* contributions, which are largely unmanageable; and
- *technical* potential for management, based on existing practices and the nature of the source-types and processes.

Furthermore, managing the priority source-types or areas requires a mixture of political will, legal mandate, institutional capacity, economic resources and social commitment. The resources and management/ institutional environment required to manage the priority sectors/ sources, should be part of the prioritisation process.

Where the existing management resources and/or enabling environment are not currently adequate, but it is feasible to access them, this should be the emphasis of management, before identifying approaches that may be less implementable. Alternatively, in those situations where an enabling environment or management resources are unlikely to be available in the short- to medium-term, it may be necessary to review the prioritisation process and concentrate on sources that have less stringent requirements. However, the implications for efficiency and equity between sectors/ sources must be considered.

***Step 2**:* *Formulate the Water Quality Use Allocation Plan; i.e. allocate the available waste load between sources in each Management Unit sub-catchment (or identify the sources where existing protocols should be implemented).*

The SMOs in each Management Unit sub-catchment with identified water quality problems must be compared to the existing (and projected) waste load, and evaluated in terms of being:

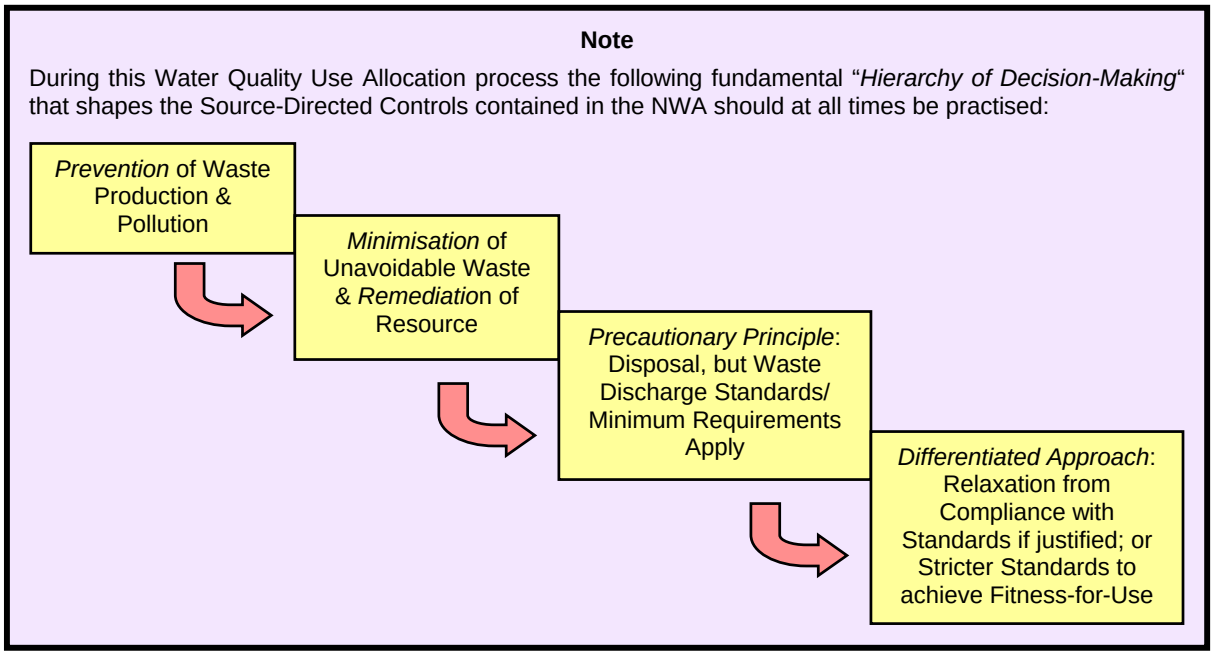
- stressed (a particular interim RWQO is already exceeded);
- threatened (is likely to be exceeded in the next 5 years); or
- unstressed (is unlikely to be exceeded in the next 5 years).

For stressed situations, the existing load must be reduced. This must include the expected increase in loading due to development, which may be restricted or phased in, as other source loads are reduced. In some cases, implementation of existing general authorisation requirements may be sufficient to meet the SMOs. It may be necessary to set more stringent water use authorisation conditions for particular sources, or to require compulsory licensing under Section 43 of the NWA. However, only activities that are defined as water use may be managed in this way, which applies to most point sources. Non-point source activities may be permissible under general authorisation, or it may be necessary to determine controlled activities in the WMA for critical non-point sources. On the other hand, cooperative governance agreements or awareness programmes may be more appropriate.

A similar process must be conducted for threatened situations, although reductions in loads are only necessary to meet the expected increase in load associated with future development in the catchment. Finally, for unstressed situations, implementation of the general authorisation requirements should be adequate, except where intensive development is likely.

Regardless of the situation or the approach, the proposed load allocations must be formulated for the critical water quality problems. This must engage the possible effect of in-stream management, associated with remediation, dilution and/or reservoir operation. There will be some iteration between these load allocations, based on the possibilities for management, the necessary considerations and the inter-relationships between loads from a particular source type.

The process of defining RWQOs, SMOs and the Water Quality Use Allocation Plan must be iterative, as this enables the affected sectors/ sources to evaluate which particular RWQOs relate to management requirements at the source. Similarly, the process must recognise that the realisation of the RWQOs is a gradual and progressive process.



***Step 3**:* *Specify required WQM Implementation Plans*

Once the various sectoral loads have been proposed for a particular source-type (or source) in a Management Unit, these need to be combined into the requirements for a WQM Implementation Plan, to give effect to the sectoral loading allocations for that source (see Chapter 6). This will dictate the loading allocation for the next five years, the groups or individuals responsible for developing the Plan and the timeframe within which it must be implemented. These WQM Implementation Plans may relate to (see Text-Box in Section 5.1):

- *point source discharges*, such as municipal waste water, mining, industrial, manufacturing;
- *non-point source discharge*, such as irrigated agriculture, dryland agriculture, settlements;
- *in-stream water quality management*, including rehabilitation, minimum streamflows or reservoir/ water resource system operating rules;
- *water use water quality management*, including options of pre-use treatment, or migration to alternative uses;
- *specific* pollution control *protocols*, e.g. a groundwater protection protocol.

It may not always be necessary to require separate Plans for different sectors/ sources in a Management Unit, particularly where compulsory licensing is not required. In this case, multi-sector WQM Implementation Plans may be developed to meet the SMOs, probably with some guidance on the relative allocations between the sectors. Depending on the local needs and preferences, any of these Plans may focus only on single "critical" sub-catchments, or whole Management Units, or they may apply to the WMA as a whole.

A WMA-wide Plan for Monitoring, Evaluation, Auditing, Corrective Action and Review of WQM is also a necessity to ensure the sustainability of WQM in the longer-term. This may be a part of a separate Component Strategy of the CMS (see Step 4), or it may be a part of this WQM Framework-Plan.

***Step 4**: Formulate linkages with other components of the CMS*

It is critical that the principles, criteria, statutory requirements, the Water Quality Use Allocations and the Implementation Plan requirements elaborated under Steps 0 – 3 be consistent with the other components of the CMS (see Section 5.2), particularly in terms of Water Quantity Allocation, Pricing, Institutional Development and Communications/ Awareness-Building. These linkages, any assumptions, and the nature of the WQM aspects of these other CMS components must be explained.

***Step 5**: Develop a Programme for implementation*

The WQM Implementation Plans must be developed and implemented within specified time-frames. The Implementation Programme presents these time-frames, together with the sectoral or stakeholder responsibilities for developing the Plans and for providing the necessary resources. This must also highlight the responsibility for monitoring and auditing the implementation of the Water Quality Use Allocation Plan, as well as any or all of the other WQM Plans, including associated corrective actions and management review to facilitate continuous management improvement.

5.4 What must be Considered?

The factors that determine water use authorisation that are outlined in Section 27(1) of the NWA must be considered in the allocation of loading between groups. These factors include:

(a) existing lawful water uses;

(b) the need to redress the results of past racial and gender discrimination;

(c) efficient and beneficial use of water in the public interest;

(d) the socio-economic impact -

(i) of the water use or uses if authorised; or

(ii) of the failure to authorise the water use or uses;

(e) any catchment management strategy applicable to the relevant water resource;

(f) the likely effect of the water use to be authorised on the water resource and on other water users;

(g) the class and the resource quality objectives of the water resource;

(h) investments already made and to be made by the water user in respect of the water use in question;

(i) the strategic importance of the water use to be authorised;

(j) the quality of water in the water resource which may be required for the Reserve and for meeting international obligations; and

(k) the probable duration of any undertaking for which a water use is to be authorised.

These factors provide the principles for allocation, but need to be interpreted and elaborated according to the local circumstances in each WMA to be useful in the allocation process. As indicated above, the approach and considerations may differ between stressed, threatened and unstressed situations.

Note

Guidelines for a coherent and systematic approach to interpretation and application of the NWA Section 27(1) water use authorisation considerations, in the respective cases of stressed, threatened and unstressed water quality situations in catchments, are an acute need and should be addressed by DWAF in the near future. A certain degree of policy-development will need to precede such Guideline development.

Where loads have to be reduced, this must be equitable, with a clear indication of which user sectors are required to reduce loads, taking account of the principles of equitable and beneficial use and technical and economic constraints. In threatened situations, an approach may be to maintain existing levels for a sector, with further development being based on load reductions from existing sources. However, this may be modified according to projected shifts in development patterns, such as from agriculture to manufacturing.

Where compulsory licensing is required, any reduction in load allocation from the existing level (water use), in order to meet the Reserve, does not require compensation. This has important implications for the definition of the Reserve (as opposed to RQOs).

5.5 What Catchment Assessment Support is required?

In order to quantify the load allocations between sectors/ sources, information is required about the relative load contribution from each source-type, or each large source, both currently and due to expected future development. The manageability of that contribution must also be estimated, in terms of the background levels, the technical effectiveness of available management options (technologies) and the social and economic impacts of those management options. Although reliable sector/ source load estimates, based on detailed point and non-point source modelling (calibrated on monitored data) would provide the greatest support for management decisions, simpler and qualitative assessment approaches may be used, particularly in less stressed situations. Particular assessment support may also be required for specific pollution control protocols; for example a groundwater protection protocol requires knowledge of the aquifer and soil characteristics.

Water Quality Catchment Assessment Study (WQCAS) Outputs Required

The following additional Outputs are required from the WQCAS, as described in *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of the CMS.* (NB: It is assumed that the Outputs listed as "Required" for Chapters 3 and 4 are already available.)

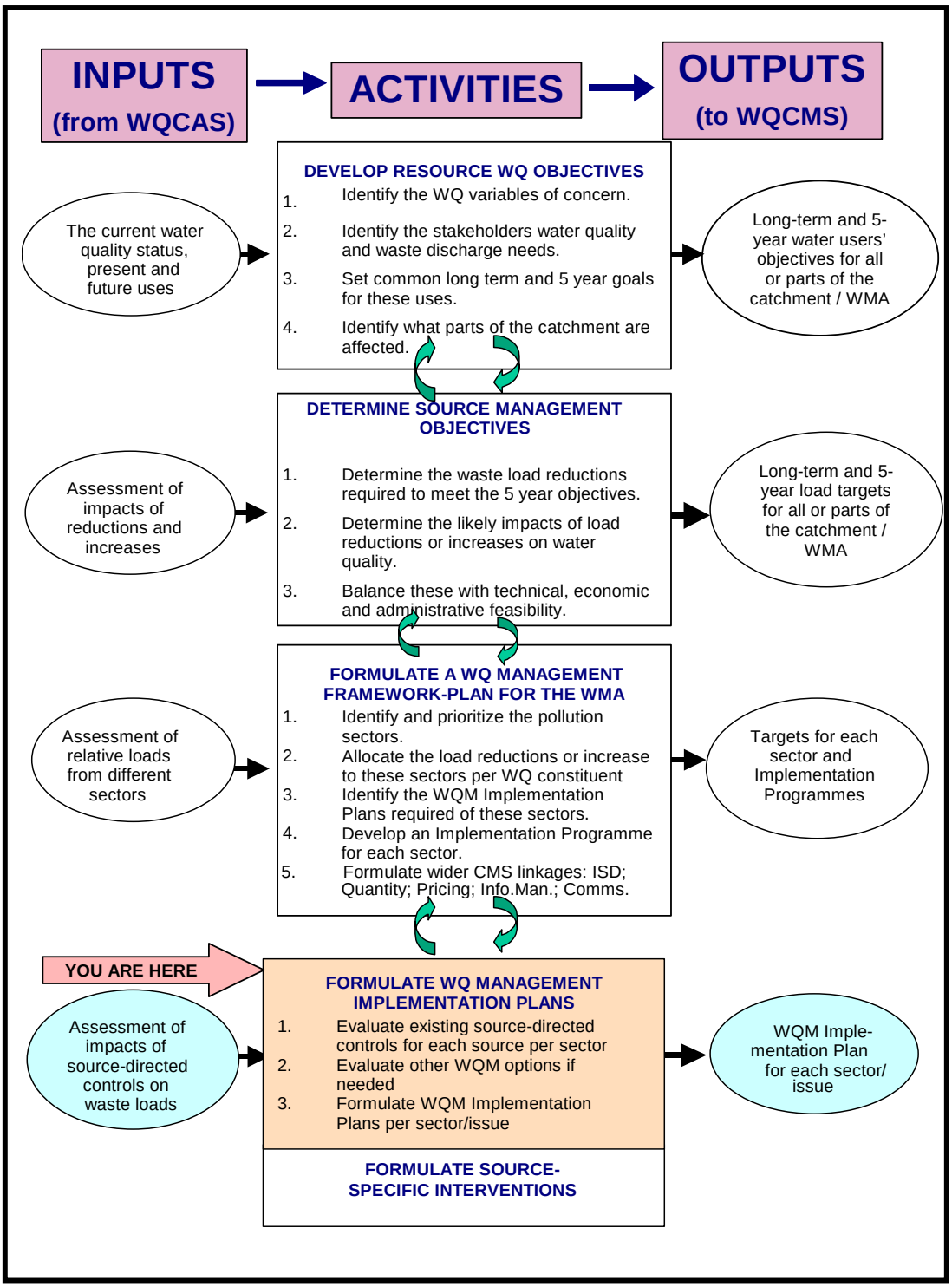
- Output 7: Point source waste discharges and source characteristics
- Output 8: Non-point source water quality loadings and impacts
- Output 11: Status report on monitoring, physical data and characterisation information
- Output 13: Water-interest institutional arrangements and linkages
- Output 15: Catchment management implications of water quality issues

5.6 Who should be Involved?

The development of the WQM Framework-Plan has both technical and non-technical input prerequisites. The water quality load allocation is a technical process, but its nature and outcomes, as well as the Implementation Programme to aimed at achieving the SMOs, need to be negotiated with the affected sectors and sources, to ensure that the social and economic considerations of Section 27 of the NWA are adequately addressed, stakeholder support for decisions is fostered and the spirit of participatory management is ensured. Therefore, water quality managers should drive the process, but always solicit considered input from the affected water users and sectoral representatives. Wherever plausible, the CMA/ DWAF should direct a particular water user sector to develop its own Water Quality Use Allocation Plan for consideration. Such an approach offers benefits in terms of participatory management, the facilitation of negotiations between the CMA/ DWAF, and the acceptance of ownership and responsibility by the very water users who are affected and who are in a position to ensure the sustainability of WQM in their sector or Management Unit.

6 FORMULATE WATER QUALITY MANAGEMENT IMPLEMENTATION PLANS

A *Water Quality Management Implementation Plan* specifies the management actions, responsibilities, resources and time-frames to mitigate or remediate the water quality impacts associated with priority sectors/ sources within Management Units, to give effect to the water quality load allocations specified in the Water Quality Management Framework-Plan. This may include statutory and/or non-statutory approaches that are more stringent than the general requirements for these sources, as well as existing pollution management protocols.



6.1 What are Water Quality Management (WQM) Implementation Plans?

WQM Implementation Plans specify the management actions, responsibilities, resources and time frames required to achieve the 5-year load allocations specified in the Water Quality Use Allocation Plan (see Section 5.3, Step 3). These should include both technical and non-technical approaches to, and both direct and indirect interventions for, WQM. WQM Implementation Plans should be aligned with the identified Management Units in the WMA.

Depending upon the nature of the problem and the potential for cooperation between sectors, these Plans may be:

- sector- and/or source-specific or multi-sectoral within an area;
- point or non-point source-, in-stream- (operation or remediation) and/or use- (treatment) oriented;
- single water quality constituent- or multiple (integrated) water quality problem-focused;
- based on statutory authorisation, direct intervention, cooperation and/or capacity-building; and
- based on the requirements of specific protocols; for example, the requirements for participatory problem solving in the "dense settlements" pollution control protocol.

6.2 How is a WQM Implementation Plan Developed?

The development of a standard WQM Implementation Plan should follow the three steps outlined below:

Step 1: *Evaluate existing Source-Directed Controls*

In most cases, the existing nationally (or regionally) defined conditions on water use authorisation (general authorisation or licensing) should be adequate to protect the resource quality of a water resource, if these are specified according to the Resource Management Class. The point of departure for a WQM Implementation Plan should therefore be the existing authorisation conditions.

The impact of full compliance with relevant water use authorisation conditions should be evaluated, for existing and expected levels of development. This should be done for all load allocations for each sector-/ source-type specified in the WQM Framework-Plan. Where non-compliance is widespread, this should be a primary focus of the WQM Implementation Plan. Only where full compliance would not meet the sectoral load allocations, should more stringent conditions be considered.

Note

The principle of “continuous improvement” in line with the “Hierarchy of Decision-Making” (see Section 5.3) should be adhered to in the prioritisations that underlie the above evaluations of Source-Directed Controls. This Hierarchy is one of the WQM pathways leading to the end-result of sustainability.

Step 2: *Identify and evaluate other possible options for water quality load controls*

Where the existing authorisation conditions are not adequate to meet the allocated load, other management options must be explored. These may include:

- Statutory Controls on water use, including more stringent authorisation conditions (through area-specific general authorisations or licences), or compulsory licensing of relevant water quality-based water users.
- Waste Discharge Charges used as an economic incentive to reduce loads to the required levels, together with funding of direct interventions to implement technologies and practices to manage loads from particular sources.
- Non-Statutory Options, particularly, cooperative governance and capacity-building to:
  - improve the effectiveness of land use and infrastructure management that has an impact on water quality
  - change water users' (in the wider definition) and land users' behaviour to focus on their potential contribution to mitigation of impacts.
- In-Stream WQM, through remediation of the water resource, reservoir/ river system operation and/ or ensuring adequate water *quantity* allocation to streamflow for dilution and assimilation of loads (possibly better than the Reserve and RQOs).
- Water Use WQM, either as Demand Management approaches relevant to WQM, or as pre-use treatment options; or as a migration to other water use types.

The impacts of these options need to be evaluated, in terms of their effectiveness in reducing loads and the socio-economic considerations discussed below. This evaluation should not only be viewed in terms of the 5-year (interim SMO) impact, but also the longer-term requirements to ensure a paradigm shift in the behaviour of stakeholders and the operation of sectors with an impact on water quality loads, towards a self-regulatory and responsible management culture.

Note

- Guidelines for a coherent and systematic approach to all the facets of water resource *remediation* are an acute need and should be addressed by DWAF in the near future. A certain degree of policy-development will need to precede such Guideline development.

Step 3: *Formulate WQM Implementation Plans*

Some of the components of the WQM Framework-Plan under discussion here are focused on direct sector- or source-defined modifications (reductions, or, occasionally, increases) in water quality loads, while others are focused on more indirect interventions (see Text-Box in Section 5.1). The suite of management options that should achieve the required water quality load reductions/ increases and that would support a long-term WQM paradigm shift in the relevant sectors/ sources should be formulated into a range of WQM Implementation Plans.

The Plans, aimed to bring about *direct* sector- /source-defined load modifications, must specify, at least, the:

- management actions required to directly achieve the individual load allocations that, when aggregated, will meet the SMOs;
- responsibilities for planning, resourcing and implementing these actions;
- time-frame for implementation;
- resources required to plan and implement these actions;
- resourcing plan and
- monitoring and auditing requirements to indicate successful implementation (this latter item might be part of a free-standing WQM Monitoring/ Auditing/ Correction/ Review Plan for the whole WMA).

The WQM Implementation Plans should be organised according to the Management Unit boundaries.

In the case of those components of the WQM Framework-Plan that are *indirectly* focused on sector-/ source-related water quality load adjustments, such as the:

- Water Use WQM Plan,
- Inventory of Linkages (and their Outlines) with other CMS Components and
- WMA-wide WQM Monitoring/ Auditing/ Correction/ Review Plan,

a similar set of specifications apply, with the exception that the specification of achievement of individual load allocations is not directly quantifiable.

6.3 What must be Considered?

In addition to the effectiveness of the options proposed in a WQM Plan, the following criteria should be evaluated:

- *Efficiency* reflects the cost-effectiveness of the option (*i.e.* the reduction for every unit of resource required). This should be assessed in terms of the initial implementation cost, as well as the ongoing operational costs.
- *Suitability* represents the adequacy or appropriateness of an option to the local conditions, and whether it will work and is adaptive to possibly changing (dynamic) situations.
- *Acceptability* indicates whether the polluters, or those people who are affected, will support the option. If not, the effectiveness of the option may be reduced through abuse or sabotage, even though it may be technically appropriate.
- *Affordability* of an option depends both upon the efficiency (cost) and the acceptability (willingness-to-pay) of the polluters. Unaffordable options will not be implemented, unless severe penalties are applied.
- *Equity* has to be a principle of any manifestation of water resource management in South Africa, prescribed by the NWA in terms of population groups, gender, and general redress of past discrimination. However, at a local scale, equity is also required in terms of representivity of sectoral obligations *vis a vis* the WQM Implementation Plans.
- *Sustainability* is dependent upon technical criteria, such as the ongoing maintenance requirements, as well as the efficiency, affordability and acceptability of the option. In some cases, it may be necessary to adopt unsustainable short-term solutions, while putting in place the wherewithall to implement long-term sustainable solutions.

These criteria ensure that the economic, social and institutional requirements of the options in the WQM Implementation Plan have been addressed. The applications of these criteria should be evaluated against the available resources for the Plan and the available enabling environment.

6.4 What Catchment Assessment Support is required?

As indicated above, the process of identifying and evaluating management options, and formulating associated WQM Plans must consider the effectiveness of the plan in achieving the allocated load. It may not be possible to define the absolute effectiveness of a management option, because site-specific conditions have a considerable impact. However, it should be adequate to assess the relative effectiveness of different options.

The selection of an assessment approach should be based on a trade-off between the resources required to use a particular technique and the increase in the reliability of the results. Unfortunately, many of these techniques are generally unreliable without extensive data and thus detailed assessment is not rewarded in the absence of sound monitoring.

Water Quality Catchment Assessment Study (WQCAS) Outputs Required

The following additional Outputs are required from the WQCAS, as described in *A Guide to Conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of the CMS.* (NB: It is assumed that the Outputs listed as "Required" for Chapters 3, 4 and 5 are already available.)

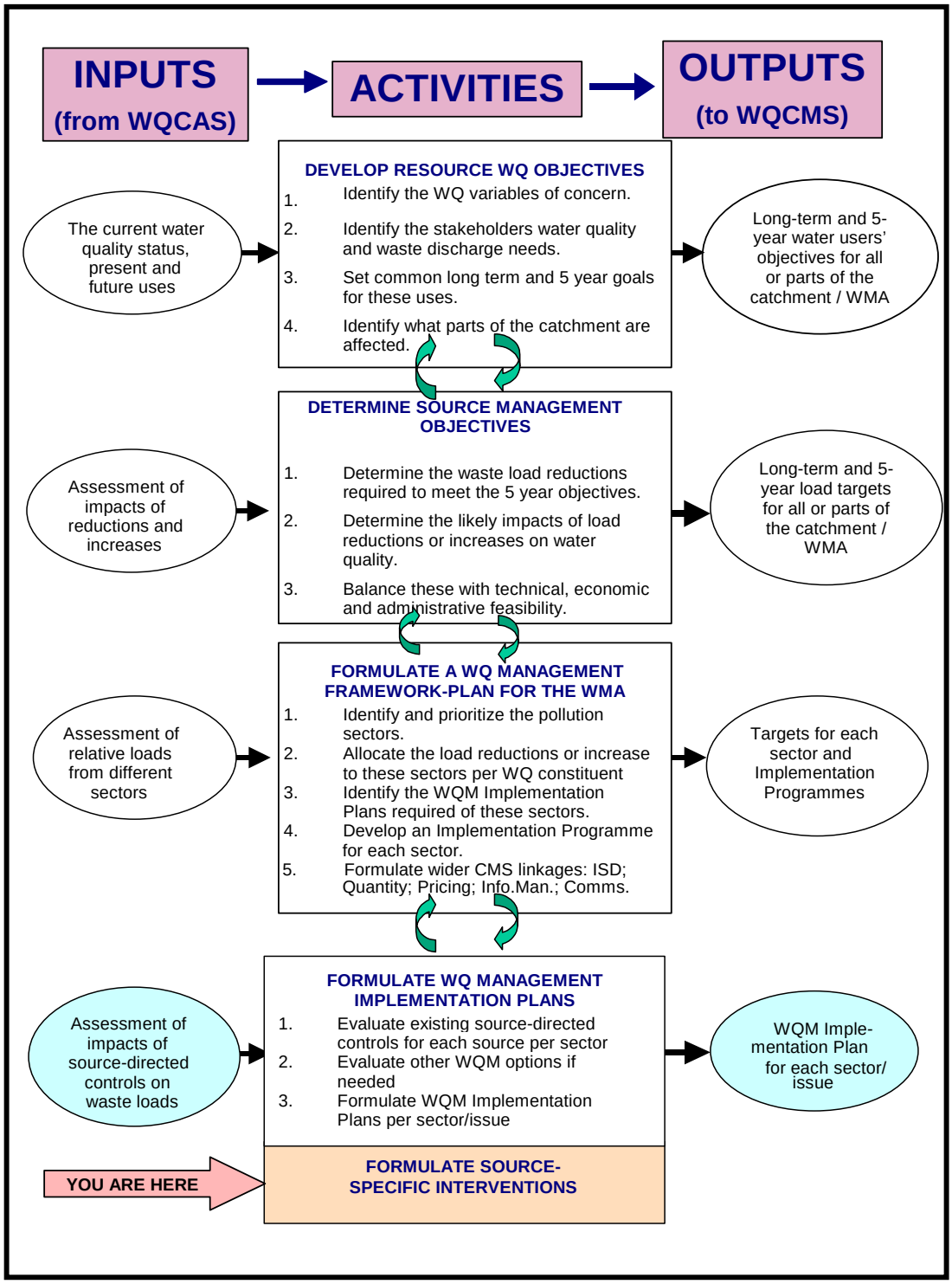
- Output 20: Priority water quality management options
- Output 21: Monitoring and auditing the implementation of management options

6.5 Who Should be Involved?

Within the boundaries of the WQM Framework-Plan, the development of WQM Implementation Plans should be undertaken by the affected sectors/ sources where possible, as they will generally be responsible for implementing the actions. However, this should be facilitated and technically supported by the water quality managers of the CMA/ DWAF. The practitioners who conduct(ed) and /or advised on the WQCAS for the specific WMA should also interface with the teams who undertake the WQM Implementation Plan development.

7 DEVELOP SOURCE-SPECIFIC INTERVENTIONS

Source-specific interventions indicate the requirements (actions and time-frames) for mitigating, remediating or managing the water quality impacts from a specific/ single source, or a group of sources of the same type in a particular localised area, as part of a water use authorisation, a cooperative agreement or a directive. They will generally be applied to specific concerns that have a significant impact on the water quality of a water resource.



7.1 What are Source-Specific Interventions?

Whereas sector-specific WQM Implementation Plans are aimed at addressing the impacts or discharge requirements of whole sectors on a catchment or sub-catchment basis, source-specific interventions address the impacts or requirements of specific (usually single) localised sources. Source-specific interventions, therefore, include licences, co-operative agreements or directives issued to a specific water use under the NWA, or certain other "authorisation vehicles" under other Acts, e.g. "Section 20" EIA approvals under the Environmental Conservation Act (No. 73 of 1989), or under the Water Services Act (No. 108 of 1997). Some of these agreements may also be based on existing pollution control protocols.

Source-specific interventions are indicated when:

- significant impacts (severity or risk) are associated with a particular source.
- hazardous, toxic or bio-accumulatory substances may be present.
- the impacts differ from other sources within the sector.
- the source-specific is in close proximity to a sensitive water user.
- remediation efforts are required due to historical impacts from the source.
- there are special social or economic circumstances.
- the resource is of national strategic importance.

Note

Licensing, though being informed and supported by the CMS, is strictly speaking not part of the CMS. However, licensing does form part of the IWRM continuum and, therefore, is one of the primary tools for WQM Implementation.

7.2 How is a Source-Specific Intervention Developed?

Source-specific interventions are developed on the request of either the CMA/ DWAF, or the specific source in question. In the former case, the CMA/ DWAF may wish to focus special attention on the source due to its significant impact on the water resource or other water users. In the latter case the source may wish to request a relaxation of existing requirements due to site-specific circumstances. In both cases, the source in question would have to bear the costs of the site-specific investigation.

Source-specific interventions must balance the site-specific requirements of the source against the impacts of the source on the interim RWQOs and the RQOs. This may require site-specific cause-and-effect modelling to determine the likely impacts on downstream water quality. However, source-specific interventions, particularly those aimed at hazardous, toxic or bio-accumulatory substances, may only need to address specific activities or processes within the source. In these cases, (for example, the phasing-out of certain processes or activities) source-specific interventions may be focused on cleaner production and may not require cause-and-effect modelling. Source-specific interventions may also be developed for specific time frames or conditions, for example, for either high- or low-flow conditions.

Source-specific interventions require decision support from site-specific water quality impact assessments. As such, they should follow the guidelines outlined in "*The Procedures to Assess the Impacts of Effluent Discharges* " (DWAF, 1995), and in the "*Non-point Source Assessment Guide"* (Pegram and Görgens, 2001). The procedures to determine site-

specific requirements for source-specific interventions are addressed in considerable detail in these documents, and are therefore not repeated here.

The CMA/ DWAF may also require additional environmental or other assessments, which may be subject to independent review, as part of the process of developing a source-specific intervention. These requirements will be highlighted in the application process, and may include:

- environmental impact assessments where catchment-level environmental impacts are expected.
- socio-economic assessments where relaxation of authorisation conditions are motivated on socio-economic grounds.
- assessments of the specific water quality needs of downstream users.

Note

- The development of source-specific interventions is a resource-intensive process, and will require special attention from the CMA/ DWAF. Source-specific interventions should be the exception rather than the norm, and should only be considered if circumstances specifically warrant special attention. For this reason, DWAF may also choose not to delegate decision-making on source-specific interventions to a particular CMA until the technical capacity of the CMA has matured.
- The outcomes of source-specific interventions are subjected to 5-year reviews and adjustments, in alignment with all the other WQM Plans.

7.3 What must be Considered?

Source-specific interventions may take one of three forms (the considerations for each of these cases are discussed separately below):

- site-specific requirements due to the "uniqueness" of the source.
- relaxation of Waste Discharge Standards or authorisation conditions in cases where little impact is expected.
- more stringent standards due to site-specific circumstances.

The factors outlined in Section 27(1) of the NWA must be considered, including:

(a) existing lawful water uses;

(b) the need to redress the results of past racial and gender discrimination;

(c) efficient and beneficial use of water in the public interest;

(d) the socio-economic impact -

(i) of the water use or uses if authorised; or

(ii) of the failure to authorise the water use or uses;

(e) any catchment management strategy applicable to the relevant water resource;

(f) the likely effect of the water use to be authorised on the water resource and on other water users;

(g) the class and the resource quality objectives of the water resource;

(h) investments already made and to be made by the water user in respect of the water use in question;

(i) the strategic importance of the water use to be authorised;

(j) the quality of water in the water resource which may be required for the Reserve and for meeting international obligations; and

(k) the probable duration of any undertaking for which a water use is to be authorised.

Unique sources

Unique sources are those, which, due to their water quality impact, special socio-economic conditions, or national strategic importance, require special attention. Unique sources may require more stringent standards due to the severity or risk of their impacts on the water resource, or, by virtue of their special socio-economic conditions, may require more lenient approaches (relaxation of conditions). For example, marginal mines may be addressed differently (over a specified time period) to those, which are on a sound economic basis.

In these cases, source-specific interventions must consider the strategic, socio-economic and labour characteristics of the source, as well as the impacts on the resource. These considerations must ensure an appropriate balance between the beneficial, equitable and sustainable use of the water resource in the interests of stakeholders and the country as a whole.

Relaxation of conditions

These would be considered in cases where sources require more lenient approaches than those proposed as Resource Management Class-based, sectoral or (sub)-catchment-specific standards. Relaxation would be considered when site-specific circumstances mitigate the impacts on the water resource, and would typically be considered when the impacts on the water resource are negligible. Relaxation may, therefore, be considered in cases where there is considerable assimilative capacity, where the source is situated far from the water resource, or where the effluent may be evaporated or irrigated without impacting on the groundwater resource.

In these cases, the impacts of relaxation on downstream water quality, specifically with respect to ensuring that the requirements of RQOs or interim RWQOs are met, would have to be carefully weighed against the social and economic benefits accrued. In these cases, the flow regime and reliability of flow would have to be carefully considered. Relaxation may therefore be based on certain high flow conditions.

Relaxation for some sources may also be considered together with water use charges that could be used to manage other regional water resource problems, as part of a waste discharge charge system.

More stringent requirements

In some circumstances more stringent standards will be required of a particular source, in order to ensure compliance with the RQOs, or interim RWQOs. These would typically include cases where sensitive users operate in close proximity to the source discharge. However, in these cases the source may not have any "unique" characteristics to afford it a special dispensation, and it would be critical to demonstrate the impacts on downstream water quality, and to balance this against the costs of achieving the more stringent standards. Again, the flow regime and reliability of the flow is an important consideration. More stringent requirements may also be linked to low flow conditions.

7.4 What Catchment Assessment Support is required?

The guidelines contained in "*Procedures to Assess the Impacts of Effluent Discharges* " (DWAF, 1995), and the "*Non-point Source Assessment Guide"* (Pegram and Görgens, 2001), outline the assessment support required for source-specific interventions. These detailed requirements and processes are therefore not repeated here.

However, it should be noted that the intention of the site-specific investigations required in this process is to assess the impacts of different management practices or discharge standards. This requires detailed modelling of the impacts of different management practices on downstream water quality, including the impact on estuaries or on groundwater. For point sources this requires detailed in-stream modelling of the fate of pollutants from the point of discharge. Such modelling is even more critical for non-conservative substances that may undergo chemical or biological assimilation within the water resource.

For non-point sources, models that disaggregate non-point source processes are critical to assess the likely load reductions from different management practices. These may have to be supplemented by in-stream models that assess the downstream fate of pollutants once they are in the water resource.

7.5 Who Should be Involved?

Source-specific interventions are prepared by the source in question for approval by the CMA/ DWAF. The primary involvement in the preparation of the intervention therefore comes from these two bodies. However, it is critical (and in fact a legal requirement) that other stakeholders have the opportunity to comment on this process, and on the final interventions, before the directives, licences or co-operative agreements come into effect. This will be particularly important when relaxation of conditions is being considered.

Wider stakeholder participation should therefore occur at two points, when the source is identified for a source-specific intervention, and when the final interventions are agreed. In the former case, stakeholders must be informed of why the source has been identified, and the intention of the source-specific intervention (*i.e.* is relaxation of conditions, or more stringent requirements being considered). Once the interventions have been agreed between the source and the CMA/ DWAF, these must also be made available for comment.

Directives and co-operative agreements in respect to source-specific interventions are also subject to the provisions of Sections 40 and 41 of the NWA. These specify the requirements for the application of a licence for a particular water use, and that the assessments may be subject to independent review. In addition, water use entitlements, directives and co-operative agreements may be included as part of the CMS, notice of which has to be published in the Gazette for comment. As such, any stakeholder may also comment on the interventions at that point.

8 HOW TO STRUCTURE THE WATER QUALITY COMPONENT OF A CMS

This Chapter provides a possible template for the water quality component of a Catchment Management Strategy, representing the combination of typical examples of the individual elements described in this Guideline.

8.1 RWQOs and SMOs

The first key water quality management elements of a CMS must be formulation of the:

- *RWQOs* (see Chapter 3), which define time-referenced and spatially incremental water quality management goals for priority contaminants to be achieved within the five years addressed by the CMS, in the surface and groundwater resources of the WMA; and
- *SMOs* (see Chapter 4), which translate these RWQOs into the incremental allowable source and/or internal loadings of priority contaminants within key sub-catchment areas of the WMA.

The following Table highlights how these objectives may be defined for a hypothetical case:

Management Unit	Constituent/ Issue	RWQOs (Interim or 5-year values)	INCREMENTAL SMO
Elands River (A22)	Total Phos-phorus (TP)	TP to remain below ***0.2 mg/l*** for 95% of the time	Total allowable load of TP less than ***20 ton/annum***
	E.Coli	*E.Coli* counts to be <***1000 #/100ml*** for 80% of the time	Dry weather discharge to average ***<5000 #/100ml***
	Dense Settlements WQ Impacts	Reduce the impacts of settlements on the quality of the resource by 30% over 5 years.	Implement the "dense settlements" pollution management protocol on settlements in sub-catchment.

8.2 WQM Framework-Plan

Chapter 5 outlines the many elements that potentially make up a WQM Framework-Plan, key among which is the Water Quality Use Allocation Plan. The WQ Use Allocation Plan presents a sub-catchment load allocation to different sector-/ source-types, to achieve the specified SMOs. The WQM Framework-Plan also specifies the individual WQM Implementation Plans required to give effect to this water quality load allocation, a Programme for implementation and a description of linkages to the Water Quantity and Ecosystem Management components and Component Strategies of the CMS.

The following Table outlines some of the typical elements of the WQ Use Allocation Plan for a typical Management Unit in a typical WMA for the case of Total Phosphorous and indicates which Implementation Plans are required, as well as which sectors/ sources take responsibility for the implementation actions:

Incremental SMO for TP in Management Unit X	Sector-/ Source-Type	Load Allocation	WQM Implementation Plan Responsibility
Total allowable load TP *<20 ton/annum*	Waste Water Works	5 ton/annum (*30% reduction in 5 years*)	Phosphorus point source-WQMIP to be developed by local authorities discharging in the sub-catchment
	Urban Washoff	5 ton/annum (*nil increase*)	Local authorities to formulate an urban cooperative non-point source-WQMIP to mitigate storm water impacts
	XXX Paper and Pulp Factory	2 ton/annum (*20% reduction in 5 years*)	XXX Paper and Pulp Factory to formulate a source-specific WQMIP to reduce effluent discharge and irrigation load
	Dryland Maize	3 ton/annum (*nil increase*)	Farmers and Dept. of Agriculture to formulate cooperation agreements to optimise fertilizer applications
	Internal Loading	1 ton/annum (10*% reduction in 5 years*)	Dam owners/ managers to develop operating strategy to reduce internal loading and phosphorus mobilisation in dams
	Other Sources	4 ton/annum	Unmanageable background and insignificant individual sources

The WQM Framework-Plan may also specify a list of priority sources for other pollution management protocols; *e.g*. a prioritised list of settlements for implementation of the "dense settlements" pollution management protocol.

8.3 WQM Implementation Plans

WQM Implementation Plans focus on either a number of water quality impacts from a particular sector-/ source-type, or on a particular water issue associated with a number of source types, and can be Management Unit based, or aimed at the complete WMA .

8.3.1 Sectoral Point or Non-point Source WQM Implementation Plan

These sectoral plans would generally focus on a number of critical water quality constituents associated with a generic source-type, and would be required to achieve the load allocation specified in the Water Quality Use Allocation Plan (within the specified time-frame). This would outline the proposed actions, time-frame, responsibilities, resources and monitoring required to achieve these load allocations. This could also include the planning required to implement given pollution control protocols.

8.3.2 Multi-Sectoral WQM Implementation Plan

In some cases, the WQM Framework-Plan would indicate that a number of sectors or sources need to develop an Integrated WQM Implementation Plan, thereby achieving the specified load allocation. This places the onus on the sectors to allocate the total load between different sector-/ source-types, through a cooperative process, which may improve the understanding and buy-in between sectors. The proposed actions, time-frame, responsibilities, resources and monitoring must be outlined.

8.3.3 In-Stream / Resource Remediation WQM Plan

Where water resource remediation or reservoir-/ system-operation is necessary to achieve the load allocations, this would be specified in a Plan, with the required actions, responsibilities, resources, time-frames and monitoring.

8.3.4 Other Types of Plans

Components of the WQM Framework-Plan not directly focused on sector-/ source-related water quality load adjustments, such as the Water Use Management Plan, the Inventory of Linkages (and their Outlines) with other CMS Components and a WMA-wide WQM Monitoring/ Auditing/ Correction/ Review Plan, also need to be specified in terms of required actions, responsibilities, resources, time-frames and monitoring.

8.4 Source-Specific Interventions

Source-specific interventions may take the form of a directive, a licence, or a co-operative agreement. Each of these may be used in any circumstance, but some are more appropriate to certain conditions. These are briefly outlined below.

8.4.1 Directives Issued to Specific Sources

A Water Management Institution may, under Section 19 of the NWA, issue a directive to a specific source to undertake special measures to address their specific impacts. These are particularly appropriate to address specific sources for special attention, and would be issued when the general or existing water use authorisation conditions are insufficient to address the site-specific impacts of the specific source. Directives issued to specific sources would, therefore, be issued where more stringent standards or actions are required of the source.

8.4.2 Licences Issued to Specific Sources

Section 40 of the National Water Act makes provision for the issue of licences to specific sources, based on the considerations in Section 27, with conditions outlined in Section 29. These would be the case of water use that is not generally authorised under Section 39, or where, for highly localised downstream protection, more stringent conditions than an existing authorisation is needed. This would also be appropriate when site-specific relaxation of sectoral, Class- or area-based conditions may be considered. Section 41 of the NWA outlines the procedures for the application of a licence.

8.4.3 Co-operative agreements

Co-operative agreements are particularly suited to situations where simple changes to certain processes or activities may realise significant water quality benefits. This is particularly important as licences and directives can only address the actual discharge to, or impact on the water resource. For example, a water user may co-operate in the phasing out of a hazardous substance in favour of innocuous substances without the need to specify effluent standards for the hazardous substance that may be difficult to monitor and enforce.