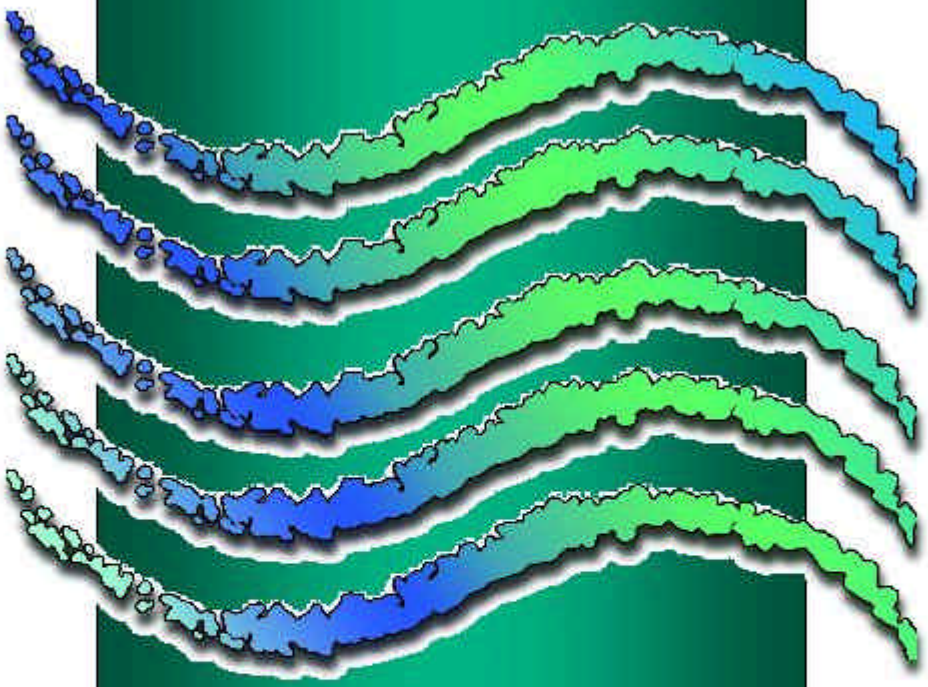
SOUTH AFRICAN

WATER QUALITY GUIDELINES

FOR COASTAL MARINE WATERS

VOLUME 2

RECREATIONAL USE



Department of Water Affairs and Forestry

First Edition 1995

SOUTH AFRICAN WATER QUALITY GUIDELINES FOR COASTAL MARINE WATERS

Volume 2: Recreational Use

First Edition, 1996

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South African Water Quality Guidelines for Coastal Marine Waters Volume 2 Recreational Use

Department of Water Affairs and Forestry
First Edition
1995

Published by

Department of Water Affairs and Forestry
Private Bag X313
PRETORIA
0001

Republic of South Africa
Tel: (012) 299-9111

Printed and bound by
The Government Printer, Pretoria

ISBN 0-621-17465-3

This report should be cited as:

Department of Water Affairs and Forestry. 1995. South African Water Quality Guidelines for Coastal Marine Waters. Volume 2: Recreational Use.

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FOREWORD

The Department of Water Affairs and Forestry is the custodian of South Africa's water resources. The water quality management goal of the Department is to ensure that the water quality of water resources remains fit for recognised uses and that the viability of aquatic ecosystems is maintained and protected. This is achieved through the involvement of role players from several tiers of government, from the private sector and from civil society.

Difficulties, however, in managing the quality of our coastal waters to ensure that both the user's water quality requirements are met and development of the coastal zone is accommodated, resulted in the establishment of *Water Quality Criteria for the South African Coastal Zone*, which was published by the South African National Committee for Oceanographic Research in 1984. Since its publication, the document formed a basis not only for feasibility studies and the planning of coastal discharges, but also for environmental impact assessments of areas subjected to waste discharges. This document was revised in 1992 in order that new national and international developments in technology and water quality policies, as well as increasing environmental pressure from both the formal and informal sectors, could be taken into account.

The revised document was, however, not in the same format as the *South African Water Quality Guidelines* which had recently been developed for inland water bodies. This necessitated the expansion of these revised water quality criteria for the coastal zone in order that similar information would be provided to that in the freshwater quality guidelines, which serve as the primary source of information for determining the water quality requirements of different water uses and for the protection and maintenance of the health of aquatic ecosystems.

The process that followed and the wide variety of organisations and individual involved in the development of these guidelines ensured the acceptance and the use of these guidelines by all significant role players, as the ***South African** Water Quality Guidelines*. These guidelines are technical documents aimed at users with a basic level of expertise concerning water quality management. However, the role players involved in the different water use sectors are expected to use these guidelines as a basis for developing material to inform water users in specific sectors about water quality and to empower them to effectively participate in processes aimed at determining and meeting their water quality requirements.

The Department recognises that water quality guidelines are not static and will therefore update and modify the guidelines on a regular basis, as determined by ongoing research and review of local and international information on the effects of water quality on water users and aquatic ecosystems. The process of developing water quality guidelines, and the involvement of key role players, is a continuing one. The first edition is published in a loose leaf, ring binder format to facilitate the regular updating of the guidelines. All those who want to comment on and make suggestions concerning the South African Water Quality Guidelines are invited to do so at any time by contacting the Director: Water Quality Management, Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001.

Finally, I wish to express my sincere appreciation to all those who have been involved in the development of these guidelines. I also look forward to their continued involvement in maintaining one of the corner-stones of the water quality management system in South Africa.

Professor Kader Asmal **MP** May 1996
Minister of Water Affairs and Forestry

ACKNOWLEDGEMENTS

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Workshop participants for setting target values

The target values or guideline values for the South African coastal zone were reviewed at a workshop held in 1992 in Stellenbosch. The workshop consisted of a broad spectrum of representatives from the scientific and engineering community, national and local authorities, industries and environmental organisations. The list of participants is presented below:

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Mr J L Pretorius, DWAF, Eastern Cape
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Ms K van Wyk, South African Nature Foundation
Mr D Visser, Portnet, Cape Town
Mr F S Vivier, Department of Health

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SECTION 5: EFFECTS OF CHANGE IN WATER QUALITY (AND TARGET VALUES) RELATED TO RECREATIONAL USE

APPENDICES

INTRODUCTION TO THE SOUTH AFRICAN WATER QUALITY GUIDELINE DOCUMENTS

The South African Water Quality Guidelines are a series of twelve documents published by the Department of Water Affairs and Forestry (DWAF). They form an integral part of the water quality management strategy to maintain South Africa's water resources fit for use. The guideline documents are presently divided into two sets:

Water Quality Guidelines for Fresh Water

Volume 1: Domestic Water Use
Volume 2: Recreational Water Use
Volume 3: Industrial Use
Volume 4: Agricultural Use: Irrigation
Volume 5: Agricultural Use: Livestock Watering
Volume 6: Agricultural Use: Aquaculture
Volume 5: Aquatic Ecosystems
Volume 8: Field Guide

Water Quality Guidelines for Coastal Marine Waters

Volume 1: The Natural Environment
Volume 2: Recreational Use
Volume 3: Industrial Use
Volume 4: Mariculture (the effects and target values related to *human health* also apply to the *collection of seafood* along the coast)

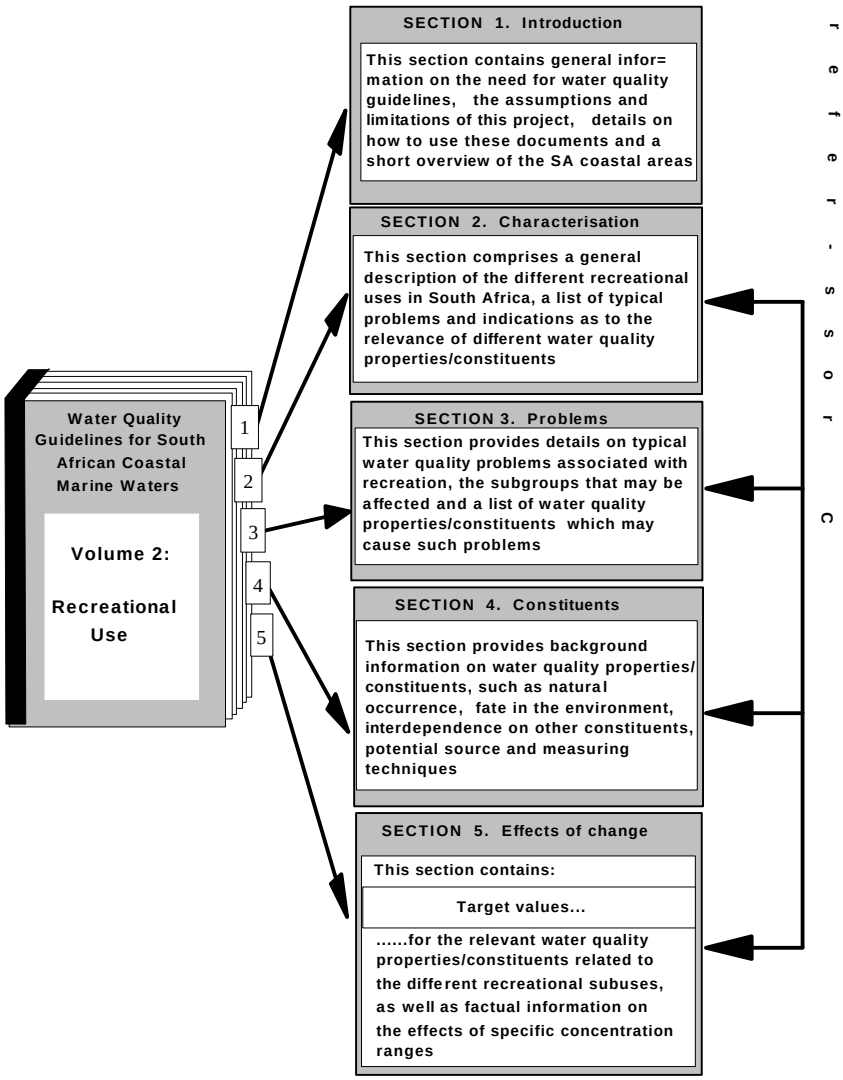
This volume is the second in a series of four documents comprising the first edition (Edition 1.0) of the South African Water Quality Guidelines for Coastal Marine Waters.

NOTES: **Should seawater be used for domestic purposes the guidelines (and target values) will be similar to those described in the set of documents for fresh water, Volume 1, i.e. Domestic Use of fresh water. Desalination of seawater is dealt with in the set of documents for coastal marine waters, Volume 2, i.e. Industrial Use of coastal marine waters.**

These documents do not specifically address estuaries or river mouths, although some of the information contained therein may be applicable. However, the need for expansion of the series to include estuaries will receive attention in the future.

HOW TO USE THIS DOCUMENT

The terms of reference for this project specified that the information contained in these documents had to address the needs of all parties involved in marine water quality, from the analyst to the manager. With the diversity of the user spectrum and the complexity of information in mind, the layout of the documents was designed in such a way so as to allow the user to 'enter' via a number of perspectives or subjects. This was accomplished by dividing the documents into different sections:

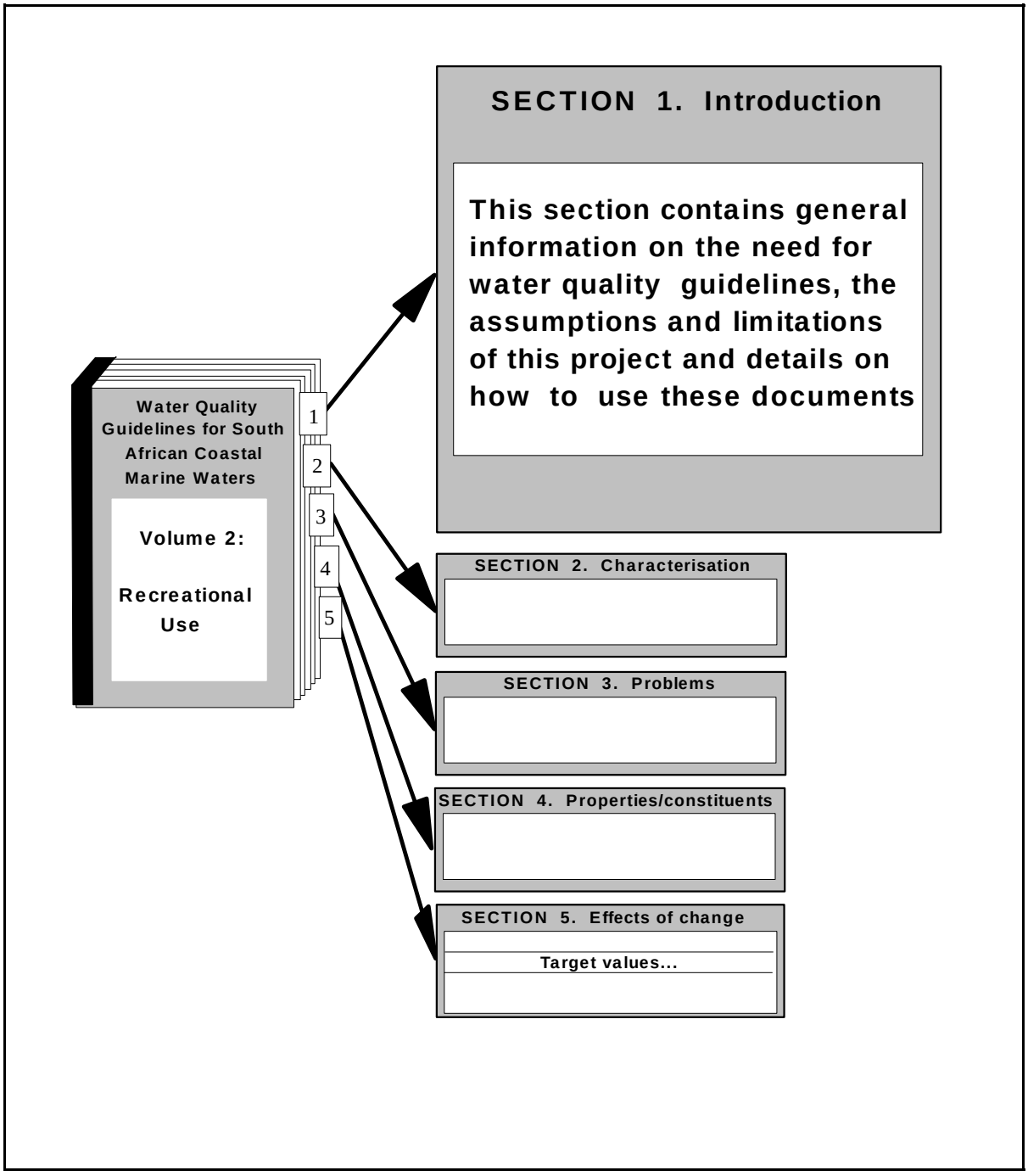


A certain degree of overlap and/or repetition was inevitable. However, to avoid unnecessary repetition of detailed information, a cross-reference system has been used. *Section 5 is regarded as the 'heart' of these documents (containing the target values), with the information contained in Sections 2-3 being complementary to that section.*

PRACTICAL EXAMPLES OF HOW TO USE THIS DOCUMENT

Issue	Reference method
A development with potential influence on water quality, is planned near a popular recreation beach where people swim	The subject is *'the user-group, i.e. 'full contact recreation'*, therefore refer to *Section 2: Characterisation of recreational uses.* Find an overview of what is meant by full contact recreation, a list of typical problems and a checklist of the relevance/non-relevance of water quality properties/constituents. Cross-references to Section 4 provide more details on, for example, the potential sources of the relevant properties/constituents, which in turn, could be matched to potential sources associated with the development. Where available, cross-references to Section 5 provide factual details on effects of different concentration ranges of relevant constituents/properties on marine organisms. Where available, the target values for South African coastal marine waters are also provided.
A water quality manager is confronted with public complaints of eye irritations at a local bathing beach	The subject is '*a problem'* , therefore refer to *Section 3: Water quality problems*. Select the problem which addresses the issue, i.e. skin, eye, ear and respiratory irriations. Find a short description of the problem, the subuses which could be affected and a list of relevant water quality properties/constituents which could cause such a problem. Cross-references to Section 4 will provide further details on the properties/ constituents, for example, potential sources. Where available, cross-references to Section 5 will provide factual details on effects of different concentration ranges of the relevant constituents/properties.
A water quality analyst finds high faecal coliform counts in a water sample from a local beach	The subject is *'a particular water quality constituent',* therefore refer to *Section 4: Water quality properties/constituents*. Select the constituent, i.e. *Microbiological indicator organism and pathogens - faecal coliforms.* Find a short description of the constituent, including useful background information on its natural occurrence, its fate in the environment and potential anthropogenic sources. Cross-references to Section 3 provide details on typical water quality problems associated with the constituent. Where available, cross-references to Section 5 will provide factual details on effects of different concentration ranges of a constituent , as well as the target values for South African coastal marine waters.

SECTION 1: INTRODUCTION



SECTION 1: INTRODUCTION
CONTENTS

THE NEED FOR WATER QUALITY GUIDELINES

Receiving water quality objectives approach

In South Africa, the ultimate goal in water quality management is to keep the water resources suitable for all designated uses. To achieve this goal, the Receiving Water Quality Objectives (RWQO) approach has been adopted. This implies that water quality objectives set, for a particular marine environment subjected to potential impact from a development, must be based on water quality requirements of designated uses in that particular area. Both point and diffuse waste loads must be taken into account, while it is also recognised that the marine environment has a certain capacity to assimilate waste without detrimental effect.

Different requirements

The water quality requirements of the different user groups are not necessarily the same. In some instances, they may even conflict. These differences imply that water which would be adequately fit for use for one specific user may not be suitable for another. In addition, water seldom becomes totally unfit for use when the quality deteriorates. Quality is thus not an intrinsic property of water, but is linked to the use made of the water. A definition of what constitutes fitness for use is thus a key issue in the evaluation and management of the quality of water resources.

Decision-making tool

The need arose for a set of documents that would contain the relevant information to assist decision-makers in defining water quality objectives or water quality requirements for the different uses.

The information captured in these documents is therefore aimed at giving a general overview of the different components which are important in marine water quality management, such as:

- the different uses and the associated water quality problems;
- information on the relevant water quality properties and constituents;
- effects of change in water quality (including target values, where available) on different uses or users.

Most of the abovementioned information has been published, but in many different books, journals and manuals.

THE NEED FOR WATER QUALITY GUIDELINES continued on next page

THE NEED FOR WATER QUALITY GUIDELINES continued...

Different uses

Water quality managers and scientists would use these documents to:

- serve as a scientific basis for the quantification of the water quality requirements for a water use;
- interpret and translate information obtained from water-quality monitoring and assessment programmes;
- assess the effect of anthropogenic activities on water quality;
- evaluate the impact of accidental spills;
- assess and evaluate management performance, effective control and auditing of water quality management practices which are essential and fundamental to good management;
- deal with public perceptions; in South Africa, as in the rest of the world, there is a growing awareness among the public of the natural environment and how it is being managed; decision-makers and water quality managers need sound scientific norms and guidelines to enable them to communicate effectively with the public on the impact of development on water quality and to deal with public perception, fears and complaints with regard to water pollution and its effects on water users;
- identify research needs (i.e. indicate where information is lacking).

These documents also provide the necessary information for water users and other interested and affected parties to assess water quality in general, as well as to evaluate the acceptability of the impact of development on water quality.

THE NEED FOR WATER QUALITY GUIDELINES continued on next page

THE NEED FOR WATER QUALITY GUIDELINES continued...

Target values

In principle, the water quality objectives or requirements of a particular water body *are the target values of the different water quality properties/constituents which have been set for the designated beneficial uses.*

The target values, i.e. 'level of a particular water quality property/constituent at which no detrimental impact should occur', described in Section 5, were taken form *Interim report: Water quality guidelines for the South African coastal zone*. Those target values were decided upon by a group of marine water quality experts in 1992 [(1)].

Practical application

At the workshop held in Stellenbosch in 1992, it was decided, in principle, that the target values set for the beneficial uses, *Recreation: Non-contact*, i.e. ensuring basic amenities (see Volume 2) and the *Natural Environment* (see Volume 1), should apply to **all** marine waters. Additional to these will be *Recreation: Primary contact and secondary contact, Mariculture and Industrial uses,* where these are designated beneficial uses of a particular water body.

In principle, a *zone of impact*, i.e. an area or volume of seawater where water quality does not comply with the target values, could be considered acceptable in the case of a marine discharge. This zone of impact should, however, be kept at a minimum and should be determined through an appropriate environmental impact assessment.

ASSUMPTIONS AND LIMITATIONS

Scope

The scope for this phase of the project was to provide additional information to enhance the existing water quality guidelines for the South African coastal zone [1], similar to those documents produced for the fresh water environment of South Africa [2-5].

The information provided in these document had to be focused on the coastal marine environment, the outer boundary roughly going up to the edge of the continental shelf, but excluding estuaries. However, the need for expansion of the series to include estuaries will receive attention in the future. Some information provided in the present documents may, however, be applicable to estuaries.

It should be noted that although these documents focus on the area inshore of the continental shelf, South African marine waters extend up to 200 km offshore. Beyond the 200 km boundary, international conventions and agreements apply to all users of the ocean.

Time and budget

The present set of documents for the coastal marine environment had to be compiled within a period of one year and within a limited budget. Within these time and budget limits, it was therefore decided that the present set of documents, i.e. Edition 1.0, had to provide a **basic framework within which existing information could be consolidated and which would also allow for future updates**, as information and funding became available. To assist in directing future updates, it therefore had to indicate the relevance/non-relevance of different aspects, as well as highlight aspects where information was lacking.

Information sources

Taking into account the time and cost constraints, it was decided to select the internationally recognised databases best suited o obtaining information on water quality issues. The databases which were decided on were:

ASFA (1983 to 1993) which includes topics such as:
- biological resources and living resources
- ocean technology, policy and non-living resources
- aquatic pollution and environmental quality
- aquaculture
- marine biotechnology.

WATERLIT (1975 to 1994), a CSIR database which contains information on water related-issues.

MEDPLAN (a medical database).

ASSUMPTIONS AND LIMITATIONS continued on next page

ASSUMPTIONS AND LIMITATIONS continued...

Information sources *continued...*

Relevant keyword selections, as provided by the different specialist groups, were used to extract information from the databases.

Appropriate data bases on a *national* scale were found to be limited or, in some instances, non-existent. Where possible, the different universities and institutes involved in water quality studies were contacted individually. It was, however, assumed that specialists would be aware of important studies which have been conducted nationally in their field of expertise.

With particular reference to Section 5 (Effects of Change in Water Quality), South African (local) information was generally limited. For this reason, it was decided to include any international data which may assist in showing trends in effects at different concentration ranges in the different trophic levels, although these may not be of the exact species as found in South Africa. As more local information becomes available, international data can be excluded from later editions.

However, these documents are NOT detailed specialist publications on the physics, chemistry or biology of the marine environment. The aim was to include information from these expert fields which is considered to be relevant to marine water quality management. The reference lists can be used to obtain more detailed information.

OVERVIEW OF THE SOUTH AFRICAN COASTAL AREAS

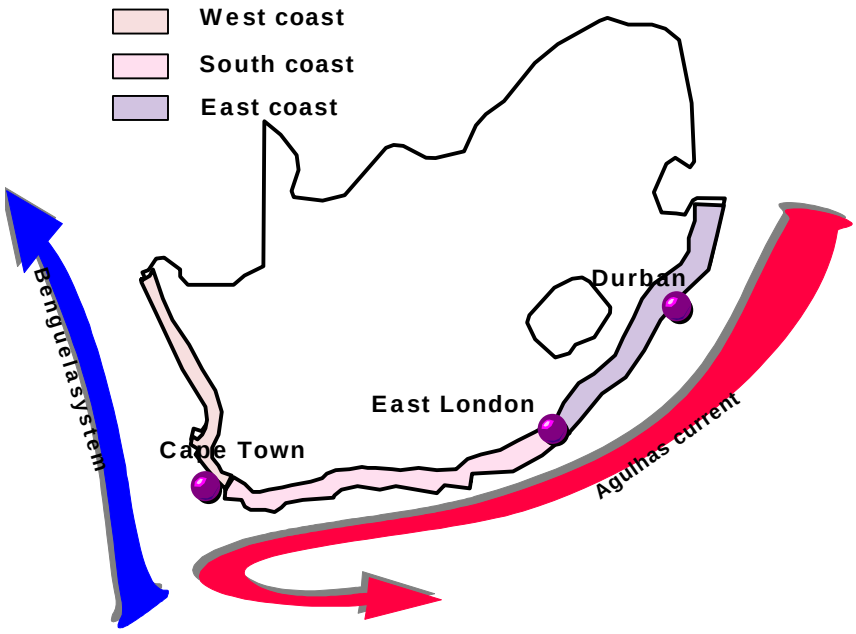
Uniqueness of seawater

Although the quality of seawater differs from fresh water in many ways, its high dissolved salt content is probably the most distinctive characteristic. This is discussed in more detail in *Section 4, Salinity*, *p 4-1*.

Coastal regions

The South African coastal water can typically be divided into three coastal regions, each of which sustains distinctive characteristics :

- West coast: cold temperate
- South coast: warm temperate
- East coast: subtropical/tropical.



OVERVIEW OF SA COAST continued on next page

Coastal regions *continued...*

West coast. The west coast of South Africa is defined as that section of coast extending from Cape Agulhas in the south-east to the Orange River in the north-west. The cold Benguela systems has a great influence on the physical and biotic characteristics of the west coast. The western coast of South Africa is dominated by coastal upwelling. This upwelling is driven by south-easterly and southerly winds which, in combination with Coriolis forces, leads to offshore drift of surface waters. Biological communities along the west coast generally exhibit low species richness, with high biomass values being achieved by a few species, including kelps, limpets, black mussels, white mussels, abalone, rock lobsters and a number of fish and bird species. The most important industry along the west coast is the fish-processing plants. The west coast is also a popular tourist area.

South coast. The south coast of South Africa is defined as that section of coast extending from Cape Agulhas to East London. The south coast is considered to be a transition zone between the cold temperate and warm subtropical regions. The Agulhas bank area is a large mixing area between the cold Benguela and warm Agulhas currents. The overlapping of different current systems along the south coast is reflected in the biota which is characterised by high species diversity. Although high in species diversity, not many species occur in such magnitude to sustain high rates of exploitation. Fishing consists mainly of lobster, demersal fish (e.g. hake and sole), pelagic fish and chokka squid, the latter being the only chokka squid line fishery in South African waters.

East coast. The east coast of South Africa is defined as that section of coast extending from north of East London up to the Mozambique border. This region can typically be further subdivided into a tropical (north of Port Edward) and subtropical coast. The warm Agulhas current is the greatest factor influencing the coastal marine environment along the east coast of South Africa. Generally, the east coast fauna and flora are relatively low in total biomass but species diversity is high with distinct Indo-Pacific affinities. Numerous industries e.g. paper and pulp, textile and chemical industries are situated along the southern part of the east coast. The east coast is also a very popular tourist attraction.

Detailed descriptions of the characteristics of the coastal regions, both abiotic and biotic features, are provided in *Volume 1: Natural Environment, Section 2.*

REFERENCES

1. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1992. Interim Report: Water quality guidelines for the South African coastal zone. Pretoria.

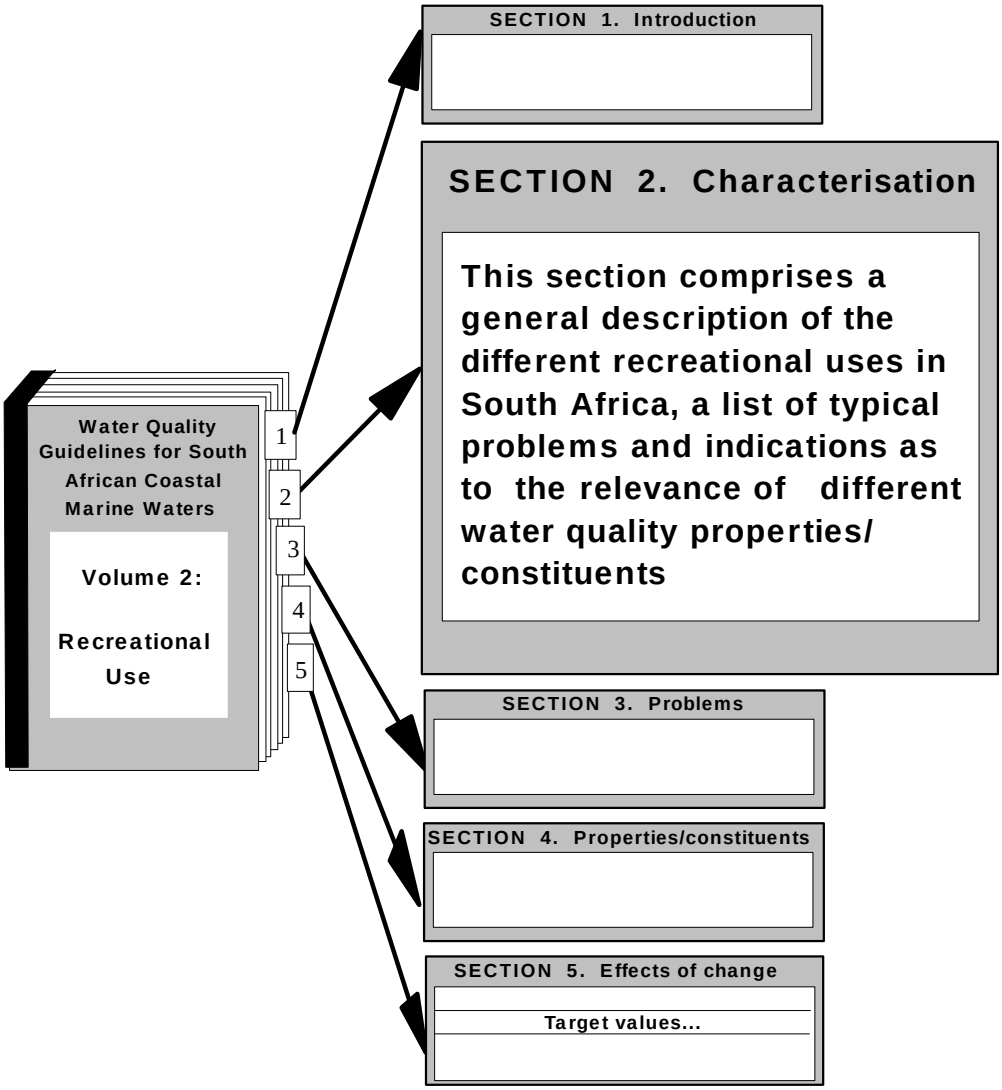
2. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 1: Domestic Use.

3. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 2: Recreational Use.

4. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 3: Industrial Use.

5. DEPARTMENT OF WATER AFFAIRS AND FORESTRY 1993. South African Water Quality Guidelines. Volume 4: Agricultural Use.

SECTION 2: CHARACTERISATION OF RECREATIONAL USE IN SOUTH AFRICA (THE DIFFERENT RECREATIONAL USES)



SECTION 2: CHARACTERISATION CONTENTS

GENERAL INTRODUCTION

Recreational use of South Africa's coastal marine waters is practised all along its 3 000 km coastline. Along the west and south coast of South Africa this usually occurs during the warmer summer months, while it is practised all year round along the subtropical east coast regions. Recreational use of coastal marine waters varies from bathing to mere enjoyment of its scenic aspects.

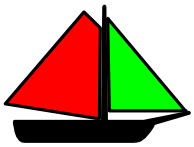
Although details on the extent and value of the South African coastal marine environment for recreation is not available, thousands of tourists occupy the popular bathing beaches, especially during the peak holiday seasons. The general public and tourists are very sensitive to any indication of pollution of seawater in recreation areas.

Recreational use of coastal marine waters is dependent on ambient water quality, since no water treatment or maintenance is practised, except where water is extracted for use in public seawater swimming pools.

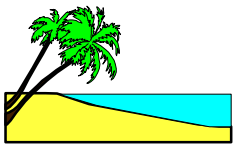
The recreational uses of coastal marine waters can be divided into three major groups:

Full contact recreation

Intermediate contact recreation



Non-contact recreation



Chapter 2.1 Full Contact Recreation

DESCRIPTION OF USE

Users

This subuse is characterised by the fact that full body contact, ingestion of water and inhalation of aerosols are likely to occur frequently throughout the activity. Activities include swimming, diving (scuba and snorkling), water skiing, surfing, paddle skiing and wind surfing.

The age group that participates in these activities spans a wide range, from infants to elderly people. The health status of these individuals may also vary, for example individuals may be able to swim despite bad health, while individuals taking part in the more strenuous sports such as wind surfing and skiing, are usually fit and healthy.

These activities usually take place in marine waters, i.e. they are regarded as 'instream uses'. Even structures like tidal pools can be classified as instream, since water supply to these pools are not regulated, but rather depend on the tide.

These activities occur all along the South African coastline, particularly at coastal cities and holiday towns. More tolerable water temperatures are probably the main reason for the greater density of users along the south and east coast in comparison to the west coast.

Problems

Typical water quality problems associated with full contact recreation include:

		For more information on problems refer to:
i.	gastrointestinal problems;	p 3-1
ii.	skin, eye, ear and respiratory irritations;	p 3-2
iii.	physical injuries;	p 3-3
iv.	hypo-/hyperthermia;	p 3-4
v.	unpleasant aesthetics, e.g. bad odours, discolouration of water and presence of objectionable matter;	p 3-5
vi.	'sticky' water;	p 3-6
vii.	corrosion;	p 3-7
viii.	clogging and choking of equipment.	p 3-8

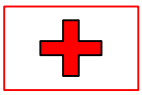
DESCRIPTION continued on next page

DESCRIPTION continued...

Norms

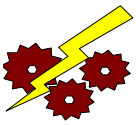
The aim of water quality guidelines is to provide scientific yardsticks against which the fitness for use of a particular water body for a designated use may be evaluated. However, the quality of a water body can be described in many different ways. It is therefore important to select specific norms upon which water quality properties/constituents relevant to describing the fitness of use, could be selected. These norms are usually based on types or 'boxes' of problems associated with a particular use of seawater. For full contact recreation the following norms are relevant:

Human Health and Safety
(Refering to problems i-iv)



Aesthetics/nuisance Factors
(Refering to problems v and vi)

Mechanical Interferences
(Refering to problems vii and viii)



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

Legend

Different water quality properties/constituents can be used to measure the effect of change in water quality for the different norms. The relevance of different water quality properties/constituents to each norm is indicated below.

The legends for the tables that follow are:

- Relevant, addressed in these documents
- Relevant, NOT addressed
- Indirectly relevant, NOT addressed
- Not relevant

Physico-chemical properties

	Human Health / Safety	Aesthetics / Nuisance	Mechanical Interference
°C Temperature	✓	✗	✗
Sal Salinity	✓	✓	✓
pH pH	✓	✗	✗
Floating matter	✓	✓	✓
SS Suspended solids	✓	✓	✓
Colour/Turbidity/ Clarity	✓	✓	✓
O_2 Dissolved oxygen	✗	✓...	✗

For more information on properties:

p 4-1

p 4-3

p 4-6

p 4-8

p 4-9

p 4-11

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued...

Nutrients

	Human Health / Safety	Aesthetics / Nuisance	Mechanical Interference
NH_4^+ Ammonium	✓	✓	✓
NO_2 Nitrite	✓	✓	✓
NO_3 Nitrate	✓	✓	✓
PO_4 Reactive phosphate	✓	✓	✓
SiO_4 Reactive silicate	✓	✓	✓

Inorganic constituents

	Human Health / Safety	Aesthetics / Nuisance	Mechanical Interference
NH_3 Ammonia	✓	✗	✗
CN Cyanide	✓	✗	✗
F Fluoride	✓	✗	✗
Cl_2 Chlorine	✓	✗	✗
H_2S Hydrogen sulphide	✓	✓	✗
Trace metals	✓	✗	✗

For more information on inorganics refer to:

p 4-13

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued...

Organic constituents

		Human Health/ Safety	Aesthetics/ Nuisance	Mechanical Interference
TBT	Organotins (tributyl tin)	✓	✗	✗
TPH	Total petroleum hydrocarbons	✓	✗	✗
Algal	Algal toxins	✓	✗	✗
Taint	Tainting substances	✗	✗	✗
	Polycyclic aromatics	✓	✓	✗
	Halogenated aliphatics	✓	✓	✗
	Halogenated ethers	✓	✓	✗
	Monocyclic aromatics	✓	✓	✗
	Nitrosamines	✓	✗	✗
	Biocides	✓	✗	✗
	Resin acids	✓	✗	✗
	Surfactants	✓	✗	✗

For more information on organics refer to:

p 4-17

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued on next page

RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS continued

Microbiological indicator organisms and pathogens

		Human Health/ Safety	Aesthetics/ Nuisance	Mechanical Interference
F coli	Faecal coliform (including *E. coli*)	✓	✗	✗
Entero	Enterococci	✓	✗	✗
Pathogen	Pathogens	✓	✗	✗

For more information on indicators/ pathogens refer to:

p 4-19

p 4-21

p 4-23

Radio-active substances

	Human Health/ Safety	Aesthetics/ Nuisance	Mechanical Interference
Radio-active substances	✓	✗	✗

REFERENCES TO EFFECTS OF CHANGE IN WATER QUALITY (SECTION 5)

		Refer to:
Physico-chemical properties	*Temperature*	p 5-1
	Salinity	p 5-3
	pH	p 5-4
	Floating matter	p 5-5
	Suspended solids	p 5-6
	Colour/Turbidity/Clarity	p 5-7
Inorganic constituents	*Hydrogen sulphide*	p 5-9
Organic constituents	*Algal toxins*	p 5-11
Microbiological indicators and pathogens	*Faecal coliforms (including E. coli)*	p 5-13
	Enterococci	p 5-14
	Human pathogens	p 5-15

Chapter 2.2 Intermediate Contact Recreation

DESCRIPTION OF USE

Users

Intermediate contact recreation includes activities such as boating, sailing, canoeing, wading, angling and parasailing, where the user may come into contact with the water, inhale aerosols or swallow water, but to a lesser extent than in the case of full contact recreation.

The age group that participates in these activities spans a wide range, from children to elderly people. The health status of these individuals may also vary.

These activities usually take place in marine waters, i.e. they are classified as 'instream use'.

These activities occur all along the South African coastline and in particular at coastal cities and holiday towns.

Problems

Typical water quality problems associated with intermediate contact recreation include:

i. gastrointestinal problems;
ii. skin, eye, ear and respiratory irritations;
iii. physical injuries;
iv. hypo-/hyperthermia;
v. unpleasant aesthetics, e.g. bad odours, discolouration of water and presence of objectionable matter;
vi. 'sticky' water;
vii. corrosion;
viii. clogging and choking of equipment.

For more information on problems refer to:

p 3-1
p 3-2
p 3-3
p 3-4
p 3-5

p 3-6
p 3-7
p 3-8

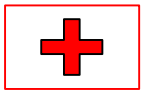
DESCRIPTION continued on next page

DESCRIPTION continued...

Norms

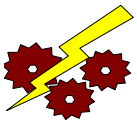
The aim of water quality guidelines is to provide scientific yardsticks against which the fitness for use of a particular water body for a designated use may be evaluated. However, the quality of a water body can be described in many different ways. It is therefore important to select specific norms upon which water quality properties/constituents relevant to describing the fitness for use, could be selected. These norms are usually based on types or 'boxes' of problems associated with a particular use of seawater. For intermediate contact recreation the following norms are relevant:

Human Health and Safety
(Refering to problems i-iv)



Aesthetics/nuisance Factors
(Refering to problems v and vi)

Mechanical Interferences
(Refering to problems vii and viii)



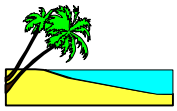
RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic constituents, organic constituents, microbiological indicator organisms, pathogens and radio-active substances will be the same as for full contact recreation, refer to p 2-5 to p 2-8.

REFERENCES TO EFFECTS OF CHANGE IN WATER QUALITY (SECTION 5)

		Refer to:
Physico-chemical properties	*Temperature*	p 5-1
	Salinity	p 5-3
	pH	p 5-4
	Floating matter	p 5-5
	Suspended solids	p 5-6
	Colour/Turbidity/Clarity	p 5-7
Inorganic constituents	*Hydrogen sulphide*	p 5-9
Organic constituents	*Algal toxins*	p 5-11
Microbiological indicators and pathogens	*Faecal coliforms (including E. coli)*	p 5-13
	Enterococci	p 5-14
	Human pathogens	p 5-15



Chapter 2.3 Non-Contact Recreation

DESCRIPTION OF USE

Users

Non-contact recreation involves all recreational activities taking place in the vicinity of marine waters, but which do not involve direct contact with the water, such as sightseeing, picnicking, walking, horse riding, hiking, camping, etc.

These activities depend on the 'instream' quality of marine waters.

These activities occur all along the South African coastline, particularly at coastal cities and holiday towns, including all coastal areas where coastal development and tourism are important activities.

Problems

Typical problems associated with non-contact recreation include unpleasant aesthetics, e.g. bad odours, discolouration of water and presence of objectionable matter.

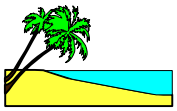
For more information on problems refer to:

p 3-5

Norms

The aim of water quality guidelines is to provide scientific yardsticks against which the fitness of use for a particular water body for a designated use may be evaluated. However, the quality of a water body can be described in many different ways. It is therefore important to select specific norms upon which water quality properties/constituents relevant to describing the fitness for use, could be selected. These norms are usually based on types or 'boxes' of problems associated with a particular use of seawater. For non-contact recreation the following norm is relevant:

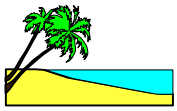
Aesthetics



RELEVANCE OF WATER QUALITY PROPERTIES/CONSTITUENTS

All properties/constituents

The relevance of ALL water quality properties/constituents, i.e. physico-chemical properties, nutrients, inorganic constituents, organic constituents, microbiological indicator organisms, pathogens and radio-active substances will be the same as full contact recreation, refer to the norm: Aesthetics/Nuisance on p 2-5 to p 2-8.

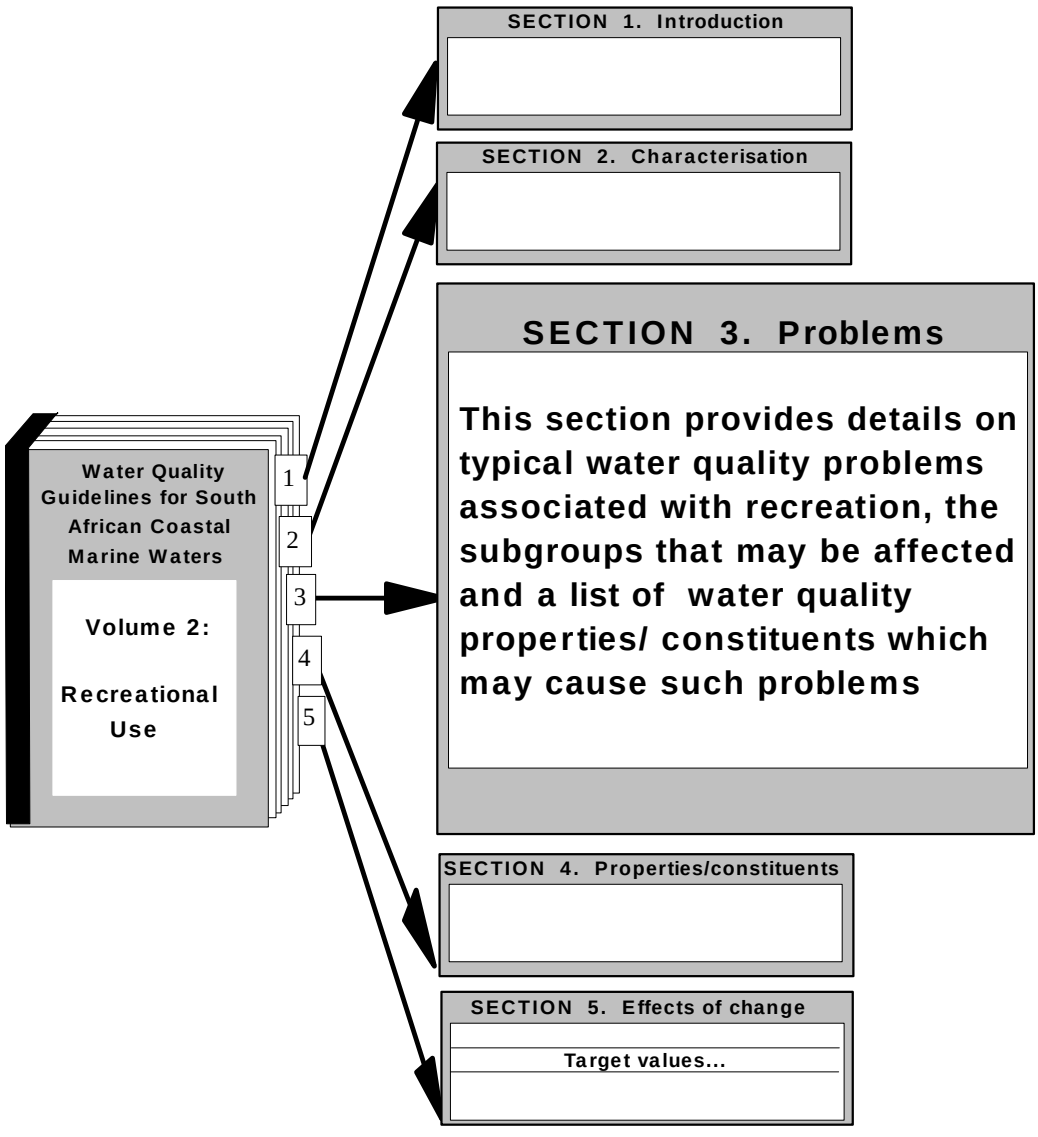


REFERENCES TO EFFECTS OF CHANGE IN WATER QUALITY (SECTION 5)

		Refer to:
Physico-chemical properties	*Floating matter*	p 5-5
	Suspended solids	p 5-6
	Colour/Turbidity/Clarity	p 5-7

		Refer to:
Inorganic constituents	*Hydrogen sulphide*	p 5-9

SECTION 3: TYPICAL WATER QUALITY PROBLEMS ASSOCIATED WITH RECREATIONAL USE



SECTION 3: PROBLEMS
CONTENTS

Chapter 3.1 Human Health and Safety

GASTROINTESTINAL PROBLEMS

Description

Most illnesses associated with recreation in the marine environment fall into this category. Clinical symptoms of gastrointestinal disorders may include diarrhoea, vomiting, nausea, pain, fever and hepatitis. In exceptional cases, infections may lead to complications such as encephalitis, meningitis, myocarditis, paralysis, Guillian-Barré syndrome and liver failure. Infections can be caused by ingestion of water and inhalation of aerosols and droplets. Indications are that transmission by direct contact with other bathers may also be quite significant with high bather densities.

Related subuses

Gastrointestinal disorders may be associated with both *full contact* and *intermediate contact recreation*, under conditions which constitute a risk of ingesting water or inhaling aerosols or droplets.

For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

Gastrointestinal illnesses are , generally caused by a variety of *human pathogens*. These include:

- Bacteria (*Salmonella, Shigella, Vibrio cholerae, Vibrio parahaemolyticus, Klebsiella pneumoniae*);
- Viruses (enteroviruses and gastroenteric viruses); and
- Protozoan parasites (*Giardia lambia, Entamoeba histloytica, Cryptosporidium parvum*).

For more information on pathogens refer to p 4-23

In certain instances, *microbiological indicator organisms* can be used to 'indicate' their presence. References to epidemiological studies conducted to establish the ability of indicator organisms to predict health risks are also provided in Section 5 for:

- *Faecal coliforms (including E. coli)*
- *Enterococci*

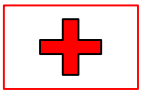
For more information on the indicator organisms refer to p 4-19 and p 2-21

Refer to:

p 5-13

p 5-14

In some instances, where a bather ingests a large volume of seawater, it may have a laxative effect as a result of the high *salinity* of seawater.



SKIN, EYE, EAR AND RESPIRATORY IRRITATIONS

Description

Skin, eye, ear and respiratory irritations are usually contracted through direct contact with water. These may include infections (open wounds, damaged skin or exposed tissue) and irritations of the skin, eyes and ears. However, detecting these effects, and distinguishing the seawater as source from other potential sources such as bather shedding and personal contact is difficult. Available evidence, however, indicates that the incidence of these infections and their public health implications tend to be underestimated.

Related subuses

Skin, eye, ear and respiratory irritations may be associated with both *full contact* and *intermediate contact recreation*, under conditions which constitute a risk of ingesting water or inhaling aerosols or droplets.

For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

Gastrointestinal illnesses are generally caused by a variety of *human pathogens*. These include:

- Baceria (*Pseudomonas aeruginosa, Staphylococcus aureus*, species of *Streptococcus and Micrococcus);*
- Viruses (Adenoviruses).

For more information on pathogens refer to p 4-23

In certain instances, *microbiological indicator organisms* can be used to 'indicate' their presence. References to epidemiological studies conducted to establish the ability of indicator organisms to predict health risks are also provided in Section 5 for:

- *Faecal coliforms (including E. coli)*
- *Enterococci*

For more information on the indicator organisms refer to p 4-19 and p 2-21

Refer to:

p 5-13

p 5-14

Certain algal toxins, e.g. neuro shellfish poison (NSP), produced, for example, by the algae *Ptychodiscus breve*, may also cause respiratory problems and eye and nose irritations. No details on specific concentrations and associated effects could, however, be obtained.

For more information on algal toxins refer to p 4-17

PHYSICAL INJURIES

Description

This involves instances where bathers are physically injured by objects which may be present in the water or where injuries are caused owing to poor visibility.

Related subuses

Physical injuries may be associated with both *full contact* and *intermediate contact recreation*, where there is a possibility of the users moving in the water.

For more information on the sub-uses refer to Section 2

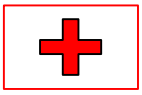
Related properties/ constituents and effects of change in water quality

Physical injuries are usually associated with objectionable matter being present in the water, e.g. floating matter, suspended solids and turbidity. More detailed information is provided in Section 5 on the effects of:

- *turbidity/colour/clarity.*

For more information on these properties refer to Section 4

Refer to p 5-7



HYPO-/HYPERTHERMIA

Description

Hypothermia is a condition of reduced body temperature due to exposure of the body to low temperatures for a length of time, while hyperthermia is a condition of elevated body temperature, both of which could have serious implications to human health. These conditions are, however, greatly dependent on the length of time of exposure.

Related subuses

Hypo-/hyperthermia may be associated with both *full contact* and *intermediate contact recreation*, where there is a possibility of the users being in the water.

For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

Hypo-/hyperthermia is obviously related to water temperature.

More detailed information on the effects of specific temperatures are provided in Section 5.

For more information on temperature refer to p 4-1

Refer to p 5-1

Chapter 3.2 Aesthetics and Nuisance Factors

UNPLEASANT AESTHETICS

Description

This problem generally refers to aesthetically unpleasant conditions which may occur, e.g. unpleasant odours, discolouration of the water and the presence of objectionable matter.

Related subuses

Aesthetic problems are associated with *all recreational activities*, i.e. full contact, intermediate contact and non-contact.

For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

Unpleasant aesthetic conditions are usually caused by the presence of objectionable matter, such as *floating matter*, *suspended solids*, *colour/turbidity* and malodorous substances such as *hydrogen sulphide*.

More detailed information on the effects of specific amounts or concentrations could not be obtained.

For more information onthese properties refer to Section 4

'STICKY' WATER

Description

In some waters the chemical composition is such that it forms objectionable deposits on the skin and hair, which makes it feel 'sticky'.

Related subuses

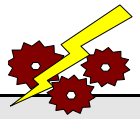
'Sticky water' may be associated with both *full contact* and *intermediate contact recreation*, where there is a possibility of the users being in the water.

For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

The probability of this problem occurring is usually reflected in high *salinity* water, an inherent property of seawater.

For more information on salinity refer to p 4-3



Chapter 3.3 Mechanical Interferences

CORROSION

Description

Certain metals have a tendency to corrode when they are immersed in water, especially soft or acidic water or seawater, i.e. corrosion of certain metals occurs in a weak electrolyte solution such as seawater.

Related subuses

Corrosion may be associated with *full contact and intermediate contact recreation* where metal equipment, not suitable for seawater, are used.

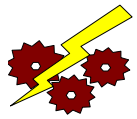
For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

Corrosion is usually associated with high *salinities*.

No data could be obtained on specific concentration ranges and problems.

For more information on salinity refer to p 4-3



CLOGGING AND BLOCKAGE OF EQUIPMENT

Description

This problem refers to the mechanical interferences that occur when objectionable matter such as litter, oil and grease, debris, etc. clog and block equipment such as engines and pumps.

Related subuses

Clogging and blockages may occur in *full contact and intermediate contact recreation* where mechanical equipment may be used.

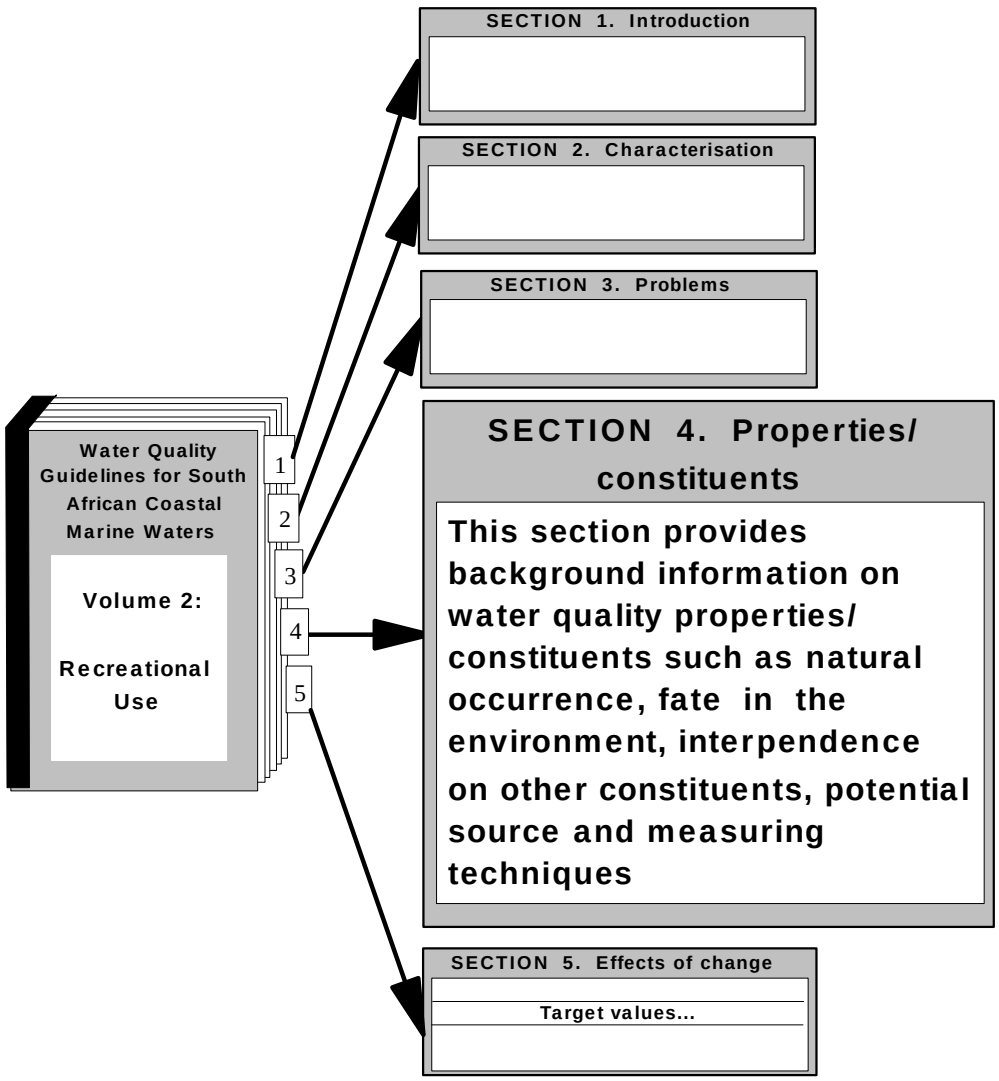
For more information on the subuses refer to Section 2

Related properties/ constituents and effects of change in water quality

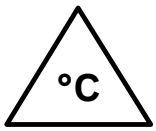
Clogging and blockages are usually as a result of objectionable *floating matter*, *suspended solids* and *turbidity* being present. No data could be obtained on specific concentration ranges and problems.

For more information on the properties/ constituents refer to Section 4.

SECTION 4: BACKGROUND INFORMATION ON WATER QUALITY PROPERTIES/ CONSTITUENTS RELATED TO RECREATIONAL USE



SECTION 4: BACKGROUND INFORMATION ON WATER QUALITY PROPERTIES/CONSITUENTS CONTENTS



Chapter 4.1 Physico-chemical Properties

TEMPERATURE

Description

Temperature is a basic property of water. Temperature, or changes in temperature, is important in the regulation or triggering of many physiological processes in marine organisms.

Natural occurrence

The temperature regime for South African marine waters differs from one coastal region to another:

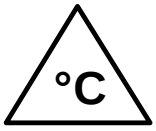
West coast. Generally, the natural temperature regime along the west coast is largely influenced by wind-induced upwelling (south-easterly and southerly winds) which varies seasonally. Seasonality is strongest in the south where south-easterly winds are rare in winter but common in summer. Seasonality diminishes to the north-west where the wind generally comes from the south throughout the year, although velocities are lower in winter [1,2]. Temperatures of the upwelled waters range from 9 °C - 14 °C, depending upon the 'strength' of the upwelling process [1]. These temperatures can increase to 16 °C and higher through sun warming after being upwelled [4]. The mixed water is bounded by an oceanic front which lies at or slightly offshore of the shelf break [5]. Temperatures of oceanic water in the area are about 20 °C [1].

South coast. Surface temperatures over most of the south coast are usually between 20-21 ºC during summer and 16-17° C during winter. During summer, thermoclines are formed by the sun heating the surface water, while during winter months the water column is generally well mixed. Upwelling may also influence the temperature regime in the coastal zone, albeit not on the same scale as along the west coast [7].

East coast. The waters of the east coast are of tropical origin with a maximum of 25 EC occurring in February in inshore waters. The difference between summer and winter averages 4 EC with a generally well mixed regime. Further offshore there is also a 4 EC change between summer and winter in the upper 50 m with summer maxima greater than 26 EC. At lower depths, seasonal variation is apparently not evident. However, short-term fluctuations in surface waters may be as high as 8-9 EC, often exceeding seasonal variations. There is evidence of localised upwelling on the inner shore occurs along various areas of the coastline [8].

Although this section gives an indication of the temperature ranges within the different coastal regions, detailed temperature regimes are very site specific. Detailed temperature data sets for a large selection of sites along the South African coast can be obtained from the South African Data Centre for Oceanography (SADCO), CSIR, Stellenbosch.

TEMPERATURE continued on next page



TEMPERATURE continued...

Fate in environment

Not relevant to temperature.

Interdependence on other constituents

Generally, temperature is not interdependent on any other water quality properties or constituents.

Measurement in seawater

For marine waters, temperature is usually measured *in situ*, using a Conductivity-Temperature-Depth-Salinity (CTDS) meter. An ordinary thermometer can also be used.

Units: ^{o}C.

Pollution sources

Anthropogenic sources which may influence water temperature in the marine environment are usually related to the discharge of cooling water from power stations and certain industries [9].

Treatability

Where seawater is used in enclosed systems, e.g. seawater swimming pools, heat exchangers can be used. The type of metal used in the heat exchanger should be chosen carefully. Generally, titanium is preferred in seawater [10].

Related problems

Typical water quality problems which may be associated with temperature, and which are addressed in this document, include:

- hypo-/hyperthermia.

For more details on problems refer to:

p 3-4

Effects of change and target values

Factual information on the effect of different temperature ranges on recreation is provided in Section 5 for:

- full contact and intermediate contact recreation.

No target values for recreation have been set for the South African coastal zone.

Refer to:

p 5-1

SALINITY

Description

Salinity refers to the dissolved salt content in seawater. Typically, the major constituents in 1 kg of average seawater with a salinity of $35x10^{-3}$ are [11]:

Na^+	-	10,78 *g*
Mg^{2+}	-	1,28 *g*
Ca^{2+}	-	0,41 *g*
K^+	-	0,40 *g*
Sr^{2+}	-	0,01 *g*
Cl^-	-	19,35 *g*
SO_4^{2-}	-	2,71 *g*
HCO_3^-	-	0,11 *g*
Br^-	-	0,07 *g*
CO_3^-	-	0,01 *g*
$B(OH)_4^-$	-	0,001 *g*
$B(OH)_3^-$	-	0,02 *g*.

Natural occurrence

The salinity regime for South African marine waters differs from one coastal region to another:

West coast. Salinities fall in the narrow range of $34,7x10^{-3}$ to $35,4x10^{3}$; the lower salinities being associated with cold upwelling water [1]. Land run-off is low and intermittent and thus dilution of these salinities only occurs in very localised areas, e.g. the Berg River mouth and the smaller estuaries further south. Due to evaporative loss, salinities as high as $37,0x10^{-3}$ have been recorded in Langebaan lagoon [12].

South coast. Salinities measured in coastal water of the south coast have revealed slight seasonal variations with highest salinities in summer ($35,4x10^{-3}$) and lowest values in winter ($35,0x10^{-3}$) [13].

East coast. Subtropical surface waters are usually characterised by relatively high salinities ($>35x10^{-3}$) caused by greater evaporation rates. However, input of fresh water from large rivers to the north (Zambezi and Limpopo) as well as input from east coast rivers result in slightly reduced summer salinities. There is generally a slight positive salinity gradient from the shoreline to the core of the Agulhas Current [8].

Fate in environment

Not relevant to salinity.

SALINITY continued on next page

SALINITY continued...

Interdependence on other constituents

Generally, salinity is not interdependent on other water quality properties or constituents.

Measurement in seawater

In marine waters, salinity is usually measured *in situ*, using a Conductivity-Temperature-Depth-Salinity (CTDS) meter.

According to *The International System of Units (SI) in Oceanography* salinity's unit is dimensionless, being the ratios between two electrical conductivities.

The practical salinity of a sample of seawater is defined in terms of the conductivity ratio, K_{15}, which is defined by [14]:

$$\frac{\text{conductivity of seawater sample}}{\text{conductivity of standard KCl solution}}$$

at 15 °C, 1 atm pressure and the standard KCl solution being 32,4356 g kg^{-1}

Where the ionic strength ('salt content') of seawater has been measured as Electrical Conductivity (EC), mS m^{-1}, conversion factors can be used. Conversion factors from EC to salinity in the range $32x10^{-3}$-$36x10^{-3}$, at different temperatures are [16]:

ELECTRICAL CONDUCTIVITY (mS m^{-1})	TEMPERATURE (°C)			
	25	20	15	10
5 437,4 5 302,5 5 167,1 5 031,4 4 895,1	6,62 6,60 6,58 6,56 6,54			
4 910,5 4 788,2 4 665,6 4 542,6 4 419,2		7,33 7,31 7,29 7,26 7,24		
4 399,6 4 289,6 4 179,4 4 068,8 3 957,9			8,18 8,16 8,13 8,11 8,08	
3 906,1 3 808,0 3 709,6 3 611,0 3 512,2				9,22 9,19 9,16 9,14 9,11

Conversion: $$\text{Salinity } x10^{-3} = \frac{\text{EC (mS m}^{-1}\text{) x factor}}{1\,000}$$

SALINITY continued on next page

SALINITY continued...

Measurement *continued...*

Where the salt content has been measured as mg l^{-1} Total Dissolved Solids (TDS), it can be converted to salinity by dividing the TDS value by 1 000.

Pollution sources

Anthropogenic influences on salinity in the marine environment are usually related to waste discharges (fresh water) which, depending on the volume discharged, may result in a short-term decrease in salinity in the immediate vicinity of the discharge.

Treatability

Where seawater is used in an enclosed system, e.g. seawater swimming pools, salinity is often elevated due to evaporation. This is usually 'treated' by adding fresh water.

Related problems

Typical water quality problems which may be associated with salinity, and which are addressed in this document, include:

- gastrointestinal problems;
- 'sticky' water;
- corrosion.

For more details on problems refer to:

p 3-1
p 3-6
p 3-7

Effects of change and target values

No factual information on the effect of different salinity ranges on recreation could be obtained.

No target values for recreation have been set for the South African coastal zone. The problems associated with recreation occur within the natural salinity range of seawater.

pH

Description

pH is a measure of the concentration of hydrogen ions in solution, according to the expression:

$pH = -\log_{10} [H^+]$, where H^+ is the hydrogen ion concentration.

At a pH of less than 7 water is acidic, while at a pH of greater than 7 water is alkaline.

Natural occurrence

The pH of seawater usually ranges between 7,9 and 8,2 [15].

Seawater in equilibrium with atmospheric CO_2 is slightly alkaline, with a pH of about 8,1 - 8,3. The pH may rise slightly through the rapid abstraction of CO_2 from surface waters during photosynthesis [14].

Decomposition of organic matter under anaerobic (anoxic) conditions involves the reduction of CO_2 itself, and leads to the formation of hydrocarbons, such as methane. Under these conditions, the pH may rise to values as high as 12 [14].

Fate in environment

Aqueous solutions containing salts of weak acids or bases, such as seawater, show a resistance to pH change (known as buffering), on the addition of acids and bases [16].

Interdependence on other constituents

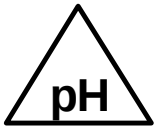
The pH of seawater can be influenced by certain gases which are soluble in seawater, such as carbon dioxide, ammonia (unionised) and hydrogen sulphide.

For example, carbon dioxide can be abstracted from seawater during phytoplankton blooms, thereby causing an increase in pH.

(In seawater CO_2 [gas] + $H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^{2-}$)

In seawater remote from contaminated or anoxic regions, the pH is mainly controlled by the $CO_2/HCO_3^-/CO_3^{2-}$ system. Other weak electrolytes slightly augment this effect (e.g. borate, phosphate, silicate and arsenate) [16].

pH continued on next page



pH continued...

Measurement in seawater	**pH is measured using a pH meter.** **The pH of seawater cannot be measured against the low ionic strength National Bureau of Standards (USA) buffers. Seawater has a high ionic strength resulting in significant errors in measurements. Artificial seawater buffers should be used [10].**	
Pollution sources	**Anthropogenic sources which may influence the pH of water are usually related to highly acidic or alkaline industrial waste waters.**	
Treatability	**In seawater, pH can be decreased by gasing with CO_2.**	
Related problems	**Typical water quality problems which may be associated with pH, and which are addressed in this document, include:** **- skin and eye irritations.**	**For more details on problems refer to:** **p 3-2**
Effects of change and target values	**Factual information on the effect of different pH ranges on recreation are provided in Section 5 for:** **- full and intermediate contact recreation.** **No target values for recreation have been set for the South African coastal zone.**	**Refer to:** **p 5-4**

FLOATING MATTER

Description

Floating matter refers to debris, oil, grease, wax, scum, foam, submerged (just below water surface) objects or any other visible substances.

Natural occurrence

Naturally occurring floating matter is usually limited to macrophytes and algae.

Fate in environment

Objectionable floating matter may end up on beaches or in sheltered areas where it becomes an aesthetic problem. It may also result in smothering or physical injury to marine life, e.g. benthic communities, sea birds and seals.

Interdependence on other constituents

Not relevant to floating matter.

Measurement in seawater

Floating matter is not usually measured quantitatively in marine waters, but is rather 'measured ' in terms of a qualitative description.

Pollution sources

Anthrophogenic sources of objectionable floating matter include:

- raw sewage (municipal waste);
- stormwater run-off (litter and debris);
- accidental oil spills (oil and grease);
- paper and pulp waste water (foaming);
- illegal dumping of ship refuse.

Treatability

Treatment is usually limited to the physical removal of objectionable floating matter, either through coarse grid systems or otherwise manually.

Related problems

Typical water quality problems which may be associated with the presence of objectionable floating matter include:

- physical injuries;
- unpleasant aesthetics;
- clogging and blockage of equipment.

For more details on problems refer to:

p 3-3
p 3-5
p 3-8

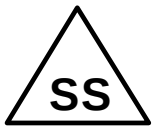
Effects of change and target values

No Information on specific effects of objectionable floating matter on recreation could be obtained. Target ranges are provided in Section 5 for:

- all recreational uses.

Refer to:

p 5-5



SUSPENDED SOLIDS

Description

Suspended solids refer to particulate inorganic and organic matter that are in suspension in the water column. The presence of suspended solids is usually attributed to a reduction in the clarity of water, i.e. light penetration or visibility. Under calm conditions suspended solids may settle from to water column to form objectionable deposits.

Natural occurrence

Naturally occurring suspended materials include finely divided organic and inorganic matter, plankton and other microscopic organisms. These are usually more evident during stormy conditions, plankton blooms and large river run-off.

Suspended solids may also be introduced to the water column through resuspension of natural debris during turbulent conditions, usually cause by strong wind and wave action.

Fate in environment

Suspended solids are usually kept in suspension since their density is similar to that of seawater and turbulence in the water column. Under calmer conditions, solids may settle out from the water column and be deposited onto the sediments.

Interdependence on other constituents

Information on the interdependence of suspended solids on other water quality constituents or properties could not be obtained.

Measurement in seawater

Suspended solids can be determined by collecting the suspended matter from a known volume of water (usually one litre) onto GF/C glass fibre filter paper [(17)].

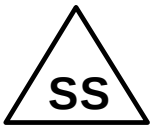
Units: mg l^{-1}.

Pollution sources

Anthropogenic sources of suspended solids include:

- **storm water run-off;**
- **sewage discharges;**
- **industrial waste.**

SUSPENDED SOLIDS continued on next page



SUSPENDED SOLIDS continued...

Treatability

Suspended solids with a diameter greater than 60 µm can be removed from seawater by using filters, e.g. sand filters.

Related problems

Typical water quality problems which may be associated with suspended solids include:

For more details on problems refer to:

- **physical injuries;** **p 3-3**
- **unpleasant aesthetics;** **p 3-5**
- **clogging and blockage of equipment.** **p 3-8**

Effects of change and target values

No information on specific effects of suspended solids on recreation could be obtained. Target ranges are provided in Section 5 for:

Refer to:

- **all recreational uses.** **p 5-6**

COLOUR/TURBIDITY/CLARITY

Description

The turbidity, colour and clarity of water are properties which are usually strongly linked to one another. Turbidity is caused by colloidal suspensions (particle size between 0,001 µm and 0,1 µm) which usually give water a 'murky' appearance, while colour is caused by substances which dissolve in water, and as a result the colour of the water changes. Both turbidity and colour, together with suspended solids, influence the clarity of water, i.e. the depth of light penetration or visibility in water. A constituent which may affect these properties of water is gypsum (calcium sulphate with two waters of hydration [$CaSO_4.2H_2O$]), a waste product of fertilizer industries.

Natural occurrence

Natural turbidity in water is caused by colloidal suspension (particle size between 0,001 µm and 0,1 µm) of, for example, clays and silt, usually introduced through river run-off. Turbidity may also be introduced to the water column through re-suspension of natural debris during turbulent conditions, usually caused by strong wind and wave action. Natural colour in water may result from the presence of natural metallic ions and humic substances, usually introduced through river run-off.

In the natural environment, gypsum only starts to precipitate from seawater at a salinity of $117x10^{-3}$ (e.g. through evaporation) [55].

Fate in environment

Owing to the high salt content of seawater, natural colloidal suspension (causing turbidity) and humic substances (natural colour) usually coagulate with specific ions and precipitate out.

Interdependence on other constituents

Turbidity and colour may be influenced by the salinity of water (see *Fate in Environment*).

The solubility product (K_{sp}) of gypsum in seawater is a function of the ionic strength (I), the solubility product at zero ionic strength (K_{sp}^o) and a number of other factors [25,56]. For example, the solubility product and the solubility (in g l^{-1}) of gypsum at 25 °C for different salinities are:

Salinity	K_{sp}	Solubility (g l^{-1})*
$20x10^{-3}$	0,0009	5,3
$25x10^{-3}$	0,0011	5,8
$30x10^{-3}$	0,0013	6,2
$35x10^{-3}$	0,0014	6,6

***Solubility (g l^{-1}) = / K_{sp} multiplied by the molecular mass of gypsum (172,17) multiplied by the density of seawater at 25 °C (1,023)**

COLOUR/TURBIDITY/CLARITY continued on next page

COLOUR/TURBIDITY/CLARITY continued...

Measurement in seawater

Turbidity can be measured on a Turbidimeter (Nephelometer) [17].

Units: NTU (Nephelometric turbidity units)

'True colour', i.e. the colour in water caused by substances in solution, can be measured through visual comparison methods such as the platinum cobalt method or a Lovibond comparator [17].

Units: Pt-Co mg l^{-1} (defined as the colour being produced by 1 mg Pt l^{-1} in the form of the chloroplatinate ion) or Hazen unit .
(1 Hazen unit = 1 Pt-Co mg l^{-1})

The clarity of water (combined effect of colour, turbidity and suspended solids) can be measured by using a Secchi disc.

Units: metres below water surface.

Pollution sources

Anthropogenic sources of colour/turbidity include:

- **industrial waste, e.g. paper and pulp and textile industries;**
- **raw sewage discharges;**
- **waste from fertilizer industries (gypsum).**

Treatability

Activated carbon filters can be used to remove turbidity or colour, although, depending on the volume of water, this can be very expensive.

Related problems

Typical water quality problems which may be associated with the presence of objectionable colour/turbidity/clarity include:

- **physical injuries;**
- **unpleasant aesthetics;**
- **clogging and blockage of equipment.**

For more details on problems refer to:

p 3-3
p 3-5
p 3-8

Effects of change and target values

General effects of colour/turbidity/clarity on recreation, as well as target values, are provided in Section 5 for:

- **all recreational uses.**

Refer to:

p 5-7

Chapter 4.2 Inorganic Constituents

HYDROGEN SULPHIDE

Description

Hydrogen sulphide is a poisonous gas which readily dissolves in water. No heterotrophic life can exist in water containing hydrogen sulphide, and such affected areas are therefore transformed into oceanic 'deserts' [18].

The speciation of H_2S in seawater at 25 °C, a pH of 8,1 and a salinity of 35×10^{-3} is H_2S (3,07 %), HS^- (96,93 %) and S^{2-} ($1,9 \times 10^{-4}$ %) [21].

Natural occurrence

Hydrogen sulphide is a frequent component of anoxic waters, attaining concentrations as high as 70 mg l^{-1} under extreme conditions [20].

Fate in environment

Dissolved oxygen in seawater is utilised by bacteria for oxidising organic matter to carbon dioxide, water and inorganic ions. In deep water of stagnant basins and in sea areas with a very slow water exchange or a high load of organic matter, all the dissolved oxygen may be utilised, leading to anoxic conditions [16].

Hydrogen sulphide behaves as a weak acid, and is present in natural waters as both the undissociated compound and the HS^- ion (below a pH of 12 the concentration of S^{2-} ion is negligible). Hydrogen sulphide is very volatile and reacts rapidly with oxygen [16].

Hydrogen sulphide is produced in anaerobic environments by the activities of sulphate-reducing bacteria, which derive energy from a process of anaerobic respiration.

$$2\ CH_2O + SO_4^{2-} \xrightarrow{\text{desulfovibria}} 2\ HCO_3^- + H_2S$$

Probably only a small fraction of H_2S is released to the atmosphere. In many environments, it reacts instead with iron to form insoluble iron sulphide, an abundant constituent of anaerobic organic rich sediments. Much of the sulphide that is not immobilised in this fashion is oxidised by bacteria that derives energy from the following reaction as soon as it reaches the aerobic level of the water profile [20]:

$$H_2S + 2\ O_2 \rightarrow SO_4^{2-} + 2\ H^+$$

Therefore, H_2S is slowly oxidised to sulphate in seawater. Evidence of this is that molecular sulphur does not accumulate in sediments in natural stagnant sea basins e.g. the Black Sea [20].

HYDROGEN SULPHIDE continued on next page

HYDROGEN SULPHIDE continued…

Interdependence on other constituents

The solubility of hydrogen sulphide decreases with increasing temperature and salinity, e.g. the solubility of H_2S in acidified seawater (pH 2,8 - 3,0) expressed as mg l^{-1} at 1 atm pressure is as follows [22]:

TEMPERATURE (°C)	SALINITY		
	$30x10^{-3}$	$35x10^{-3}$	$40x10^{-3}$
0	6 730,8	6 672,9	6 611,5
10	4 975,7	4 945,0	4 910,9
15	4 338,4	4 314,5	4 287,3
20	3 817,0	3 796,5	3 776,1
25	3 380,7	3 367,1	3 350,1
30	3 019,5	3 005,9	2 992,2

In contact with oxygen, hydrogen sulphide is *rapidly* oxidised to sulphur in an *acid* medium, but *slowly* to sulphate in more neutral solutions like seawater [18].

Also refer to *Fate in the Environment* on p 4-13.

Measurement in seawater

Hydrogen sulphide in seawater can be analysed photometrically or titrimetrically. The photometric method is more sensitive and accurate[3].

Pollution sources

Although hydrogen sulphide is usually not directly introduced to the marine environment through anthropogenic sources, those with high oxygen demand (reflected in high organic content, high biochemical oxygen demand or chemical oxygen demand) can favour conditions for the formation of hydrogen sulphide.

Treatability

Where seawater is used in enclosed systems, e.g. seawater swimming pools aeration is probably the most practical way of reducing hydrogen sulphide levels.

HYDROGEN SULPHIDE continued on next page

HYDROGEN SULPHIDE continued…

Related problems

Typical water quality problems which may be associated with hydrogen sulphide include:

- unpleasant aesthetics.

For more details on problems refer to:

p 3-5

Effects of change and target values

No information on effects of different ranges of hydrogen sulphide on recreation could be obtained.

No target values for recreation have been selected for the South African coastal zone.

Algal

Chapter 4.3 Organic Constituents

ALGAL TOXINS

Description

Some natural inhabitants of the sea, e.g. marine algae, produce toxins which pose a health risk to humans and other marine organisms (the latter will not be addressed in this document). Although these are not typical water quality properties/constituents, it is important to be aware of these toxins, especially in areas where people are in contact with seawater or where seafood is cultured or collected for human consumption.

The most well-known toxins include [29]:

- **paralytic shellfish poison (PSP) caused by the toxin known as saxitoxin in shellfish which have fed on toxic dinoflagellate plankton (red tide) of the genus *Gonyaulax;***
- **diarrhetic shellfish poisoning (DSP);**
- **neurotoxic shellfish poisoning (NSP) (aerosol toxins), *Ptychodiscus breve*, being the most widely studied organism causing NSP.**

Human intoxication related to PSP has only been associated with the consumption of contaminated shellfish, and rarely, if ever, with recreation in seawater [29].

NPS toxins differs from PSP and DPS in that the toxic effects do not result from ingestion of affected shellfish. Algal physiological processes and/or cell lysis results in the release of these toxins in the water where they act as contact poisons. [29].

Natural occurrence

Algal blooms off the South African west and south coasts occur naturally throughout the year, but are most abundant during late summer and autumn. Some of these, for example, certain red tide species, do produce algal toxins [29].

Blooms of the algae *Gonyaulax polygramma* and *Gymnodinium* sp. have also been reported in False Bay [29].

Fate in environment

Information on the fate of algal toxins in the marine environment could not be obtained.

ALGAL TOXINS continued on next page

ALGAL TOXINS continued...

Interdependence on usually other constituents	**The occurrence of algal blooms, including those producing algal toxins, is dependent on factors such as water temperature and nutrient availability [29].**
Measurement in seawater	**Methods for analysing algal toxins in seawater could not be obtained. However, chromatographic techniques have been used to analyse for these toxins in mussel tissue [30].**
Pollution sources	**Nutrient enrichment of the sea may stimulate algal blooms, including those producing algal toxins. Anthropogenic sources of nutrients include [9]:** **- sewage discharges;** **- run-off from agricultural areas, especially where fertilizers are applied;** **- septic tank seepage.**
Treatability	**Practical methods of removing algal toxins from seawater could not be obtained.**
Related problems	**Typical problems associated with algal toxins, and which are discussed in this document, include:** **- gastrointestinal problems;** **- skin, eye, ear and respiratory irritations.**
Effects of change and target values	**No data could be obtained on specific concentration ranges of algal toxins and associated effects on recreation.** **No target values have been selected for the South African coastal zone.**

For more details on problems refer to:

p 3-1
p 3-2

Chapter 4.4 Microbiological Indicator Organisms and Human Pathogens

FAECAL COLIFORM (including *Escherichia coli*)

Description

Faecal coliforms refer to a group of total coliforms which are more closely related to faecal contamination, and which generally do not readily replicate in the water environment. *Escherichia coli* (*E. coli*) is a member of the group of faecal coliform bacteria. It has the important feature of being highly specific to the faeces of warm-blooded animals and for all practical purposes, these bacteria cannot multiply in any natural water environment [27].

These bacteria were selected as indicators of faecal pollution because they typically occur in the faeces of man and warm-blooded animals.

However, some human diseases associated with polluted seawater are caused by viruses. Certain shortcomings of faecal coliforms to indicate virological quality have been shown which might be attributed to the following [27]:

- **viruses are only excreted by infected individuals and coliform bacteria by almost all humans and warm-blooded animals;**
- **viruses are excreted for relatively short periods, while coliform bacteria is excreted fairly consistently;**
- **the structure, composition, morphology and size of viruses differ fundamentally from that of bacteria, which implies that behaviour and survival in water differ extensively.**

Natural occurrence

Although faecal coliforms are not a natural water quality property/constituent of marine waters, they are fairly consistently excreted by humans and other warm-blooded animals.

Fate in environment

The survival of faecal coliforms in the marine environment is dependent on a variety of variables including temperature, exposure to ultraviolet light irradiation in sunlight, salinity, osmotic shock, microbiological antagonism, adsorption to solids and sediments and ingestion by molluscs.

The rate of bacterial die-off in the marine environment is usually expressed in T_{90} values, which is the time required for the bacterial density to decrease by 90 %. The T_{90} values are usually greater during day time compared to night time, primarily as a result of higher ultraviolet light irradiation during the day [28].

Faecal coliforms continued on next page

F coli

Feacal coliforms continued...

Interdependence on other constituents

Refer to *Fate in the Environment* on p 4-19.

Measurement

In routine monitoring, faecal coliforms in seawater are usually measured according to the membrane filter technique [17].

Results are expressed as:

Faecal coliform (*E. coli*) counts per 100 ml.

Pollution sources

Major sources of faecal contamination to marine waters include [9]:

- **sewage discharges;**
- **bathers themselves, especially at densely populated beaches;**
- **septic tank seepage;**
- **stormwater run-off;**
- **contaminated river run-off.**

Treatability

Not relevant to indicator organisms. Treatment should be focused on the microbiological organisms that pose the actual health risk, i.e. the human pathogens.

Related problems

Typical problems associated with the presence of microbiological indicators in seawater used for recreational purposes are usually related to human health, for example:

- **gastrointestinal problems;**
- **skin, eye, ear and respiratory irritations.**

For more details on problems refer to:

p 3-1
p 3-2

Effects of change and target values

References to epidemiological studies conducted to establish the applicability of faecal coliforms to predict health risks, as well as target values are provided in Section 5 for:

- **full contact and intermediate contact recreation.**

Refer to:

p 5-13

ENTEROCOCCI

Description

Enterococci and faecal streptococci refer to vaguely defined groups of Gram-positive spherical bacteria, some of which are of human and/or animal faecal origin, and some of which are members of the natural flora of various environments. Because of the limited specificity of tests commonly used in these groups, they can, for all practical purposes, be considered the same[27].

Enteroccoci has been shown to be a valuable indicator for determining the extent of faecal contamination in marine waters [17].

Natural occurrence

Although enterococci are not a natural water quality property/constituent of marine waters, it is fairly consistently excreted by warm-blooded animals [17].

Fate in environment

The survival of enterococci in the marine environment is dependent on a variety of variables including temperature, exposure to ultraviolet light irradiation in sunlight, salinity, osmotic shock, microbiological antagonism, adsorption to solids and sediments and ingestion by molluscs.

The rate of bacterial die-off in the marine environment is usually expressed in T_{90} values, which is the time required for the bacterial density to decrease by 90 %. The T_{90} values are usually greater during day time compared to night time, primarily as a result of higher ultraviolet light irradiation during the day [28].

Interdependence on other constituents

Refer to *Fate in the Environment* above.

Measurement

In routine monitoring, enterococci in seawater is usually measured according to the membrane filter technique [17].

Results are expressed as:

Enterococci counts per 100 ml.

Pollution sources

Major sources of faecal contamination to marine waters include [9]:

- **sewage discharges;**
- **bathers themselves, especially at densely populated beaches;**
- **septic tank seepage;**
- **stormwater run-off;**
- **contaminated river run-off.**

ENTEROCOCCI continued on next page

Entero

ENTEROCOCCI continued...

Treatability	**Not relevant to indicator organisms. Treatment should be focused on the microbiological organisms that pose the actual health risk, i.e. the human pathogens.**	
Related problems	**Typical problems associated with the presence of microbiological indicators include:** **- gastrointestinal problems;** **- skin, eye, ear and respiratory irritations.**	**For more details on problems refer to:** **p 3-1** **p 3-2**
Effects of change and target values	**References to epidemiological studies conducted to establish the applicability of using of enterococci to predict health risks, as well as target values are provided in Section 5.** **No target ranges for recreation have been selected for the South African coastal zone.**	**Refer to:** **p 5-14**

Pathogen

HUMAN PATHOGENS

Description

This document will deal with *human* pathogens, in particular. Human pathogens refer to microbiological organisms which may cause disease or other health problems in humans. In terms of marine waters, this can either be through contact or ingestion of water containing these organisms or through the consumption of seafood which has been cultured in contaminated waters.

Generally, human pathogens can be divided into three broad groups, i.e.:

- ***Bacteria*, including organisms such as *Salmonella*, *Shigella, Klebsiella pneumoniae, Pseudomonas aeruginosa*, *Staphylococcus aureus*, species of *Streptococcus* and *Micrococcus*, *Vibrio parahaemolyticus, Vibrio cholerae, Vibrio vulnificus* and *Listeria monocytogenes* [25,27,31];**
- ***Viruses*, including enteroviruses, gastroenteric viruses and adenoviruses [25];**
- ***Protozoan parasites*, including *Giardia lambia*, *Cryptosporidium parvum* and *Entamoeba histolytica* [27,31].**

Natural occurrence

Some human pathogens which are known to cause infections in humans, such as *Vibrio parahaemolyticus* and *Vibrio cholerae*, may be natural inhabitants of the marine environment.

Fate in environment

Not much detail is known on the fate of human pathogens in marine waters. Generally, the survival of human pathogens in the marine environment is dependent on a variety of variables including temperature, exposure to ultraviolet light irradiation in sunlight, salinity, osmotic shock, microbiological antagonism, adsorption to solids and sediments and ingestion by molluscs. Obviously, survival is extensively prolonged in environments which protect against antimicrobial agents. Because of their small size, simple structure and resistant outer shell (capsid), viruses generally survive longer than bacteria.

Interdependence on other constituents

Refer to *Fate in the Environment* above.

Measurement in seawater

Methods for testing for human pathogens in seawater vary and largely depend on the type of organism. Because indicator organisms are usually measured in routine monitoring for pathogenic contaminants, methods of testing for human pathogens will not be discussed in detail in this document. These methods can, however, be obtained from a variety of publications [17,26,27].

HUMAN PATHOGENS continued on next page

Pathogen

HUMAN PATHOGENS continued...

Pollution sources

Major sources of faecal contamination to marine waters include [9]:

- **sewage discharges;**
- **bathers themselves, especially at densely populated beaches;**
- **septic tank seepage;**
- **stormwater run-off;**
- **contaminated river run-off.**

Treatability

Where seawater is used in enclosed systems or where it is extracted before use, UV-irradiation and ozonation can possibly be used to treat the water. This should, however, be done with great care since certain marine organisms are sensitive to such treatments.

In seawater, the effectiveness of chlorine as a disinfectant, e.g. in tidal pools, is doubtful. When chlorine is added to water the following reactions occur:

$$Cl_2 + H_2O \rightleftharpoons H^+ + Cl^- + HOCl$$
$$HOCl \rightleftharpoons H^+ + OCl^-$$

The disinfecting ability of the hypochlorous acid (HOCl) greatly exceeds that of the hypochlorite ion (OCl^-) and the equilibrium between the two is pH-dependent. At pH 5 available chlorine is almost entirely present as hypochlorous acid, but at pH 10 as hypochlorite. At the pH of seawater (i.e. about 8,2), it can therefore be expected that the disinfectant rate of chlorine will be much reduced [6].

Related problems

Typical problems associated with human pathogens, and which are discussed in this document, include:

- **gastrointestinal problems;**
- **skin, eye, ear and repiratory irritations.**

For more details on problems refer to:

p 3-1
p 3-2

Effects of change and target values

No data could be obtained on the specific counts of human pathogens in seawater and the associated effects on recreation.

No target values for recreation have been selected for the South African coastal zone.

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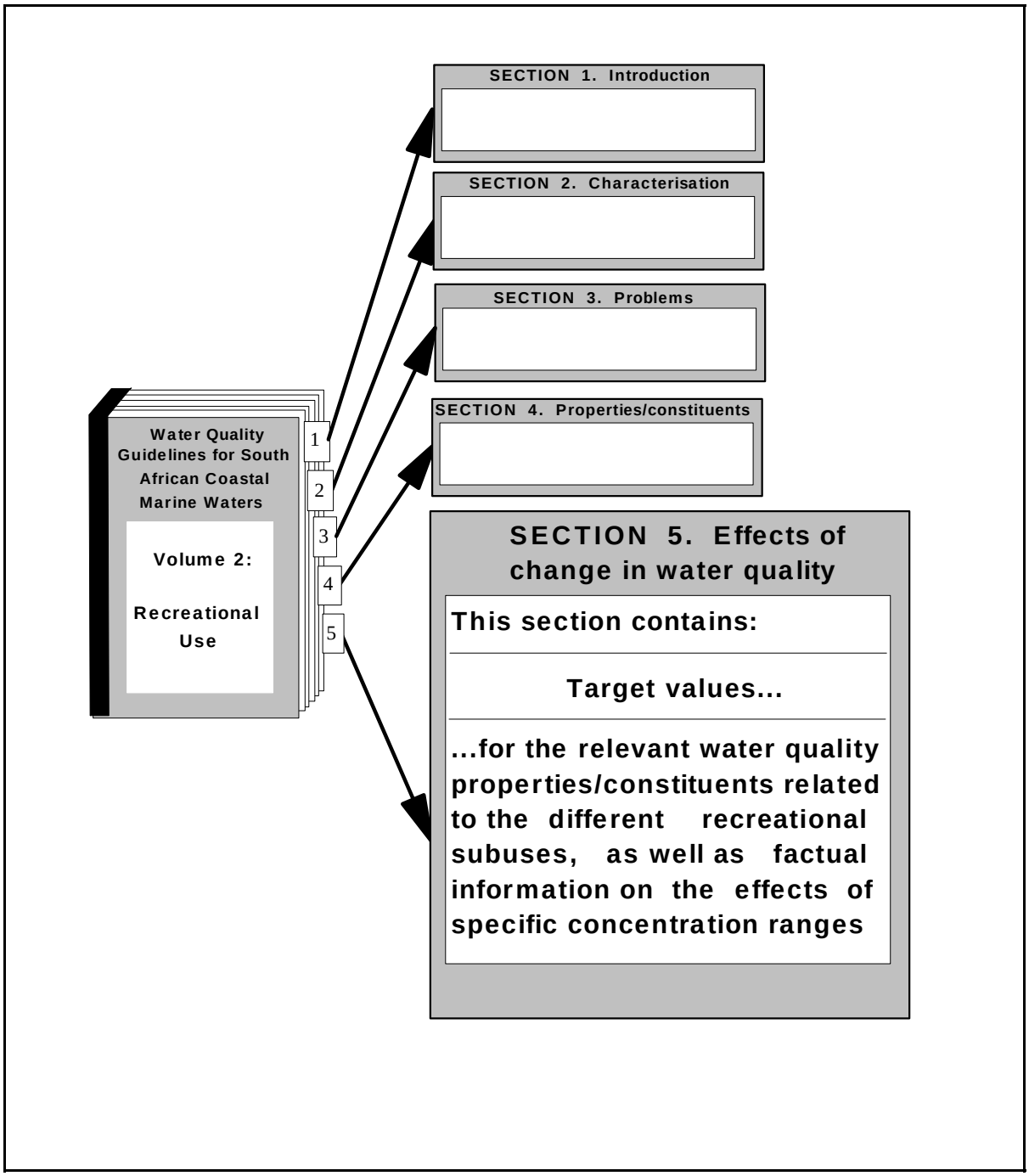
SECTION 5: EFFECTS OF CHANGE IN WATER QUALITY RELATED TO RECREATIONAL USE (INCLUDING TARGET VALUES)



SECTION 5: EFFECTS OF CHANGE CONTENTS

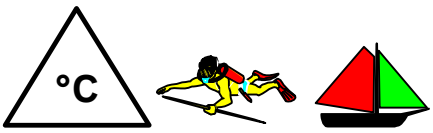
Chapter 5.1 Physico-chemical Properties

TEMPERATURE (Refer to p 4-1)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

TEMPERATURE RANGE (°C)	Human Health/Safety
No target value has been selected for the South African coastal zone [1]	
< 15	Extended periods of continuous immersion may cause death in some individuals and will be extremely stressful to anyone are not wearing underwater protective clothing [2,3]. The relationship between water temperature and survival time in cold water is illustrated on the next page [3]
15 - 35	No detrimental effect [2]
26 -30	Comfortable for most individuals throughout prolonged periods of moderate physical exertion [7]
> 33	Physiologically, neither adult nor child would experience thermal stress under modest metabolic heat production (normal skin temperature is 33 °C) [2]
> 34 -35	Survival of an individual will depend on tolerance to an elevated internal body temperature, since there is a risk of injury with prolonged exposure [2]. The degree of risk varies with the water temperature, immersion time and the metabolic rate of the individual [7]

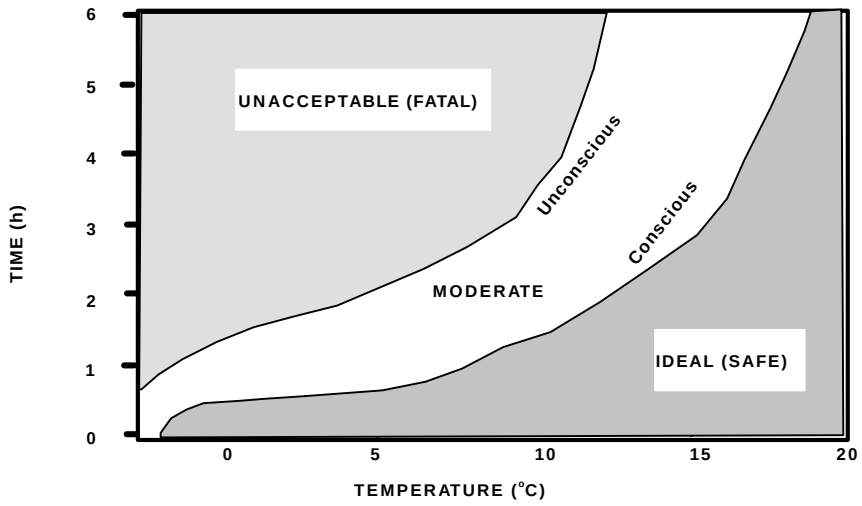
TEMPERATURE continued on next page



TEMPERATURE continued …

Full contact and intermediate contact
continued...

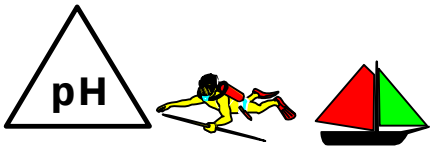
NOTE: **The relationship between water temperature and survival time in cold water can be illustrated as follows[3]:**



SALINITY (Refer to p 4-3)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

SALINITY RANGE	Human Health/Safety	Aesthetics/Nuisance	Mechanical Interferences
No target value has been selected for the South African coastal zone [1]			
Salinity of seawater (about $35x10^{-3}$)	May have a mild laxative effect if water is swallowed accidentally (presence of magnesium sulphate and sodium sulphate) [2]	Salt deposits on the hair and skin may be a nuisance factor to some swimmers creating a 'sticky' effect	Corrosion of metal equipment, unless protected against corrosion [5]

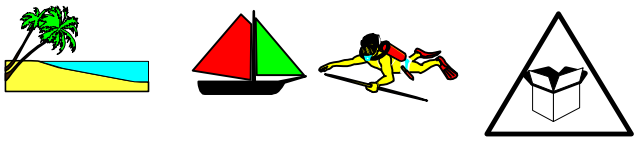


pH (Refer to p 4-6)

Full contact and intermediate contact

(Refer to p 2-3 and p 2-11)

RANGE	Human Health/Safety
No target value has been selected for the South African coastal zone [1]	
< 5,0	Severe eye irritations occur [7] Skin, ear and mucous irritations are likely to occur [7]
5,0 - 6,5	Where the buffering capacity of the water is low, swimming in water with this pH is acceptable. However, in seawater where the buffering capacity can be very high eye, ear, skin and mucous irritations may occur [7]
6,5 - 8,5	No detrimental effects. Minimal eye irritations may occur. The pH is well within the buffering capacity of the lachrymal fluid of the human eye [7]
8,5 - 9,0	Where the buffering capacity of the water is low, swimming in water with this pH is acceptable. However, in seawater where the buffering capacity can be very high eye, ear, skin and mucous irritations may occur [7]
> 9,0	Eye irritations become increasingly severe as pH increases [3] Skin, ear and mucous irritations are likely to occur [3]



FLOATING MATTER (Refer to p 4-8)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

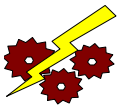
TYPE	Human Health/Safety	Aesthetics/Nuisance	Mechanical Interferences
Target for the South African coastal zone [1]: - **Water should not contain floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance;** - **Water should not contain materials from non-natural land-based sources which will settle to form putrescence;** - **Water should not contain submerged objects and other subsurface hazards which arise from non-natural origins and which would be a danger, cause nuisance or interfere with any designated/recognized use**			
Refuse, scum, foam, oil and grease, nuisance macrophyte, etc.	May obstruct view and result in physical injuries	May have visual impact or cause objectionable odours on decay [1].	May cause clogging of equipment such as diving gear, boat engines, etc.

Non-contact
(Refer to p 2-15)

The target range and effects will be the same as for *full contact and intermediate contact* recreation, refer to the norm: *Aesthetics/Nuisance* above

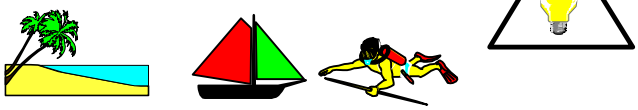
SUSPENDED SOLIDS (Refer to p 4-9)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

CONCENTRATION (mg l^{-1})	 Aesthetics/Nuisance	 Mechanical Interferences
Target range for the South African coastal zone: The concentration of suspended solids should not be increassed by more than 10 % of the ambient concentration (1)		
	Although it could not be quantified, the presence of suspended solids may cause visual impact	Although it could not be quantified, the presence of suspended solids may result in clogging and blockage of equipment such as diving gear, boat engines, etc.

Non-contact
(Refer to p 2-15)

The target range and effects will be the same as for *full contact and intermediate contact* recreation, refer to the norm: *Aesthetics/Nuisance* above



COLOUR/TURBIDITY/CLARITY (Refer to p 4-11)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

COLOUR/TURBIDITY/ CLARITY	Human Health/Safety	Aesthetics/Nuisance
Target for the South African coastal zone [1]: **Turbidity and colour acting singly or in combination should not reduce the depth of the euphotic zone by more than 10 % of background levels measured at a comparable control site.** **The colour (substances in solution) of water should not exceed background levels by more than 35 Hazen units.**		
0 - 2,75 (Secchi disc depth in m)	Perceived to be suitable for swimming, in terms of judging water depth and seeing possible hazards [4]	No adverse visual impact [6]
2.75 - 1,5 (Secchi disc depth in m)	Perceived, on average, to be suitable for swimming [4]	No adverse visual impact [6]
1,5 - 1,0 (Secchi disc depth in m)	Minimum visibility required for water to be suitable for swimming [2]	No visual impact [6]
> 1,0 (Secchi disc depth in m)	Generally considered as unsuitable for swimming unless all subsurface hazards are removed and water depth indication is clearly posted [7]	Some visual impact [6]

Non-contact
(Refer to p 2-15)

The target range and effects will be the same as for *full contact and intermediate contact* recreation, refer to the norm: *Aesthetics/Nuisance* above

Chapter 5.2 Inorganic Constituents

HYDROGEN SULPHIDE (Refer to p 4-13)

All recreational uses
(Refer to Section 2)

HYDROGEN SULPHIDE	 **Aesthetics/Nuisance**
No target value has been set for the South African coastal zone [1]	
	Although it could not be quantified, the presence of hydrogen sulphide can cause unpleasant odours

Chapter 5.3 Organic Constituents

ALGAL TOXINS (Refer to p 4-17)

Full contact and intermediate contact

(Refer to p 2-3 and p 2-11)

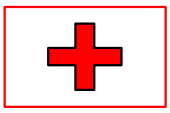
ALGAL TOXINS	 **Human Health/Safety**
No target values have been selected for the South African coastal zone [1]	
	No data could be obtained

Chapter 5.4 Microbiological Indicator Organisms and Human Pathogens

NOTE: Generally, information on diseases associated with recreation in marine environments in South Africa is limited. This is due to the absence of a public health infrastructure for epidemiological research. Although the available information indicates that the risk of infection is low at most bathing beaches in South Africa, pollution of marine water does occur, which implies that there is a risk at least in certain areas. Meaningful studies in South Africa are presently (1994) in progress.

FAECAL COLIFORMS (including *Escherichia coli*) (Refer to p 4-19)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)



Human Health/Safety

Target range for the South African coastal zone [1]:

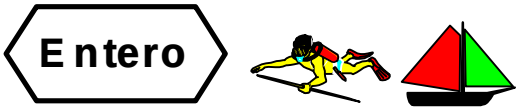
Maximum acceptable count per 100 ml:
100 in 80 % of the samples
2 000 in 95 % of the samples

A number of large epidemiological studies have been conducted across the world to establish the effectiveness of microbiological organisms, such as faecal coliforms (including *E. coli*) and Enterococci, as indicators of human health risks. Examples include:

- Cape Town, South Africa [8];
- Tel Aviv, Israel [9];
- Hong Kong [10,11,12];
- Sidney, Australia [13];
- New York, USA [14,15];
- England [16].

These studies revealed that numerous factors, including age group, health status of the bather and other sources associated with similar health risks, often result in difficulties in interpreting results.

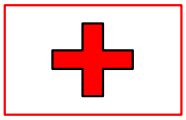
Because of the complex nature of these results, it was decided not to extract any data which might be viewed out of context and it is therefore recommended that the reader refer to the original publications for more detailed information.



ENTEROCOCCI (Refer to p 4-21)

Full contact and intermediate contact

(Refer to p 2-3 and p 2-11)



Human Health/Safety

No target range has been selected for the South African coastal zone [1]

A number of large epidemiological studies have been conducted across the world to establish the effectiveness of microbiological organisms, such as Enterococci, as indicators of human health risks. Examples include:

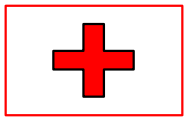
- Cape Town, South Africa [8];
- Tel Aviv, Israel [9];
- Hong Kong [10,11,12];
- Sidney, Australia [13];
- New York, USA [14,15];
- England [16].

These studies revealed that numerous factors, including age group, health status of the bather and other sources associated with similar health risks, often result in difficulties in interpreting results.

Because of the complex nature of these results, it was decided not to extract any data which might be viewed out of context and it is therefore recommended that the reader refer to the original publications for more detailed information.

HUMAN PATHOGENS (Refer to p 4-23)

Full contact and intermediate contact
(Refer to p 2-3 and p 2-11)

HUMAN PATHOGENS	 **Human Health/Safety**
No target values have been selected for the South African coastal zone [1]	
	No data could be obtained

NOTE: **The minimum infectional dose for a number of faecal pathogens may be as follows [17]:**

Vibrio cholerae	**10^9**
Escherichia coli	**10^4 - 10^5**
Salmonella sp.	**10^5 - 10^9**
Salmonella typhi	**10^2 - 10^3**

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APPENDICES

APPENDIX A: SUMMARY OF TARGET VALUES FOR RECREATIONAL USE

Physico-chemical properties

	FULL CONTACT	INTERMEDIATE CONTACT	NON-CONTACT
Temperature	-	-	-
Salinity	-	-	-
pH	-	-	-
Floating matter, including oil and grease	Water should not contain floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance; Water should not contain materials from non-natural land-based sources which will settle to form putrescentce Water should not contain submerged objects and other subsurface hazards which arise from non-natural origins and which would be a danger, cause nuisance or interfere with any designated/recognized use		
Colour/turbidity/ clarity	Should not be more than 35 *Hazen units* above ambient concentrations (colour) Should not reduce the depth of the euphotic zone by more than 10 % of ambient levels measured at a suitable control site (turbidity)		
Suspended solids	Should not be increased by more than 10 % of ambient concentrations		
Dissolved oxygen	-	-	-

SUMMARY OF TARGET VALUES continued on next page

Target values

SUMMARY OF TARGET VALUES continued...

Nutrients

	FULL CONTACT	INTERMEDIATE CONTACT	NON-CONTACT
Ammonium	-	-	-
Nitrite	-	-	-
Nitrate	-	-	-
Reactive phosphate	-	-	-
Reactive silicate	-	-	-

Inorganic constituents

	FULL CONTACT	INTERMEDIATE CONTACT	NON-CONTACT
Ammonia	-	-	-
Cyanide	-	-	-
Fluoride	-	-	-
Chlorine	-	-	-
Hydrogen sulphide	-	-	-
Arsenic	-	-	-
Cadmium	-	-	-
Chromium	-	-	-
Copper	-	-	-
Lead	-	-	-
Mercury	-	-	-
Nickel	-	-	-
Silver	-	-	-
Tin	-	-	-
Zinc	-	-	-

SUMMARY OF TARGET VALUES continued on next page

SUMMARY OF TARGET VALUES continued...

Organic constituents

	FULL CONTACT	INTERMEDIATE CONTACT	NON-CONTACT
Organotins (Tributyltin)	-	-	-
Total petroleum hydrocarbons	-	-	-
Poly cyclic aromatic hydrocarbons	-	-	-

Microbiological indicator organisms

	FULL CONTACT	INTERMEDIATE CONTACT	NON-CONTACT
Faecal coliforms (including *E. coli*)	Maximum acceptable count per 100 ml: 100 in 80 % of the samples 2 000 in 95 % of the samples		-

APPENDIX B: INTERNATIONAL TARGET VALUES FOR RECREATIONAL USE

Physico-chemical properties

	CANADA[1]	US-EPA[2]	EEC (afterUK)[3]	AUSTRALIA[4]
Temperature	Thermal characteristics should not cause an appreciable increase or decrease in the deep body temperature of users	-	-	-
Salinity	-	-	-	-
pH	6,5 to 8,5	-	6 to 9	5 to 9, assuming low buffering capacity near the extremes
Floating matter, including oil and grease	Free of substances that: -form objectionable deposits; -float, such as debris, scum, oil and nuisance organisms. Should not be present in concentrations that could be visible, detected by odour or deposited on shoreline (oil and grease)	Free of substances that: -form objectionable deposits; -float, e.g. debris, scum, oil.	Floating materials, such as wood, plastic articles, etc. should be absent No visible film on surface of the water (oil) No lasting foam	Oil and petrochemicals should not be noticeable as a visible film. Nuisance organisms (phytoplankton scum, macrophytes, ect. should not be present in excessive amounts.
Colour/turbidity/ clarity	*Turbidity* should not be increased by more than 5 NTU overall natural turbidity when turbidity is low (<50 NTU) *Clarity* - Secchi disc: -1,2 m; and -'Learn to swim' areas visible to the bottom *Colour* - Max limit : 100 Pt-Co units	Water should be free from substances producing objectionable colour or turbidity	No abnormal change in colour *Sechhi disc depth:* 1 m - 90%ile (guide) 2 m - 95%ile (mandatory)	The natural clarity should not be reduced by more than 20%. Natural hue of water should not changedby more than 10 points on Munsell scale. Natural reflectance should not be change by more than 50%. Horizontal sighting of a 200 mm black disc should exceed 1,6 m.
Suspended solids	-	-	-	-
Dissolved oxygen	-	-	80 to 120% saturation (90%ile)	-

INTERNATIONAL TARGET VALUES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Nutrients

	CANADA[1]	US- EPA[2]	EEC (after UK)[3]	AUSTRALIA[4]
General	Waters should be free of substances that produce undesirable aquatic life	Waters should be free of substances that produce undesirable or nuisance aquatic life	-	-
Nitrite	-	-	-	-
Nitrate	-	-	-	No single value. Indication of levels at which problems have been experienced: 10-60 µg l^{-1}
Phosphate	-	-	-	No single value. Indication of levels at which problems have been experienced: 1-10 µg l^{-1}
Total phosphorous	-	0,1 µg l^{-1} (elemental)	-	-
Silicate	-	-	-	-

INTERNATIONAL TARGET VALUES continued on next page

INTERNATIONAL TARGET VALUES continued...

Inorganic Constituents

	CANADA[1]	US-EPA[2]	EEC (after UK)[3]	AUSTRALIA[4]
Ammonia	-	-	-	-
Cyanide	-	-	-	0,1 mg l^{-1}
Fluoride	-	-	-	-
Chlorine	-	-	-	-
Hydrogen sulphide	-	-	40 µg l^{-1} (24 h max average)	-
Gypsum	-	-	-	-
Arsenic	-	-	500 µg l^{-1} (total) (95%ile)	0,05 mg l^{-1}
Cadmium	-	-	-	0,005 mg l^{-1}
Chromium	-	-	500 µg l^{-1} (total) (95%ile)	0,05 mg l^{-1}
Copper	-	-	500 µg l^{-1} (total) (95%ile)	-
Iron	-	-	3 000 µg l^{-1} (total) (95%ile)	-
Lead	-	-	500 µg l^{-1} (total) (95%ile)	0,05 mg l^{-1}
Manganese	-	-	-	-
Mercury	-	-	-	0,001 mg l^{-1}
Nickel	-	-	500 µg l^{-1} (total) (annual arithmetic mean)	0,1 mg l^{-1}
Silver	-	-	-	0,05 mg l^{-1}
Tin (inorganic)	-	-	-	-
Vanadium	-	-	-	-
Zinc	-	-	500 µg l^{-1} (total) (95%ile)	-

INTERNATIONAL TARGET VALUES continued on next page

International

INTERNATIONAL TARGET VALUES continued...

Organic constituents

	CANADA[1]	US-EPA[2]	EEC (after UK)[3]	AUSTRALIA[4]
Organotins (Tributyltin)	-	-	-	-
Total petroleum hydrocarbons	-	-	0,3 mg l^{-1} (90%ile) (mineral oils)	-
Polycyclic aromatic hydrocarbons	-	-	-	0,01 µg l^{-1}
Algal toxins	-	-	-	-
Tainting substances	-	-	-	-
Other organics	-	-	-	Refer to Reference No 4

INTERNATIONAL TARGET VALUES continued on next page

INTERNATIONAL TARGET VALUES continued...

Microbiological indicator organisms and pathogens

	CANADA[1]	US-EPA[2]	UK[3]	AUSTRALIA[4]
Total coliform	-	-	*Guide:* 500 per 100 ml (80%ile) *Mandatory:* 10 000 per 100 ml (95%ile)	-
Faecal coliform	2 000 counts l^{-1} (geometric mean of at least 5 samples taken within 30 days) Resample if: > 4 0 00 counts l^{-1}	-	*Guide:* 100 per 100 ml (80%ile) *Mandatory:* 2 000 per 100 ml (95%ile)	*Primary contact:* 150/100 ml *Secondary contact:* 1000/100 ml) (median over bathing season)
E. coli	2 000 counts l^{-1} (geometric mean of at least 5 samples taken within 30 days) Resample if: > 4 0 00 counts l^{-1}	-	-	-
Enterococci (faecal streptococci)	350 counts l^{-1} (geometric mean of at least 5 samples taken within 30 days) Resample if: > 700 counts l^{-1}	35 per 100 ml (geometric mean of at least 5 samples equally spaced over 30 days) No sample should exceed a one-sided confidence limit using the following guidance: Freq. bathing - 75%CL Mod. bathing - 82% CL Light bathing - 90% CL Infreq bathing - 95% CL based on a site-specific log std deviation. If site data are insufficient to establish a log std deviation, then use 0,7 as the log std deviation	*Guide:* 100 per 100 ml (90%ile) (faecal streptococci)	*Primary contact:* 35/100 ml *Secondary contact:* 230/100 ml (median over bathing season)
Salmonella	-	-	0 per litre	-
Enteroviruses	-	-	0 PFU per 10 litre	-
Protozoa	-	-	-	Should be absent

INTERNATIONAL TARGET VALUES continued on next page

International

REFERENCES

1. CANADIAN WATER QUALITY GUIDELINES. 1992. Updated version of Canadian water quality guidelines 1987. Prepared by the Task Force on Water Quality Guidelines of the Canadian Council of Resource and Environmental Ministers. Canada.

2. EPA. 1986. *Quality criteria for water*. EPA 440/5-86-001. United States Environmental Protection Agency, Washington, USA.

3. WATER RESEARCH CENTRE. 1990. Design guide for marine treatment schemes. Volume II. Environmental design and data collection. *Report* No **UM 1009**. Water Research Centre, Swindon, UK.

4. AUSTRALIAN WATER QUALITY GUIDELINES FOR FRESH AND MARINE WATERS. 1992. Australian and New Zealand Environment and Conservation Council, Australia.

APPENDIX C: GLOSSARY OF TERMS

Abalone	Perlemoen.
Abiotic	The non-living component of an ecosystem**.**
Absorption	Penetration or uptake of one substance into the body of another (chemical terms).
Adiponitrile	An intermediate in the manufacture of nylon.
Adsorption	Attachment of molecules or ions to a substrate by manipulation of electrical charge or pH.
Adsorbed	*see* Adsorption.
Aerobic	Where oxygen is available or where molecular oxygen is required for respiration.
Algicidal dose	Amount of a chemical required to kill algae.
Alginate	One of a class of salts of algin, such as sodium alginate.
Aliphatic	Refers to an organic compound of hydrogen and carbon characterised by a straight chain of carbon atoms.
Amperometric titration	A titration involved in measuring an electric current or changes in current during the cause of the titration.
Amphipod	Invertebrates belonging to the order Crustaceans.
Anoxic	Limited or no oxygen availability.
Anaerobic	Where insufficient oxygen is available or where molecular oxygen is not required for respiration.
Anthropogenic	External, e.g. storm water is an anthropogenic source of pollution to the sea.
Atomic spectrophotometry	A method of measuring concentration of substances, usually trace metals, by measuring spectra arising from either emission or absorption of electromagnetic radiation by atoms
Autolyse	(Autolysis) Return of a substance to solution as of phosphate removed from seawater by plankton and returned when these organisms die and decay (path).
Bacteria	Extremely small, relatively simple prokaryotic microorganisms.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Balanoid zone (upper)	One of four distinct zones recognised on most rocky beaches, high on the shore above the lower Balanoid zone. Limpets and barnacles are characteristic of this zone.
Balanoid zone (lower)	One of four distinct zones recognised on rocky shores, just above the infratidal (subtidal) zone. Algae dominate in this zone.
Barnacle	The common name for a number of species of crustaceans.
Bathymetric	(Bathymetry) The science of measuring ocean depth in order to determine the sea floor topography.
Benthic	Inhabiting the bottom of a water body.
Bioassay	A method for quantitatively determining the concentration of a substance by its effect on a suitable organism or plant under controlled conditions.
Biochemical oxygen demand (BOD)	The amount of dissolved oxygen required to meet the metabolic needs of aerobic organisms in water rich in organic matter.
Biolimiting nutrient	A nutrient whose availability in surface waters limit biological production when not available in sufficient concentrations.
Biomass	The dry weight of living matter, including stored food, present in a species population and expressed in terms of a given area or volume of habitat.
Biotic	Pertaining to life or living organisms and/or induced by actions of living organisms.
Broodstock	Animals used for breeding purposes.
Byssogenesis	The generation of the tuft of strong filaments by which bivalve molluscs are attached to the substratum.
Buffering capacity	A measure of the relative sensitivity of a solution to pH changes on addition of acids or bases.
Carnivorous	Eating flesh (animals).
Chaetognanth	(Chaetognatha) A phylum of abundant arrow worms.
Chemical oxygen demand (COD)	It is the amount of dissolved oxygen required to oxidise all organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant.
Chemolitho-autotroph	A type of bacteria that derives its energy from the assimilation of carbon dioxide from the oxidation of ammonia, sulphur compounds, iron compounds, methane and hydrogen.

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Glossary

GLOSSARY OF TERMS continued...

Chephalopod	(Cephalopoda) Exclusively marine organisms constituting the most advanced class of mollusca, including squids, octopuses and Nautilus.
Chlorophyll a	Refers to the green pigment in plants and algae which is fundamentally part of the process of photosynthesis. Chlorophyll is used as a measure of the amount of algae (phytoplankton) in water.
Chromatographic	Preferential absorption of chemical compounds (gases or liquids) in an ascending molecular weight sequence onto a solid adsorbent material, such as activated carbon, silica gel or alumina.
Ciliate	(Ciliatea) Refer to the single class of protozoan subphylum Ciliophora.
Clarity	Refers to the depth to which light can penetrate in a water body.
Coastal zone	For the purpose of these documents, it refers to coastal marine waters.
Cochlear zone	A zone found on the south coast on rocky shores between the infratidal (subtidal) and lower Balanoid zone. It is named after the limpet *Patella cochlear* that forms a dense band at the low-tide mark.
Coelenterate	(Coelenterata). A phylum of the Radiata whose members typically bears tentacles and possess intrinsic nematocysts.
Colloidal suspension	A mixture of two substances, one of which, called the dispersed phase (or colloid), is uniformly distributed in a finely divided state through the second substance, called the dispersion medium (or dispersing medium). Both phases may be a gas, liquid or solid.
Continental shelf	The zone around a continent, extending from the shoreline to the continental slope.
Continuous flow bioassay	A bioassay where the test organisms are kept in a flow-through system where the water has a particular concentration of the substance/s to be tested for.
Copepod/s	(Copepoda). An order of crustaceans, containing free-living, parasitic and symbiotic forms.
Coriolis force	A velocity-dependent pseudo force in a reference frame which rotates with respect to an inertial reference frame. It is equal and opposite to the product of the mass of the particle on which the force acts and its Coriolis acceleration.
Crustaceans	Animals having joint feet and mandibles, two pairs of antennae and segmented, chitin-encased bodies, including lobster and prawns.
Cyst	A normal or pathogenic sac with a distinct wall, containing fluid or other material.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Demersal fish	Fish living near or at the bottom of the sea.
Depuration rate	Rate at which bivalves loose accumulated substances.
Desorption	Detachment of molecules or ions from a substrate by manipulation of electrical charge or pH.
Detritivore	Any animal that feeds on loose organic material (detritus) removed directly from the water or that collects on the substratum at the bottom of the sea.
Diarrhetic shellfish poison	Algal toxin causing gastrointestinal problems.
Diatoms	The common name for a group of micro-algae, noted for their symmetry and sculpturing of siliceous cell walls.
Dinoflagellate	An order of flagellate protozoan, most members having fixed shapes determined by thick covering plates.
EC	Electrical conductivity.
EC_{50}	Effective concentration where 50% of the test organisms die.
Ecosystem	A functional system which includes the organisms of a natural community together with their abiotic environment.
EEC	European Economic Community.
El Nino	A warm current setting south along the coast of Peru generally developing during February to March concurrently with a southerly shift in the tropical rain belt.
Ephemeral	Carries water only during or immediately after rainfall or snow melt.
Epidemiological	(Epidemiology) The study or science of diseases in a community.
Epiphytes	Plants which grow non-parasitically on another plant or on some non-living structure, deriving moisture and nutrients from the air.
Epipsammic	Attached to sand particles.
Euphotic zone	The surface water layer up to a depth where 1% of the surface illumination still penetrates.
Euryhaline	In marine organisms, indicating the ability to tolerate a wide range of salinities.
Eutrophication	Excessive algal or plant growth caused by high nutrient concentrations.

GLOSSARY OF TERMS continued on next page

GLOSSARY OF TERMS continued...

External behaviour response	An external, as apposed to physiological response, to changes in water quality such as abnormalities in migration patterns, movement or swimming speed.
Facultative	Having the ability to live under different conditions.
Filter feeder	An organism that uses complex filtering mechanisms to trap food particles suspended in water, e.g. mussels and oysters.
Fitness for use	The suitability of the quality of water for one of the following five recognised uses: domestic use, agricultural (mariculture) use, industrial use, recreational use and water for the natural environment.
Flora	Plant life characterising a specific geographic region or environment.
Fauna	Animal life characterising a specific geographic region or environment.
Fecundity	The number of eggs produced by an individual or species.
Gas chromatography	A separation technique whereby a sample is distributed between two phases. One of these is a stationary bed of large surface area, and the other a gas (carrier gas) which percolates through the stationary phase.
Gastropod	(Gastropoda) A large morphologically diverse class of the phylum Mollusca, comprising, for example, the limpets and abalone.
Geotactic	Locomotion response to gravity.
Gram-positive	Refers to bacteria which hold the colour of the primary stain when treated with Gram's stain.
Gravid	Pertaining to a female animal when carrying young or eggs.
Grazers	Animals which feed of larger plant material, e.g. algae and kelp, such as abalone.
Herbivore	An animal that eats only vegetation or plant material.
Heterotrophic	Obtain nourishment from the ingestion and breakdown of organic matter.
High performance liquid chromatography	A separation technique in which the sample is introduced into a system of two phases. Differences in the distribution shown by the solutes cause them to travel at different speeds in the system. The mobile phase is a liquid.
Hydride generation cold-vapour method	A method where a volatile hydride is formed and decomposed thermally to enable measurement by atomic absorption.
Hydroid	(Hydrioda) An order of coelenterates, including colonial forms, with well developed polyp stages.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Hydrolysis Decomposition or alteration of a chemical substance in water.

Hyper- Excessive, exceeding, above, over.

Hypo- Low, under, below.

Hypoxia Lack of sufficient oxygen.

Humic substances A general category of naturally occurring, biogenic, heterogeneous organic substances that can be characterised as being yellow to black in colour, of high molecular weight, and refractory. There are three major fractions of humic substances, i.e. humin (not soluble in water at any pH), humic acid (not soluble in water under acidic conditions, pH below 2, but becomes soluble at greater pH) and fulvic acid (soluble in water under all pH conditions).

Iodometric titration Titration performed with a standard solution of iodine.

Industrial uses For the purpose of these documents, industrial use of seawater means 'water that is taken from the sea to be used in industrial processes or to be processed for a particular use outside the sea'. Industrial uses of seawater therefore include:

- seafood processing;
- salt production;
- desalination;
- water supply to commercial aquariums/oceanariums;
- harbours/ports (excluding recreational use, mariculture practices, natural environment - these will be addressed elsewhere);
- cooling water;
- ballast water;
- coastal mining;
- make-up water for marine outfalls;
- exploration drilling;
- scaling and scrubbing.

Infratidal (Subtidal) Defined as the zone seaward from the spring-tide low-water mark to a water depth of about 10-20 m.

In situ In the original location.

Intertidal The zone between the spring-tide low-water and spring-tide high-water mark.

Invertebrate An animal lacking a backbone and internal skeleton.

Ionic strength A measure of the average electrostatic interactions among ions in an electrolyte.

Isopod (Isopoda) An order of crustaceans characterised by a cephalon bearing one pair of maxillipods in addition to the antennae, mandibles and maxillae.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Lachrymal fluid	Tear-like fluid.
LC_{50}	Lethal concentration which brings about a 50 % mortality in an experimental population exposed to the substance.
LC_{5}	Lethal concentration which brings about a 5 % mortality in an experimental population exposed to the substance.
LC_{95}	Lethal concentration which brings about a 95 % mortality in an experimental population exposed to the substance.
LC_{100}	Lethal concentration which brings about a 100 % mortality in an experimental population exposed to the substance.
LD_{50}	Lethal dose which brings about a 50 % mortality in an experimental population exposed to the substance.
Longshore drift	Movement of materials by currents, caused by waves, that set parallel to the shore; usually within the nearshore region in the breaker zone.
Limpet	Several species of gastropod molluscs which have a conical and tent-like shell with ridges extending from the apex to the border.
Lipophylic	Refers to a substance that is soluble in a lipid.
Littorina zone	The highest zone on rocky shores with only a few species of plant and animal life. The tiny gastropod Littorina is very abundant.
Macrophytes	Refers to macroscopic forms of aquatic plants and includes of algae and aquatic vascular plants.
Mariculture	For the purpose of these documents, the mariculture use includes the official mariculture practices along the South African coast (including future possibilities): - seaweed; - molluscs - bivalves; - molluscs - gastropods; - crustaceans; - finfish.
Mesozooplankton	Organisms which take the of animal plankton for part of their life cycle.
mg l^{-1}	Milligrams per litre.
mm TL	Millimetres total length.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Monocyclic	Refers to a molecule that contains one closed ring.
Motor activity	Locomotion.
Natural environment	For the purpose of these documents, the word Natural Environment is used as the collective word to describe the natural plant and animal life of the sea, subdivided into three trophic levels: - primary producers; - primary consumers; - secondary consumers.
Nematode	A segmented worm.
Neritic	Refers to the region of shallow water adjoining the coast, extending from the low-water mark to a depth of about 200 m.
Norm	Yardsticks by which changes in water quality can be measured.
NTU	Nepheloretic turbidity units in which the turbidity of water is measured.
Nudibranches	(Nudibranchia) Molluscs lacking a shell and a mantle cavity, while the gills vary in size and shape.
Nutrient type distribution	Refer to the distribution of a chemical constituent in the sea. This distribution exhibits surface depletion and bottom enrichment as a result of the involvement of the constituent in biogeochemical cycles.
Offshore drift	Movement of materials by currents flowing away from the shore.
Oligochaete	(Oligochaeta) A class of the phylum Annelida, including worms that exhibit both external and internal segmentation and setae which are not borne on parapodia.
Omnivorous	Eating both animals and plant material.
Oocytes	Eggs before the completion of maturation.
Opisthobranches	(Opisthobranchia) A subclass of to the class Gastropoda containing he sea hares, sea butterflies and sea slugs, generally characterised by having gills, a small external or internal shell and two pairs of tentacles.
Optimum range	Most favourable range.
Osmolarity	The molarity of an ideal solution of a undissociated substance that exerts the same osmotic pressure as the solution being considered.
Oviposition	The laying of eggs.

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GLOSSARY OF TERMS continued...

Oxic	Sufficient oxygen availability.
Oyster belt	A zone found on rocky shores along the east coast of South Africa between the Littorina and upper Balanoid zones.
Ozonation	Disinfection using ozone, an oxidising agent.
Palaearctic	Refers to animals migrating from the Arctic regions.
Pluteus	A free-swimming larvae of sea urchins and brittle stars.
Paralytic shellfish toxin	Algal toxin which may cause neurological effects.
Pathogen	(Pathogenic) Causing disease.
Pelagic	Living in the water column in contrast to living on the bottom of a water body.
Peptides	A compound of two or more amino acids joined by a peptide bond.
Phosphatisation	Forming a phosphate coating on a metal.
Phospholipids	Any of a class of esters of phosphoric acid containing one or two molecules of fatty acids, an alcohol and a nitrogenous base.
Phospho-nucleotides	Components of DNA.
Photodegeneration	Degradation by light e.g. ultraviolet light.
Photolysis	The use of radiant energy to produce chemical energy.
Photometrically	(Photometry) The calculation and measurement of quantities describing light, such as luminous intensity, sometimes taken to include measurement of near-infrared and near-ultraviolet radiation as well as visible light.
Photic zone	*see* Euphotic zone.
Phytoplankton	Planktonic plant life.
Plasm cortisol	A specific cell body.
Piscivorous	Feeding on fish.
Polychaete	(Polychaeta) The largest class of the phylum Annelida, distinguished by paired, fleshy appendages (parapodia) provided with setae on most segments.
Polycyclic	Refers to a molecule that contains two or more closed rings.

GLOSSARY OF TERMS continued on next page

Glossary

GLOSSARY OF TERMS continued...

Pre-ENSO	Before El Nino southern oscillation.
Primary producer	Defined as those organisms that synthesise complex organic substances using simple inorganic substances and sunlight.
Primary consumer	Defined as those organisms that primarily live off plants.
Problems	For the purpose of these documents, problems specifically refer to 'problems encountered by a particular use or user of marine water which are caused by a particular water quality property or constituent'.
Proteinaceous	Pertaining to a substance having a protein base.
Proteolytic	Catalising the breakdown of protein, usually by enzymes.
Protozoa	A diverse phylum of eukaryotic micro-organisms; the structure varies from a simple uninucleate protoplast to colonial forms . The body is either naked or covered by a cyst. Locomotion is by means of pseudopodia or cilia or flagella.
Putrescence	Rot.
Pyrolytic	Decomposition of a substance by applying heat.
Raphe-bearing valves	A slit-like line in diatom valves.
Recreational use	For the purpose of this document, recreational use is water that is used for: - full and intermediate contact recreation (swimming, water skiing, windsurfing); - non-contact recreation (boating, fishing, bird watching, etc.)
Respiratory pore axis	The axis on which the respiratory pores are situated, e.g. in abalone.
Salinity	Refers to the salt content of soil or water.
Scaling	The formation of dense coating of predominantly inorganic material formed from the precipitation of water soluble constituents.
Seasonality	Refers to changes associated with the four seasons of the year.
Secchi disc	An opaque white disk used to measure the transparency or clarity of seawater by lowering the disk into the water vertically and noting the greatest depth at which it can be visually detected.
Secondary consumer	Defined as those organisms primarily living off other animals.
Senescent algal cells	(Senescence) The study of biological changes related to ageing.

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Glossary

GLOSSARY OF TERMS continued...

Seston	Minute living organisms and particles of non-living matter which float in water and contribute to turbidity.
Site specific	Refers to conditions that are unique or specific to a certain site or location.
Solubility product	A constant defining the equilibria between solids and their respective ions in solution.
Spectrophotometry	A procedure to measure photometrically the wavelength range of radiant energy absorbed by a sample under analysis. It can be visible light, ultraviolet light or x-rays.
Spermatozoa	A mature male germ cell, also known as sperm.
Sporophyte	An individual of the spore-bearing generation in plants exhibiting alternation of generation.
Static bioassay	A bioassay where the test organisms are placed into a tank which contains substances at fixed concentrations.
Stenohaline	In marine organisms, indicating the ability to tolerate a narrow range of salinities.
Stripping voltammetr	Technique whereby the concentration and speciation of trace metals can be determined using a hanging mercury drop electrode.
Sublethal	The concentration or dose of a toxic substance below the threshold which causes death.
Substrata	The substrate on which a plant grows or to which an organism is attached.
Subtidal	Refer to *Infratidal*.
Supersaturation	Refers to a solution containing more solute than equilibrium conditions will allow.
Surf zone	The area between the landward limit of wave up-rush and the furthest seaward breaker.
Thermocline	A temperature gradient as in a layer of seawater in which the temperature decrease with depth is greater than that of the overlying and underlying water.
Threshold concentration	The highest concentration of a water quality constituent that can be tolerated before damage is done to the organism or process.
Terrigenous	Derived from land.

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Glossary

GLOSSARY OF TERMS continued...

Titrimetrically	A technique where the substance to be determined is allowed to react with an appropriate reagent added as a standard solution, and the volume of solution needed for complete reaction is determined.
Tolerable range	The extreme values (upper and lower values) that are permitted by the tolerance
Treatability	The ability and extent to which undesirable properties or constituents can be remove or converted from a water body.
Target value/range	The value or range of a water quality property or constituent where there is no known impairment of use, or significant effect on a particular water use. It is this range which describes the desirable water quality and which should be strived for.
Trochophore	A generalised but distinct free-swimming larvae found in several invertebrate groups.
Ubiquitous	Abundantly, common occurrence.
Upwelling	The phenomenon by which deep, colder and nutrient-rich ocean waters are introduced into the well-mixed surface layer.
$\mu g\ l^{-1}$	Micrograms per litre.
US EPA	United States Environmental Protection Agency.
Valency	The number of electrons required to be gained or lost by an atom to reach a state where the outermost electron shell is full.
Veliger	A mollusc larval stage.
Vitellogenin	To produce a protein which is present in the liver, which is then transported into the yolk protein.
Virus	A typical virus consists of nucleic acid (DNA or RNA) neatly rapped in a protective protein coat (capsid). The latter carries a receptor site which will attach to matching receptor sites only on certain cells. This determines the host specificity of viruses.

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GLOSSARY OF TERMS continued...

Water quality criteria	(US EPA) A designated concentration of a constituent that, when not exceeded, will protect an organism, an organism community or a prescribed water use or quality with an adequate degree of safety. (Canada) Scientific data evaluated to derive recommended limits for water uses. (Australia) Scientific and technical information used to provide an objective means for judging the quality needed to maintain particular environmental value (water use).
Water quality guideline	(South Africa) A description of the effects of changes in water quality of a water quality constituent on a recognised use in terms of selected norms. (Canada) A numerical concentration or narrative statement recommended to support and maintain designated water use. **(**Australia) Water quality guidelines translate the criteria into a form that can be used for management purposes
Water quality objective	(Canada) A numerical concentration or narrative statement which has been established to support and maintain a designated water use. (South Africa) A value, not to be exceeded, set for a specific water quality constituent in a defined water body portion or a water body, to ensure with a given measure of reliability, its agreed fitness for use. This is an achievable value determined by considering the water quality requirements of recognised water users as well as relevant physical, technological, economic and sociopolitical issues**.**
Water quality property/constituent	A chemical (or biological) substance or physical property that describes the quality of a water body. For the purpose of this document water quality refers to water quality constituent, substance or property only.
Water quality standard	(US EPA) A term used in the US EPA literature which is similar to a water quality objective. A standard connotes a legal entity for a particular reach of waterway or for an effluent.
winkle	A gastropod snail.
WHO	World Health Organisation.
Winkler Titration	A titrimetric method for determining the dissolved oxygen concentration in seawater.
Zooanthids	Colonial sea anemones.
Zooplankton	Microscopic animals which move passively in aquatic ecosystems.

APPENDIX D: INDEX

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