SECTION 4:
ENVIRONMENTAL QUALITY OBJECTIVES

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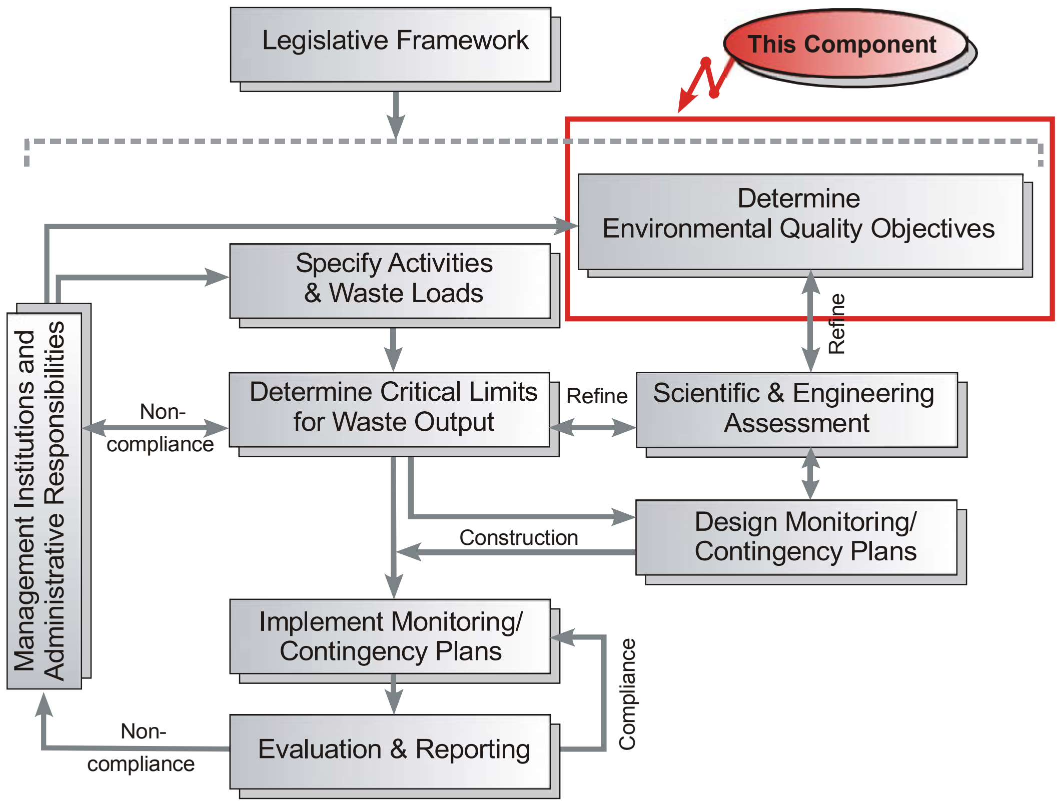

PURPOSE:

The purpose of this component is:

- ***To define the extent of the study areas (i.e. study area boundaries)***
- ***To produce a map (preferable a geo-referenced map) indicating important ecological and conservation areas and the location of the beneficial use areas in the study areas***
- ***To determine site-specific environmental quality objectives for the identified beneficial uses, as well as the ecosystem's requirements. For environmental quality objectives to be practical and effective management tools from a water quality point of view, they need to be set in terms of <u>measurable</u> target values or target ranges for specific chemical or microbiological constituents in the water column, sediment and/or biological tissue.***

4.1 IDENTIFICATION OF STUDY AREA BOUNDARIES

Definition of the extent of the area within which this management framework should be applied is very important. The extent of the anticipated influence of the proposed discharge, both in the near and far field, must be taken into account. The selection of study area boundaries is site specific, depending on the physical and biogeochemical processes, as well as the quantity and quality of waste inputs to the area. Important issues that need to be taken into account in the selection of the study boundaries include:

- Proximity of depositional areas that could result in cumulative effects associated with waste inputs to the area

- Possible synergistic effects in which the negative impact from a wastewater discharge could be aggravated through interactions with other waste inputs to the area, or with even natural processes.

Recognised and approved technologies applied by a qualified scientist, such as numerical modelling, have been successfully used to assist in the determination of study area boundaries. These models integrate physical and biogeochemical processes in the marine environment and their interaction with waste inputs over space and time, providing a quantitative means of determining the extent of significant influence.

The scope of the study area must cover the far field scale (e.g. an entire bay). For example, any estuaries that lie within the far field domain of an offshore or surf zone wastewater discharge should also be included, as these estuarine environments could possibly be the most important long-term depositional environments for the particulate loads.

Consequently, at the start of an investigation, the definition of the spatial limits of the study area and the selection of sampling locations should be carried out with reference to all existing information on physical (hydrodynamics and geophysics) and biogeochemical processes and the marine ecology, as well as the results of any predictive modelling that has already been carried out (WRc, 1990).

In the case in which wastewater disposal takes place at a particular point in an enclosed bay, it is not only important to understand the processes occurring throughout the bay, but also those at its boundaries. For example, hydrodynamic processes generated outside the bay can ultimately influence transport and fate processes inside the bay, as is the case in Saldanha Bay, a semi-enclosed bay on the west coast of South Africa.

4.2 IDENTIFICATION OF IMPORTANT ECOSYSTEMS AND BENEFICIAL USES

Measurable environmental objectives need to be set in consultation with stakeholders to ensure the successful implementation of any management plan. The identification and mapping of key marine ecosystems and beneficial uses in a particular area provide the basis for the determination of the site-specific environmental quality objectives.

In addition to identifying sensitive marine ecosystems, it is also important that designated beneficial uses be identified. The following activities are defined as beneficial uses of marine waters in South Africa (RSA, DWAF, 1995):

- recreation
- mariculture (and fisheries)
- industrial uses (e.g. abstraction of seawater for cooling and fish processing).

NOTE:

Although the South African Water Quality Guidelines for Coastal Marine Waters (DWAF, 1995) lists 'Maintenance of Ecosystems' as a beneficial use, a more recent approach is to recognise the aquatic ecosystems (e.g. marine ecosystems) as a resource that needs protection in its own right so as ultimately to support designated beneficial uses. For this reason, this document deals with the resource (i.e. 'Marine Ecosystem') and its requirements separately from the 'Beneficial uses'

The beneficial uses of a particular area should not only include existing uses, but should also take into account any future activities or uses planned for the area. An example of a beneficial use map is provided in Figure 4.1.

The following need to be considered in establishing future uses of an area:

- Strategic planning related to the study area on a national and regional/provincial level
- Local authority structure plans
- Future planning of industries and uses in the area.

Environmental quality objectives can be based on:

- National and international legal requirements e.g. target values for toxic substances in sediments in terms of the *London Convention* (refer to refer to Appendix B in *Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa: Appendices* [RSA DWAF Water Quality Management Sub-Series 13.4])

- Generic target values, e.g. as recommended in the *'South African Water Quality Guidelines for Coastal Marine Waters'* (to assist managers in setting environmental quality objectives, this set of documents was published in 1995 [RSA DWAF, 1995])

- Site-specific conditions (e.g. obtained through site-specific field measurements and numerical modelling outputs).

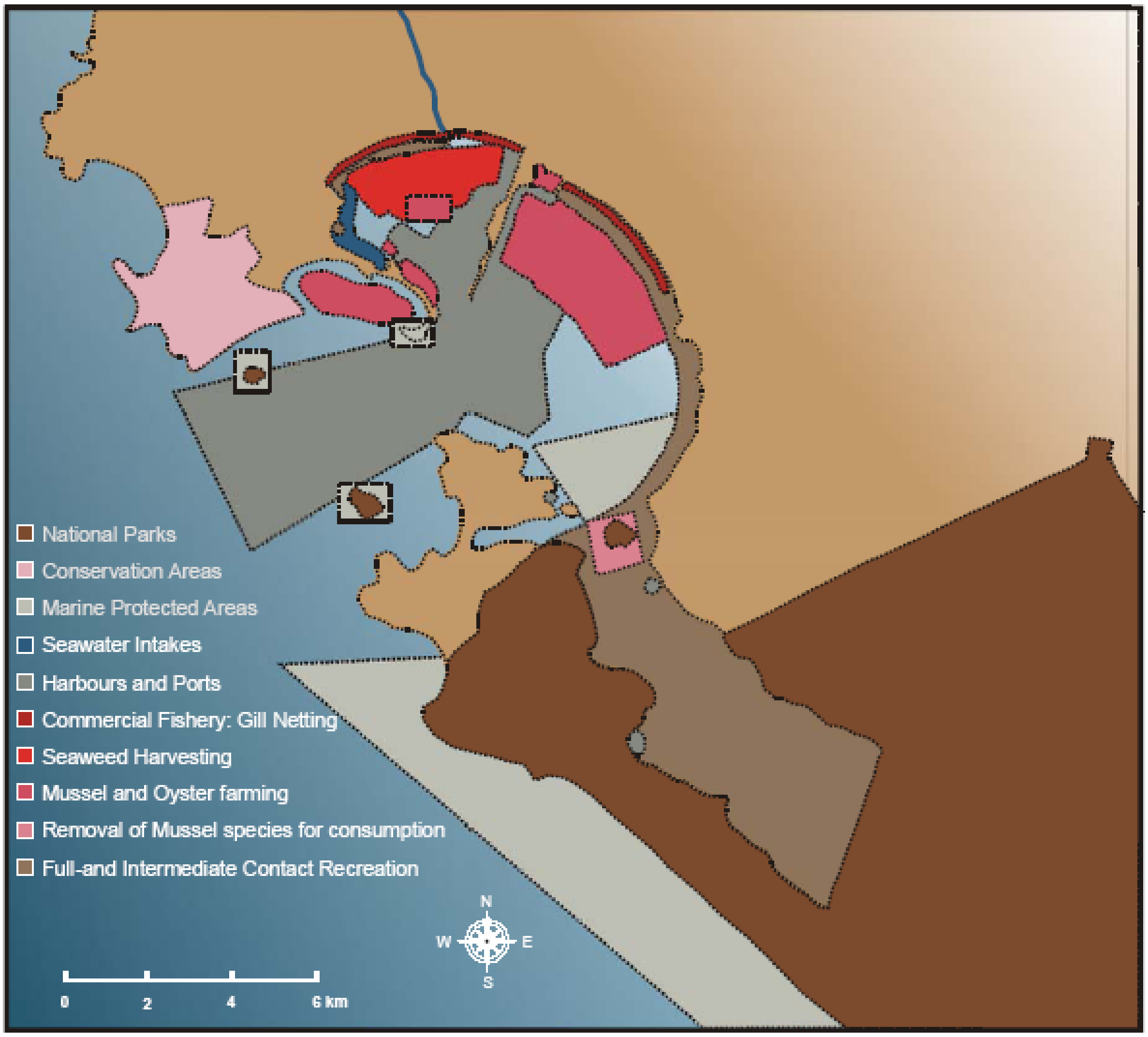

FIGURE 4.1 ***Example of a map illustrating sensitive marine ecosystems and beneficial use areas (adapted from Taljaard & Monteiro, 2002)***

Although objectives can also be set, for example, in terms of the abundance and diversity of biotic components or in terms of broad objectives for a specific beneficial use (e.g. 'safe for swimming'), such objectives need to be extended to measurable target values or ranges for specific chemical or microbiological constituents to be of use from a water quality management perspective.

NOTE:

International marine water quality guideline documents that could also be consulted in setting environmental quality objectives, (e.g. where South Africa currently does not have recommended target values) include:

- ***Australia and New Zealand (ANZECC, 2000a)***
- ***Canada (Environment Canada, 2002)***
- ***US-EPA (US-EPA, 2002a).***

4.2.1 Marine Ecosystems

The South African marine environment can be subdivided into three main biogeographical regions, each with its own climatic, physical and biogeochemical characteristics (Figure 4.2).

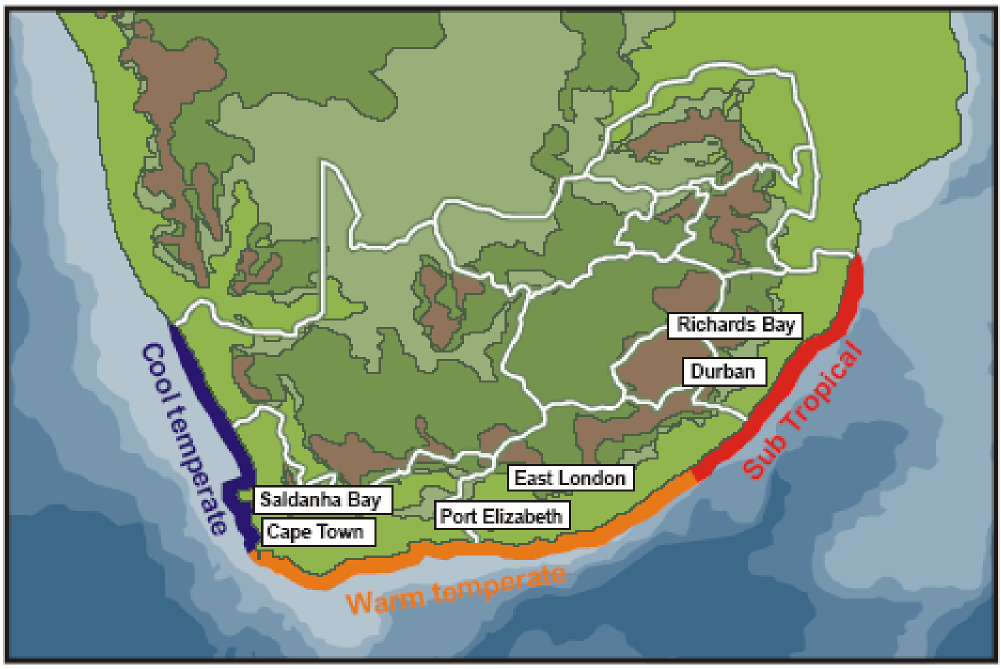

FIGURE 4.2: Biogeographical regions along the South African coast

Although marine ecosystems function as units, with no clear boundaries, the aquatic domains can be categorised to some extent into:

- Estuaries
- Surf zone areas
- Offshore marine environment.

NOTE:

Methodology for the* Determination of the Preliminary Ecological Reserve for Estuaries *(RSA DWAF 2004), issued under the National Water Act, through the Directorate: Resource Directed Measures, provides guidance on setting resource quality objectives for estuaries. To ensure alignment with these methods (or future updates thereof), they need to be consulted in setting resource quality objectives.

Within these domains, marine ecosystems typically occur in different zones, namely:

- Intertidal benthic zone (i.e. area between spring low-water mark and spring high-water mark)
- Subtidal benthic zone (i.e. sediments beyond the spring low-water mark)
- Pelagic zone (i.e. water column).

Intertidal and subtidal benthic zones comprise rocky or soft sediment substrata. Soft sediment substrata range from sandy to muddy and support a range of benthic communities.

It is important to understand the relationship between trophic levels, namely:

- Primary producers, i.e. algae and the other marine plants
- Primary consumers, i.e. organisms that primarily live off plants
- Secondary consumers, i.e. organisms that mainly live off other animals.

With regard to waste disposal activities, the impact on marine ecosystems can broadly be categorised into (RSA DWAF, 1995):

- Abnormal growth stimulation (e.g. excessive nutrients)
- Biological health (e.g. toxic compounds affecting, for example, the reproductive rate of organisms)
- External behaviour responses (e.g. pollutant affecting movement and burrowing habits of organisms).

NOTE:

In defining site-specific ecological objectives to maintain ecological integrity, the US-EPA uses the concept of balanced indigenous populations (US-EPA, 1994). A balanced indigenous population is defined as:

> **An ecological community which (a) exhibits characteristics similar to those of nearby healthy communities existing under comparable but unpolluted/unaffected environmental conditions, (b) may reasonably be expected to become re-established in the polluted water body segment from adjacent waters if the source of pollution were to be removed.**

(Balanced indigenous populations generally occur in unpolluted areas. The second part of the definition concerning re-establishment of communities is included because of its relevance to proposed improved quality of discharges and to discharges into areas that are already stressed by anthropogenic influences other than their own.)

Typical biological characteristics to be assessed in the determination of a balanced indigenous population include:

- ***Species composition, abundance (or biomass), dominance and diversity***
- ***Spatial and temporal distribution***
- ***Growth and reproduction of populations***
- ***Disease frequency***
- ***Trophic structure and productivity patterns***
- ***Presence/absence of certain indicator species***
- ***Bioaccumulation of toxic compounds***
- ***Occurrence of mass mortalities, e.g. of fish and invertebrates.***

From a water quality management perspective, it is necessary to define specific water quality requirements that need to be attained to achieve ecological objectives, for example, as defined by a *balanced indigenous population* (see note box above). Such water quality requirements need to be presented as measurable target values or ranges for specific biogeochemical constituents. In this regard, the *South African Water Quality Guidelines for Coastal Marine Waters* provides recommended target values for a range of water quality constituents to prevent negative impacts on marine ecosystem functioning (RSA DWAF, 1995).

The *South African Water Quality Guidelines for coastal marine waters* do not provide target values for organic constituents such as poly-aromatic hydrocarbons. Where these are a potential concern, target values should be established by means of chemical analysis, analysis of accumulator organisms and/or bioassays (e.g. toxicity testing). Synergistic effects (the interactive effect of numerous compounds) should also be taken into account. In principle, no parameter should exceed its local background value by more than 10% unless sufficient evidence exists to suggest that such deviations will not adversely affect marine ecosystem functioning.

The *South African Water Quality Guidelines for coastal marine waters* do not provide guidelines for setting quality objectives for sediments. Such objectives are typically determined from site-specific field measurements and numerical modelling output. Other guidelines include those of the Department of Environmental Affairs and Tourism, which provide suggested levels of ANNEX I and ANNEX II substances under the London Convention (unpublished documentation from the Department of Environmental Affairs and Tourism, Cape Town). These guidelines are particularly aimed at areas that require dredging (e.g. ports). Concentrations in sediments to be dredged and to be dumped elsewhere should not exceed the target values listed below:

ANNEX I Substances (units in ppm)

SUBSTANCE	***SPECIAL CARE***	***PROHIBITION***
Cadmium	*1.5 – 10.0*	*> 10.0*
Mercury	*0.5 – 5.0*	*> 5.0*
Combined levels of above	*1.0 – 5.0*	*> 5.0*
Organohalogens	*0.05 – 0.1*	*> 0.1*
Oils	*1000 – 1500*	*> 1500*
Persistent plastics: 4% by volume, suitably comminuted		
Radioactive materials: to be determined by the IAEA		

ANNEX II Substances (units in ppm)

SUBSTANCE	***SPECIAL CARE***	***PROHIBITION***	***AGREEMENT AT 8th CONSULTATIVE MEETING****
Arsenic	*30 – 150*	*> 150*	*1000*
Chromium	*50 – 500*	*> 500*	
Copper	*50 – 500*	*> 500*	*1000*
Lead	*100 – 500*	*> 500*	*500*
Nickel	*50 – 500*	*> 500*	
Zinc	*150 - 750*	*> 750*	*1000*
Combined levels of above	*50 – 500*	*> 500*	*1000*
Cyanides	*-*	*0.1*	*1000*
Fluorides	*-*	*-*	*1000*
Organosilicon compounds	*-*	*-*	*1000*
Pesticides	*-*	*-*	*500*

* *According to the agreement at the 8th consultative Meeting of Contracting parties to the London Convention, significant amounts for these substances were $\geq$ 0.1% by weight, or 0.5% by weight for lead and pesticides.*

Current practice in most other countries is to define what is referred to as 'List I' and 'List II' substances (refer to Appendix C in the *Operational Policy for disposal of land-derived water containing waste to the marine environment of South Africa: Appendices* [RSA DWAF Water Quality Management Sub-Series No. 13.4]). List I substances are regarded as being particularly hazardous because of their toxicity, persistence and bioaccumulation and need to be *eliminated* from wastewater discharges. List II substances, in contrast, are considered less hazardous but nevertheless have a deleterious effect on the aquatic environment. List II substances must be *controlled*. List II substances, therefore, are typically those for which specific target values need to be determined.

List I and List II substances, and associated target values are currently not available for South Africa and should be addressed in future revisions of the *South African Water quality Guidelines for Coastal Marine Waters.* The following are recommended for consideration as List I and List II substances for South Africa:

PROPOSED LIST I SUBSTANCES

Families and groups classified as List I substances are:

- *Merury: Metalloids and metals and their compounds*
- *Cadmium: Cadmium and its compounds*
- *Poly-aromatic hydrocarbons derived from industrial processes, e.g. refinements of crude oil*
- *Organohalogen compounds and substances which may form such compounds in the marine environment*
- *Organophosphorus compounds and substances which may form such compounds in the marine environment*
- *Organotin compounds and substances which may form such compounds in the marine environment*
- *Persistent synthetic materials which may float, sink or remain in suspension and which may interfere with any legitimate use of the sea*
- *Substances having proven carcinogenic, teratogenic or mutagenic properties in or through the marine environment*
-

PROPOSED LIST II SUBSTANCES

Families and groups classified as List II substances are:

- *Metalloids and metals and their compounds*

Zinc	*Selenium*	*Tin*	*Vanadium*
Copper	*Arsenic*	*Barium*	*Cobalt*
Nickel	*Antimony*	*Beryllium*	*Thallium*
Chromium	*Molybdenum*	*Boron*	*Tellurium*
Lead	*Titanium*	*Uranium*	*Silver*

- *Cyanides and fluorides*
- *Pathogenic micro-organisms*
- *Thermal discharges*
- *Substances which have, directly or indirectly, an adverse effect on the oxygen content of the marine environment, especially those which may cause eutrophication, e.g. inorganic nitrogen and phosphate*
- *Substances which have an adverse effect on the oxygen balance owing to the quantities in which they are discharged, such as particulate organic matter*
- *Crude oils and hydrocarbons of any origin*
- *Biocides and their derivatives not covered in List I.*
- *Organosilicon compounds and substances which may form such compounds in the marine environment, excluding those which are biologically harmless or are rapidly converted into biologically harmless substances*
- *Non-biodegradable detergents and other surface-active substances*
- *Substances which have a deleterious effect on the taste and/or smell of products for human consumption derived from the aquatic environment, and compounds liable to give rise to such substances in the marine environment*
- *Acid or alkaline compounds of such composition and in such quantity that they may impair the quality of seawater*
- *Substances which, though of a non-toxic nature, may become harmful to the marine environment or may interfere with any beneficial use of the marine environment owing to the quantities in which they are discharged.*

4.2.2 Beneficial Uses

i. Recreational Use

The recreational use of the coastal marine waters can be sub-divided broadly into three major groups, i.e.:

- **Full contact recreation**, referring to activities such as swimming, diving (scuba and snorkelling), water skiing, surfing, paddle skiing, wind surfing, kite surfing, parasailing and wet biking. During these activities full body contact with the water and ingestion of water is likely to occur frequently. Tidal pools are also classified as contact recreation sites

- **Intermediate contact recreation**, including activities such as boating, sailing, canoeing, wading, and angling, where users may come in contact with the water or swallow water, but to a much lesser extent than is the case with contact recreation

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

With respect to the recreational use of marine waters, the impacts of waste disposal activities can be categorised broadly into:

- Human health and safety (e.g. where bacteriological contamination can cause illnesses)
- Aesthetics or nuisance factors (e.g. pollutants causing discolouration of the sea)
- Mechanical Interferences (e.g. where floating matter damages boat propellers).

The *South African Water Quality Guidelines for Coastal Marine Waters* provides recommended target values for a range of water quality constituents relating to the recreational use of marine waters (RSA DWAF, 1995).

NOTE:

It has been proposed that the target values recommended for microbiological parameters in the South African water quality guidelines for coastal marine waters (DWAF, 1995) be revised so as to take into account recent scientific findings, as well as recent trends and developments on the international front. The guidelines should also address issues concerning day-to-day management of microbiological quality where it is often difficult to work with percentile values. For example, present monitoring programmes only provide single samples from a specific site on a particular monitoring run and it will be useful, therefore, if the guidelines could also accommodate 'single-value-cut-off' objectives (Taljaard et al., 2000).

ii. Mariculture (including harvesting of seafood) and Fisheries

Mariculture refers to the farming of marine and/or estuarine organisms in land-based (i.e. 'off-stream' tanks using pumped seawater) or water-based (i.e. 'in-stream') systems. Typically, mariculture focuses on:

- Seaweeds (e.g. *Gracilaria*)
- Molluscs (e.g. mussels and oysters)
- Crustaceans (e.g. prawns)
- Finfish (e.g. trout and salmon).

Seaweed culture is a well-established industry internationally and is used, amongst other things, to produce agars. In South Africa, attention is focused on the collection of *Gracilaria* (Saldanha Bay). Seaweeds are primary producers requiring sufficient light and inorganic nutrients to grow.

In South Africa, mollusc culture mainly comprises mussels, oysters and abalone. Mussel farming is concentrated in the Saldanha Bay and St Helena Bay areas, while oyster farming is more widely distributed, extending from Alexander Bay on the west coast, to Port Alfred along the south-east coast. Abalone farming also extends from the west coast (Port Nolloth) to immediately north of East London. Bivalves (e.g. mussels and oysters) are filter-feeding organisms, and as a result, they can accumulate pollutants and toxins during their feeding processes. Abalone is primarily fed on macrophytes (e.g. kelp) or fishmeal-based artificial food.

Efforts to culture crustaceans in South Africa are limited to the Kwazulu-Natal coast where the temperature regime is more suitable for producing prawns efficiently (i.e. warmer waters).

Although finfish farming presently is not practised extensively in South Africa, the bulk of international mariculture production is in the form of finfish.

Marine organisms, such as those listed above, are also harvested directly from the sea for human consumption. These are harvested by:

- Commercial fisheries
- Subsistence fisheries
- The general public.

With respect to mariculture activities, harvesting of seafood and fisheries, the impacts of pollution can broadly be categorised into:

- Biological health (e.g. toxic compounds affecting, for example, the reproductive rate of organisms)
- Human health (e.g. through bacteriological contamination and bio-accumulation of toxic substances)
- Aesthetics (e.g. pollutants causing tainting of seafood)
- Mechanical interference (e.g. where floating matter damages equipment).

Recommended target values for a range of water quality constituents to prevent negative impacts in water used for mariculture activities are provided in the *South African Water Quality Guidelines for Coastal Marine Waters*, which also recommend similar target values for the maintenance of marine ecosystems (RSA DWAF, 1995).

In South Africa, standards (i.e. concentration limits of constituents as required by law) controlling the quality of *fish and shellfish flesh* for human consumption are set out in the following legislation:

- Foodstuffs, Cosmetics and Disinfectants Act (Act 54 of 1972), Regulation - Marine food, 2 November 1973

- Foodstuffs, Cosmetics and Disinfectants Act (Act 54 of 1972), Regulations related to metals and foodstuffs, 9 September 1994.

In principle, these food quality standards should be met if the quality of the water from which these organisms are harvested or cultured complies with the recommended target values for mariculture, as specified in the *South Africa Water Quality Guidelines for Coastal Marine Waters* (RSA DWAF, 1995).

iii. Industrial Use

Industrial uses of the marine environment consist of numerous activities such as:

- Fish processing: In the processing of seafood, seawater in often abstracted from the sea to be used in the processing. Such waters are usually subjected to further treatment, e.g. flocculation and UV irradiation. Treatment generally consists of passing water through bar or wire screens to remove larger particles. The quality of seawater used in processing, washing and canning of seafood is critical since any water quality problems can easily be passed onto the final product.
- Salt Production: Seawater is pumped into solar ponds from where the water evaporates under the influence of wind and solar radiation.
- Desalination: Currently, desalination of seawater is not a major activity in South Africa, but in areas such as the Middle East, desalination is widely used for obtaining potable water.
- Aquariums and Oceanariums: Marine aquaria and oceanariums use large quantities of seawater pumped directly from the sea. Between 10 – 100% of the total tank volumes may be replaced daily.
- Harbours and Ports: Harbours and ports are primarily industrial entities which, as a result of their sheltered nature, tend to accumulate pollutants. Of particular concern in harbour areas in which regular dredging is required, is the chemical contamination of sediments. Areas that require dredging need to meet guidelines provided in terms of ANNEX I and ANNEX II substances under the London Convention (refer to Section 3 for details). Dredging operations are governed by the London Convention, which is given legal effect in South Africa by the Dumping at Sea Control Act 73 of 1980.
- Cooling water: The intake of seawater for cooling is mainly associated with conventional and nuclear power plants (e.g. Koeberg Nuclear Power Station).
- Ballast water: Intake of ballast water, used for vessel trim, stability and manoeuvrability, usually occurs inside harbours and ports.
- Coastal Mining: Coastal mining includes activities such as diamond mining along the west coast of South Africa which abstracts seawater for use in various processes.
- Make-up water for marine outfalls: In the operation of some offshore marine outfalls, seawater is used as make-up water to ensure the proper hydraulic functioning of the outfall system.
- Exploration Drilling. This use mainly refers to oil and gas exploration drilling operations, which generally occur in the offshore marine environment.
- Scrubbing and Scaling: There are industries that use seawater, for example, to scrub smoke stack emissions (e.g. Alusaf in Richards Bay). Seawater is pumped to the top of the stacks and the smoke emissions are passed through the seawater to remove (‘scrub’) dust particles.

With respect to the industrial uses of seawater, the impact of waste disposal activities primarily relate to:

- Human health (e.g. where contaminated seawater may be used for food processing)
- Aesthetics (e.g. tainting of seafood during processing)
- Biological health (e.g. health of animals in oceanariums)
- Mechanical and process interferences (e.g. through the clogging of filters).

The *South African Water Quality Guidelines for Coastal Marine Waters* provide recommended target values for a range of water quality constituents relating to the industrial uses of marine waters (RSA DWAF, 1995).