UN-WATER THEMATIC PRIORITY AREA ON WATER QUALITY

SMALL SCALE FUNDING AGREEMENT

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SCOPING STUDY

INTERNATIONAL WATER QUALITY GUIDELINES FOR AQUATIC ECOSYSTEMS

Report

Vienna, 25th January 2012

DISCLAIMER

The scoping study was commissioned by the UN-Water Thematic Priority Area (TPA) on Water Quality under the direction of the United Nations Environment Programme (UNEP) through a small-scale funding agreement between UNEP and Vienna University of Technology - Institute for Water Quality, Resources and Waste Management. Nevertheless, members/partners of the TPA, including UNEP, are not responsible for the accuracy of the information contained in this report and they do not necessarily share or affirm any opinions expressed therein.

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The scoping study was carried out at Vienna University of Technology - Institute for Water Quality, Resources and Waste Management (IWAG-TU) with the guidance of Prof. Helmut Kroiss, Prof. Norbert Kreuzinger and Prof. Matthias Zessner.

Dr. Paul T. Yillia coordinated the study and presented various aspects of the findings at three international water events, namely: i) 2011 World Water Day (Official Ceremony) Cape Town, South Africa (Workshop on *International Water Quality Standards/Guidelines for Aquatic Ecosystems*); ii) 2011 World Water Week in Stockholm, Sweden (Workshop on *Which Water Quality for Which Uses? A Regulators' and Practitioners' Perspective*) and; iii) EQSPAE – 2011 (*International Conference on Deriving Environmental Quality Standards for the Protection of Aquatic Ecosystems*), Hong Kong, China. The organizers of the three events and the conveners of the workshops are acknowledged for facilitating oral presentation and discussion of the findings of the study. Thanks also to various speakers from different parts of the world for their presentations and/or comments on water quality standards/guidelines during those events. Their remarks significantly augmented the content of this report.

Most of the reference information used in the study was sourced from water quality guidelines documents and related reports that are available free of cost on the World Wide Web. The original authors and the institutions/organizations that own the documents are acknowledged accordingly.

This report was prepared by Dr. Paul T. Yillia with technical support and contributions from various personnel at IWAG-TU. It was revised in response to comments from Dr. Thomas Chiramba and Ms. Elizabeth Khaka (UNEP).

LIST OF ABBREVIATIONS AND ACRONYMS

ANZECC:	Australian and New Zealand Environment and Conservation Council
ARMCANZ:	Agriculture and Resource Management Council of Australia & New Zealand
CCME:	Canadian Council of Ministers of the Environment
CRS:	Congressional Research Service (United States of America)
CWA:	Clean Water Act (United States of America)
DWAF:	Department of Water Affairs and Forestry (South Africa)
EPA:	Environmental Protection Agency (United States of America)
EQG:	Environmental Quality Guidelines (Canada)
EQS:	Environmental Quality Standards
EU:	European Union
EV:	Environmental Value
ILO:	International Labour Organization
MNHW:	Minister of National Health and Welfare (Canada)
NASWM:	National Agenda for Sustainable Water Management (New Zealand)
NHMRC:	National Health and Medical Research Council (Australia)
NIWA:	National Institute of Water and Atmospheric Research (New Zealand)
NWQMS:	National Water Quality Management Strategy (Australia)
PPP:	Polluter Pays Principle
SSFA:	Small Scale Funding Agreement
TPA:	Thematic Priority Area on Water Quality (UN-Water)
TWQR:	Target Water Quality Range
UN:	United Nations Organization
UNEP:	United Nations Environment Programme
US:	United States of America
USD:	United States (of America) Dollar
WFD:	Water Framework Directive (European Union)
WHO:	World Health Organization
WSSCC:	Water Supply and Sanitation Collaborative Council
WWD:	World Water Day
WWW:	World Water Week (Stockholm, Sweden)

EXECUTIVE SUMMARY

In September 2010, UN-Water established a thematic priority area (TPA) on water quality to enhance interagency collaboration on water quality and support governments in addressing global water quality challenges. The TPA recognizes the importance of guidelines/standards in achieving water quality objectives and providing a regulatory basis to prevent and control pollution in aquatic ecosystems. It is aware that some initiatives have already been taken to develop guidelines/standards in some countries but no such initiative has occurred at the global level. A major task of the TPA is to develop 'international' water quality guidelines for aquatic ecosystems, which could be applied or adapted at the global level. As a foundation for this undertaking, the TPA commissioned a scoping study in March 2011 under the direction of UNEP with the aim of providing an overview of existing water quality standards/guidelines for aquatic ecosystems and developing a plan to develop "international" water quality guidelines for aquatic ecosystem, as well as identifying the technical working group(s)/experts that would be required for the undertaking.

The scoping study examined the water quality guidelines/standards of several countries, including Australia & New Zealand, Canada, South Africa and the United States, as well as one region, namely, the European Union. The study established that those guidelines/standards can serve as stimulus for the TPA's initiative to develop 'international' guidelines for aquatic ecosystems. This report provides a conceptual framework of water quality guidelines within which the features of the proposed guidelines for aquatic ecosystems can be applied. A distinctive element of the framework is the specification of guidelines for human use-related values, each providing specific water quality objectives and the information to make judgments on the fitness of water for various uses. It is inferred that developing ecosystem guidelines within a broader framework of water quality guidelines is indispensable as water quality guidelines are typically developed in the context of human use-related values. Nevertheless, guidelines for human use-related values such as drinking-water, recreational water use, agricultural water use are not to be developed within the current arrangement as some of them like drinking-water and recreational and agricultural uses have been developed already at the international level.

It is suggested in this document that the main features of the proposed guidelines for aquatic ecosystems could be displayed as interconnected chapters and supporting documents. For example, the contents of the entire guidelines when they are developed shall be summarized in a section, preferably the introduction, to help readers understand and use the guidelines and its supporting texts correctly. It shall describe the layout of the guidelines and support documents to ease user identification of various sections in the document and the relevant

materials connected to them. Volume I of the proposed guidelines shall comprise the main part of the document. It should provide the framework for water resource management, and an outline of water quality guidelines for aquatic ecosystem, with trigger values and/or descriptive statements, and the context within which they can be applied. Supporting documents can be released in Volume II. It is proposed that support documents should be developed as accompanying texts to facilitate understanding and use of the main text. Supporting documents may include, for example, protocols and other documents that will aid implementation and/or adaptation of the guidelines for site specific criteria in different regions.

The guidelines development process can be achieved through a multitier approach with several simultaneous undertakings in three main parts, from development to adaptation/application of the guidelines. Part I (Pre-development Phase) could commence with an initiation period for strategic planning and consensus building. Action to establish a guidelines secretariat could be initiated already during this period to mobilize resources and international support for the entire process. Part II (Development Phase) could focus exclusively on guidelines development, which should be initiated through multiple consultations and accomplished through meetings of various Technical Working Groups. Part III (Post-development Phase) could entail promotion of the guidelines for their application and/or adaptation for local use. This may possibly include promotion and dissemination, capacity development, as well as monitoring and evaluation, which should ultimately lead to the revision and upgrade of the first edition. It is advisable that throughout the process, the proposed Technical Working Groups described in this document should work simultaneously to optimize output. Their activities may be coordinated by a technical advisory committee and facilitated by the guidelines secretariat and a steering committee, comprising members of the TPA. The terms of reference for the various committees are provided in this report.

When they are eventually developed, the guidelines should not be seen as blanket values or statements for international regulation on water quality. Instead, they should aim at providing a framework by assembling information and guiding principles for planning and management to help managers establish and achieve water quality objectives locally. It is very likely that the process for developing the guidelines could last for a minimum four to five years to produce the first edition. Therefore, it is advisable to manage the process in relatively small work packages with interim results that must be evaluated within short cycles. Throughout the process, substantial financial resources and human capacity will be required, and for this collaboration at various levels will be crucial. There is no doubt that the undertaking is going to be challenging but it can be done and in many ways it can be argued that it has to be done, considering the current state of the world's aquatic ecosystems and the associated risk to human health.

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1. INTRODUCTION

1.1. Background

Water shapes and sustains life on Earth, and as a matter of fact, living systems cannot develop without water, making it a necessity for all living things and for many human activities as well. This inescapable dependence on water has led to the notion of a "general right to water for all living systems". This has been expressed variously as "human right", "water right" or "right of natural systems", which has to be respected by sharing available water resources in an equitable manner for all generations. But, always, the use of water by living systems, human beings in particular, has consequences on water quality and quantity. In addition, both quality and quantity issues affect the availability of water for human use and the needs of ecosystems. The ultimate goal of formulating water quality guidelines/standards is to share and use water judiciously, with a special focus on achieving a suitable compromise on water quality and quantity issues for various human uses, while at the same time maintaining the requirements of ecosystems in a sustainable way. Water quality guidelines/standards are indispensable tools for effective monitoring and regulation of anthropogenic uses to protect aquatic ecosystems and human health, and safeguarding water resources for present and future generations. They are the basis of any water quality-based pollution control programme on aquatic ecosystems. Water quality guidelines/standards define the management objectives for a water body by identifying its values, designating its uses and setting criteria (including the standard of judgment/principle for evaluation) to measure the accomplishment of those values/uses. In addition, guidelines/standards can also provide guidance to water quality managers and regulators, and support laws/policies to protect water quality from pollutants based on data and sound scientific judgment of pollutants and their effects on the environment and people.

In the last few decades, progressive developments in scientific principles and methodologies, as well as policy deliberations have improved the derivation and application of various types of water quality guidelines in different parts of the world. Currently, the UN-Water Thematic Priority Area (TPA) on Water Quality is leading a global initiative to develop guidelines for aquatic ecosystems that can be adapted or applied globally for various water management scenarios. As a mechanism of UN-Water, the TPA advocates action on water quality at the international level. The TPA is chaired by UNEP, which is charged with the responsibility of coordinating its activities. The origin of the TPA dates back to an international gathering on World Water Day (WWD) in 2010, which focused primarily on the global water quality challenge. Several UN-Water members and partners at that meeting joined efforts to raise

awareness about the urgent need to address water quality challenges, and encouraged governments, organizations, communities and individuals around the world to act immediately. Consultation between some members and partners of UN-Water during that meeting recommended that UN-Water builds on its achievements in the area of water quality and establish a mechanism to maintain those achievements. In particular, the consultations recommended a broader approach to the global water quality challenge, with UN-Water as the forerunner through a longer-term perspective. Consequently, a thematic priority area on water quality was constituted in September 2010 to enhance interagency collaboration on water quality and support governments and relevant organizations address water quality challenges.

Upon the endorsement of the scope of work for the TPA, the first step was to outline its activities. Among the activities was a mapping exercise, which was accompanied by a needs assessment survey. It emerged from the survey that water quality guidelines for aquatic ecosystems with an international dimension do not exist to assist governments and water quality management institutions tackle water quality challenges. This deficiency is seen as a major obstacle for most governments and international organization, especially in developing countries to effectively address water quality problems at the local level. This necessitated a scoping study on water quality guidelines for aquatic ecosystems. The scoping study is a core activity of the TPA. The study was commissioned in March 2011 under the direction of UNEP through a Small-Scale Funding Agreement between UNEP and the Institute for Water Quality, Resources and Waste Management (IWAG-TU) at Vienna University of Technology in Austria.

1.2. Purpose of the Scoping Study

The purpose of the scoping study was to provide an overview of existing water quality standards/guidelines for aquatic ecosystems, and identify ongoing and planned initiatives to develop such standards/guidelines. The focus of the study was on the exposition of the conceptual framework and approach used in developing those guidelines rather than the reproduction and interpretation of the recommended criteria. It was expected that the scoping study will form the basis for the development of guidelines for aquatic ecosystems that will be adapted or applied at the global level. The study should compile recommendations on what is required to develop guidelines for aquatic ecosystems, establish the framework and outline of the guidelines by building on existing ones, and prepare a work plan on how the guidelines can be developed. The plan should outline the key processes involved, identify the technical working groups and expert meetings required, and prepare the terms of references for the working groups.

1.3. Scope of this Report

In the form of an introduction, the opening statements of this report describe the background and purpose of the scoping study. Subsequent sections in sequence provide details on the procedure used to generate the information that has been documented, and aspects of the main activities that were undertaken, as well as the major accomplishments of the study. Section 2 describes the scope of the literature study, the choice of documents that were examined and the method used. The main activities undertaken during the inception phase and the post-inception phase are listed in Sections 2. 3. Among the activities recorded are; i) contribution of IWAG-TU at the official ceremony of the 2011 World Water Day in Cape Town, South Africa where preliminary findings of the study were discussed; and ii) participation of IWAG-TU at the 2011 World Water Week in Stockholm, Sweden where the main findings of the scoping study and a work plan to develop the guidelines were presented. Section 3 presents the findings in three parts, i.e. i) some examples of existing national and regional guidelines for aquatic ecosystems, ii) some lessons drawn from their development and implementation and iii) some guiding concepts when developing guidelines. The outline of the proposed guidelines is previewed in Section 4, and a work plan to develop the guidelines is presented in Section 5. Specifically, Section 4.1 places the proposed guidelines within a conceptual framework of human use-related water quality guidelines such as guidelines for drinking-water and guidelines for recreational water use. An outline of the proposed guidelines with brief descriptions of the proposed chapters is provided in Section 4.2. Section 5.1 describes a comprehensive work plan for developing the guidelines. This section includes details of the basic steps and key processes involved, as well descriptions of the technical working groups and expert meetings that will be required. The terms of reference for the technical working groups is presented in Section 5.2, which is followed by a budget (Section 5.3) of the estimate costs for the major undertakings. The main conclusions and recommendations drawn from the study are summarized in Section 6, and a list of the main documents that were examined is specified in the reference section. Finally, the terms of reference for the scoping study and the implementation plan that was developed in response to it are appended in the section for appendices.

2. METHOD

2.1. Literature Study and the Selection Criteria

An online study of literature was undertaken to identify key sources of data and distinguish among different types of guidelines/standards. The literature search was internet-based and lasted for three months. The search terms were mainly key words such as “water quality guidelines”, “water quality standards”, “water quality criteria”, and names of notable water regulations and regulators. In addition, the bibliographic lists of some of the documents that were examined were further scrutinized. When this was possible, they were additionally examined to obtain supplementary information. It was originally planned that the literature study would be complemented by expert consultations and group discussions, as well as open web-based communication and e-mail correspondence. However, the last two methods were unsuccessful as it was difficult to get any satisfactory response by those means.

The selection of flagged documents was based on scope and relevance, with respect to the terms of reference of the scoping study. Therefore, the choice of any document, or any guidelines/standards for that matter, is by no means an indication of quality or the overall usefulness of the document relative to others. In reality, usefulness was evaluated on the basis of relevant information contained in the document rather than its relative importance. It must be stated that the selection criteria was influenced by inevitable limitations of the literature review exercise, in particular, the discretion of those involved in the study. For a study of this nature, it is very understandable that many useful documents that could be made available by other means were inaccessible to the investigators during the study.

2.2. Scoping for Water Quality Guidelines/Standards

A systematic examination was undertaken to make appropriate comparisons of existing water quality guidelines/standards, draw inferences and distil key lessons. Although the focus of the study was on water quality guidelines/standards for aquatic ecosystems, other water quality guidelines/standards were examined for the procedural steps taken in their development and application. It turned out eventually that this information is scarcely available.

The literature study and accompanying analysis examined three main categories of water quality standards and guidelines with examples from different countries and one region:

i. International guidelines/standards:
   e.g. WHO Drinking Water Quality Guidelines, including the framework for Safe Drinking-water (Water Safety Plan); WHO Guidelines for Safe Recreational Water Environments – Vol. 1 (Coastal and Freshwaters) and Vol. 2 (Swimming Pools and Similar Recreational Environments); WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater – Vol. 1: (Policy and regulatory aspects), Vol. 2: (Wastewater use in agriculture), Vol. 3 (Wastewater and excreta use in aquaculture), Vol. 4 (Excreta and greywater use in agriculture).
ii. Regional guidelines/standards:
   e.g. EU: Water Framework Directive; Urban Waste Water Directive; Industrial Pollution Prevention & Control; Flood Risk Directive; Nitrate Directive; Bathing Water Directive and Drinking Water Directive.
iii. National guidelines/standards:
   e.g. Australia & New Zealand Water Quality Guidelines; Canadian Water Quality guidelines; South African Water Quality Guidelines; United States Clean Water Act.

Even though the literature study tried to include all relevant information that was accessible through the internet, it should be stated that the list of guidelines presented in this document is by no means complete, considering the limitations of the process and the problems associated with accessing such information by other means.

2.3. Activities

2.3.1. Inception Phase

i. In February 2011, IWAG-TU reviewed the UN-Water TPA's Terms of Reference (Appendix I) and developed an implementation plan in response to the Terms of Reference to undertake the study. The Implementation Plan (Appendix II) was then accepted by UNEP, followed by a joint drafting and signing of the SSFA between UNEP and IWAG-TU in March, 2011. After the signing of the SSFA, IWAG-TU was briefed by UNEP through a teleconference on the terms and scope of the scoping study. Both the signing of the SSFA and the briefing took place in March 2011.
ii. IWAG-TU undertook preliminary research on water quality guidelines/standards in preparation for a UNEP workshop on water quality guidelines at the official 2011 World Water Day event in Cape Town, South Africa. On March 21 2011, IWAG-TU co-facilitated the workshop with UNEP and presented some preliminary findings of the study. The workshop provided a platform to present and discuss the background, scope, process

and expectations of the scoping study to a wider audience and seek out contributions from institutions and individual experts to guide the study.

iii. In April 2011, IWAG-TU prepared a draft inception report with own interpretation of the tasks as specified in the SSFA with the following; i) scope of the assignment in terms of content and process, ii) detailed work plan, and iii) methods to be applied. The inception report was presented to UNEP for comments and recommendation.

2.3.2. Post-inception Phase

i. IWAG-TU continued further consultations with UNEP via e-mail and telephone conversations to seek in-depth understanding of the expectations of UN-Water TPA on the scoping study, including the TPA's contribution and the envisaged process to develop them.

ii. IWAG-TU identified existing water quality standards/guidelines for the environment and ongoing and planned initiatives to further develop them. IWAG-TU collected relevant literature and analyzed the information collected, especially, on existing water quality standards/guidelines for ecosystems at the international, regional and national levels to get an overview of how they were developed and how well they meet the needs for monitoring and management of aquatic ecosystems.

iii. IWAG-TU prepared an outline that describes the proposed water quality guidelines for ecosystems, with a work plan (procedure) to develop them. The procedure outlined the process and listed the technical working groups and expert meetings required, as well as their terms of reference.

iv. IWAG-TU compiled recommendations on developing 'international' water quality guidelines for ecosystems building on the existing ones and supporting literature. The studied literature helped to consolidate the recommendations into three key areas, i.e. operation objective of the proposed guidelines, type and composition of the guidelines and the guidelines development process.

v. The findings of the scoping study and the work plan were presented by IWAG-TU at the 2011 WWW in Stockholm in August 2011. Various comments and suggestions from the participants at that meeting have been incorporated in this report.

vi. Aspects of the draft report of the scoping study were discussed at the International Conference on Deriving Environmental Quality Standards for the Protection of Aquatic Ecosystems (EQSPAE – 2011) in Hong Kong, China (3-7 December 2011). Matters discussed at that meeting regarding international collaboration to harmonize water quality guidelines were incorporated in this report.

3. FINDINGS

3.1. Stimulus for International Guidelines

The literature study and analysis examined three main categories of water quality standards/guidelines, i.e. international, regional and national. A number of water quality guidelines, which are applied at the global level for human use related values were considered valuable even if they are not directly intended to safeguard the integrity of aquatic ecosystems. The following guidelines were particularly useful for developing the proposed work plan, and establishing the recommendations and conclusions drawn in this document: WHO Drinking-water Quality Guidelines (including various revisions/editions); WHO Guidelines for Safe Recreational Water Environments – Vol. 1 (Coastal and Freshwaters) and Vol. 2 (Swimming Pools and Similar Recreational Environments); WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater – Vol. 1: (Policy and regulatory aspects), Vol. 2: (Wastewater use in agriculture), Vol. 3 (Wastewater and excreta use in aquaculture), Vol. 4 (Excreta and greywater use in agriculture). These guidelines provide direction for developing the proposed guidelines for aquatic ecosystem, especially with regards to the procedure used in developing them and the experience derived from the process. But the stimulus for developing the proposed guidelines for aquatic ecosystems may be derived primarily from national/regional initiatives as listed in the sub-sections below.

3.1.1. Australian & New Zealand Water Quality Guidelines

The Australian & New Zealand Environment and Conservation Council (ANZECC) developed water quality guidelines for marine and freshwater systems (ANZECC guidelines). The main objective is to provide an authoritative guide for setting water quality objectives required to sustain current (or likely future) environmental values (uses) for natural and semi-natural water resources in Australia and New Zealand. The guidelines are part of Australia's National Water Quality Management Strategy (NWQMS) and share New Zealand's National Agenda for Sustainable Water Management (NASWM). With the guidelines, both Governments and the general public (particularly catchment/water managers, regulators, industry, consultants and community groups) are provided with a framework and a sound set of tools for conserving and managing ambient water quality of rivers, lakes, estuaries and marine ecosystems in the two countries.

The ANZECC guidelines consist of three volumes: Volume 1 (comprising Chapters 1–7) contains the body of the guidelines with chapters on aquatic ecosystems, primary industries, recreational water, drinking water, and monitoring and assessment. It specifies the trigger values for the protection of aquatic ecosystems and the numerical criteria/guideline values or narrative statements for protection of other environmental values such as drinking water and recreation. Volume 2 (Chapter 8) provides further guidance on protecting aquatic ecosystems, and describes water quality issues, modifying factors, decision trees, toxicant profiles and biological assessment. Volume 3 (Chapter 9) provides further guidance on water quality for primary industries. In some cases, for more complex water issues, the water quality that supports the environmental values may be expressed as: i) a target load, such as for salinity or nutrients; ii) a descriptive statement, or iii) an index of ecosystem health. For example, in some coastal lakes, the proportion of lake covered by a certain type of filamentous algae may indicate the chance of a blue-green algal bloom developing.

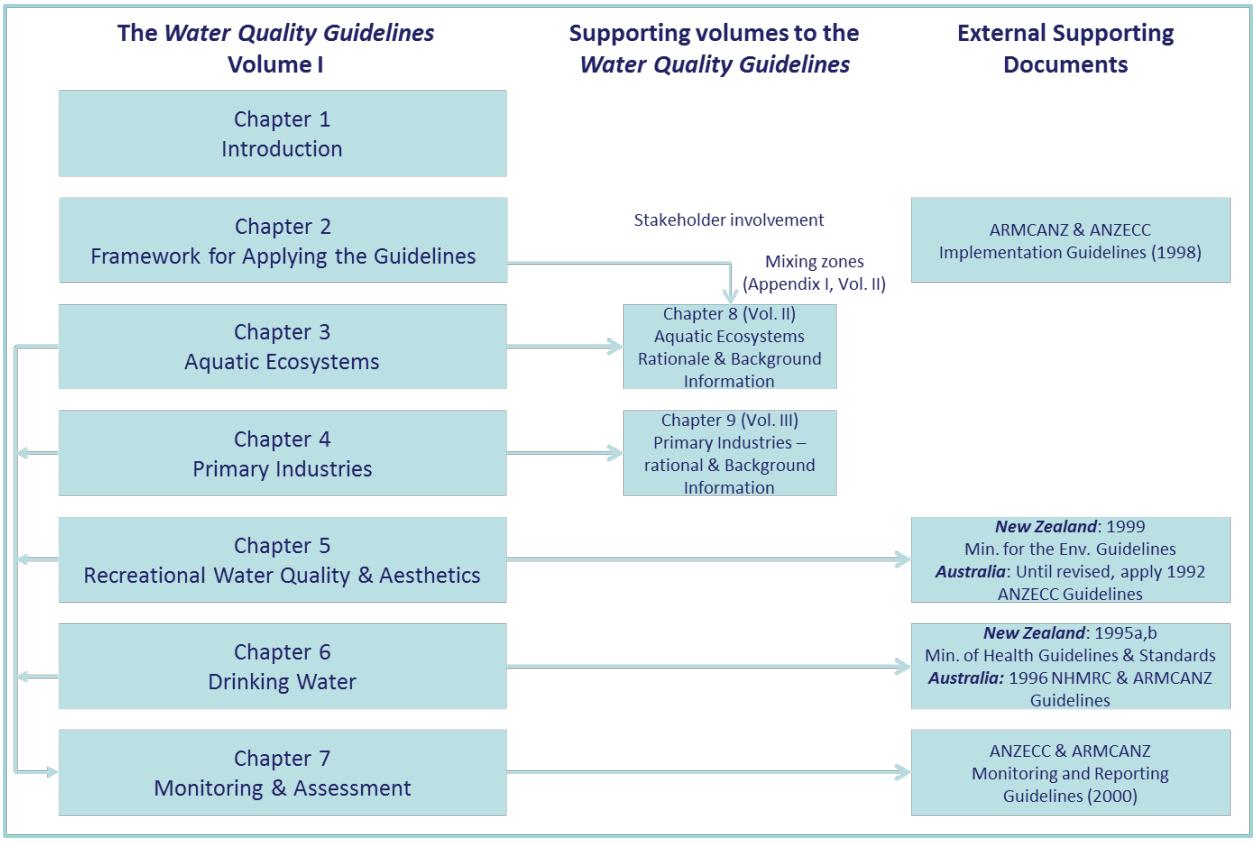

Figure 1: The Australia & New Zealand Guidelines at a glance (Adapted from ANZECC/ARMCANZ, 2000)

The ANZECC guidelines have a strong scientific basis. They were developed through a rigorous process drawing on leading scientists and resource managers in both countries. This makes them a reliable and authoritative source. They also provide a mechanism for developing guidelines for specific water bodies and they have been incorporated into relevant environmental policies, plans, legislation, and/or regulations in many jurisdictions throughout Australia and New Zealand. The ANZECC guidelines present descriptive statements, as well as numerical concentration limits that can be applied for the protection of up to six ecosystem types, as well as groundwater and guidelines for different water uses, including drinking water and recreational water. Specifically, the guidelines outline or provide the following information:

- important principles, objectives and philosophical basis underpinning the development and application of the guidelines;
- management framework recommended for applying the water quality guidelines to the natural and semi-natural marine and fresh water resources in Australia and New Zealand;
- summary of the water quality guidelines proposed to protect and manage the environmental values supported by the water resources and;
- advice on designing and implementing water quality monitoring and assessment programmes;

Like most water quality management programmes in several countries, the water management strategy of Australia and New Zealand is aimed at achieving sustainable use of water resources by protecting and improving their quality while maintaining economic and social development. Both countries follow a three-tiered approach for water quality management — i) national, ii) State or Territory, and iii) regional or catchment. Nevertheless, management of water bodies is encouraged at the catchment level. This means a critically discerning approach to setting water quality objectives is encouraged at the local level for specific local situations. State or Territory and/or local jurisdictions are encouraged to use the national water quality guidelines to formulate their own regional guidelines or specific water quality objectives. Hence, the national guidelines are not mandatory. This is sound judgment when one considers the vast range of environments or ecosystem types in Australia and New Zealand. This means the responsibility for the level of protection that should be applied to water bodies rests on the shoulders of local stakeholders and State/Territory or regional governments. In effect, each State/Territory uses its own water planning and environmental policy tools to establish a framework that is compatible and consistent with the agreed national guidelines. A similar approach is pursued in Canada for developing and implementing the Canadian Water Quality Guidelines.

3.1.2. Canadian Water Quality Guidelines

The Canadian Water Quality Guidelines provide protection of freshwater and marine life from anthropogenic stressors such as chemical inputs or changes to physical components (e.g., pH, temperature, and debris). But they also include guidelines/criteria for the protection of agricultural water uses for irrigation and livestock, raw water for drinking water supply, recreational water quality and aesthetics, and industrial water supplies. The guidelines are part of the Canadian Environmental Quality Guidelines (EQGs), which are endorsed by the Canadian Council of Ministers of the Environment (CCME). EQGs are used by federal, provincial, and territorial governments to achieve the highest levels of environmental quality across Canada. They support various legislative acts at the federal and provincial level and they may be used by territorial governments to develop point-source licenses and permits for discharges.

The Canadian guidelines for aquatic ecosystems are numerical limits or narrative statements based on the most current, scientifically defensible toxicological data available for the parameter of interest. Like all national protocols in Canada, they include minimum requirements to ensure the protection of all forms of aquatic ecosystems, and their respective uses. The guidelines are not restricted to any particular (biotic) species. This means water quality managers may determine the appropriateness of the guidelines for specific local situations. Nonetheless, a consistent approach for the protection of aquatic life is maintained. Also the protocol emphasizes best scientific judgment in all cases, so the nature of the parameter and the variation in the quality and quantity of supporting information necessitates modifications to the derivation procedures from time to time.

Canadian EQGs, in general, are not blanket values for national environmental quality management even though it is acknowledged that the use of national protocols ensures consistency, transparency, and scientific defensibility. In reality, the federal EQGs form the scientific basis upon which further site-specific criteria, guidelines, objectives, or standards are developed within the various jurisdictions. However, as variations in environmental conditions across Canada affects environmental quality in different ways, users of EQGs are advised to consider local conditions and other supporting information (e.g., site specific background concentrations of naturally occurring substances) during the implementation of EQGs. Therefore, provincial and territorial jurisdictions may have or may develop site-specific science-based environmental assessment tools (e.g., criteria, guidelines, objectives, and standards), which may differ from the recommended national EQGs Actually, the legislative authority for implementation of Canadian EQGs and other environmental assessment tools lies primarily with each provincial or territorial jurisdiction, with the exception of federal lands. Also for ecosystems of superior quality, impairment to national guideline concentrations is discouraged.

3.1.3. European Union Water Framework Directive

The Water Framework Directive (WFD) is a legal framework to protect and restore the water environment across Europe by a specified date, 2015, and ensure the long-term sustainable use of water resources in Europe. With the WFD, the EU provides instruments for the management of inland surface waters, groundwater, transitional waters and coastal waters in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts. The environmental objectives of the Directive are defined in Article 4, which has been described as the core article. Article 4.1 defines the general objective to be achieved in all surface and groundwater bodies, i.e. good status by 2015, and introduces the principle of preventing any further deterioration of status. Details of the main environmental objectives in the Directive are provided in Article 4.1, (a) surface waters, (b) groundwaters and (c) protected areas, with the following elements:

- No deterioration of status for surface and groundwaters and the protection, enhancement and restoration of all water bodies;
- Achievement of “good status” by 2015, i.e. good ecological status (or potential) and good chemical status for surface waters and good chemical and good quantitative status for groundwaters;
- Progressive reduction of pollution of priority substances and phase-out of priority hazardous substances in surface waters and prevention and limitation of input of pollutants in groundwaters;
- Reversal of any significant upward trend of pollutants in groundwaters;
- Achievement of Standards and objectives set for protected areas in Community legislation.

The normative definitions for the environmental objective of "good status" are described in great detail in Annex V of the Water Framework Directive. Taking into account the results of an intercalibration exercise, Member States are required to specify detailed values defining the status for each water body. As stated in Article 4.2, where more than one of the objectives relates to a given water body, the most stringent shall apply irrespective of the fact that all objectives must be achieved. The WFD is viewed as an invaluable source of guidance for all those concerned with water management in the European Union. Related EU Directives to the Water Framework Directive include: Urban Waste Water Directive, Industrial Pollution Prevention & Control, Flood Risk Directive, Nitrate Directive, Bathing Water Directive, Environmental Quality Standards and the EU Drinking Water Directive. All Directives must be incorporated in Member State laws and each Directive includes a date by which

implementation must be completed. Regulations of each Directive are legally binding in all Member States. Member States can be taken to court and fine them if EU legislation is not implemented. However, almost all enforcement of EU legislation occurs within the Member States even though a small number of regulations are enforced at the EU level, notably competition law. There are reports that this has often led to complaints about uneven implementation of regulations in different countries but there is no sign at the moment that Member States wish to give more power to the Commission in this area.

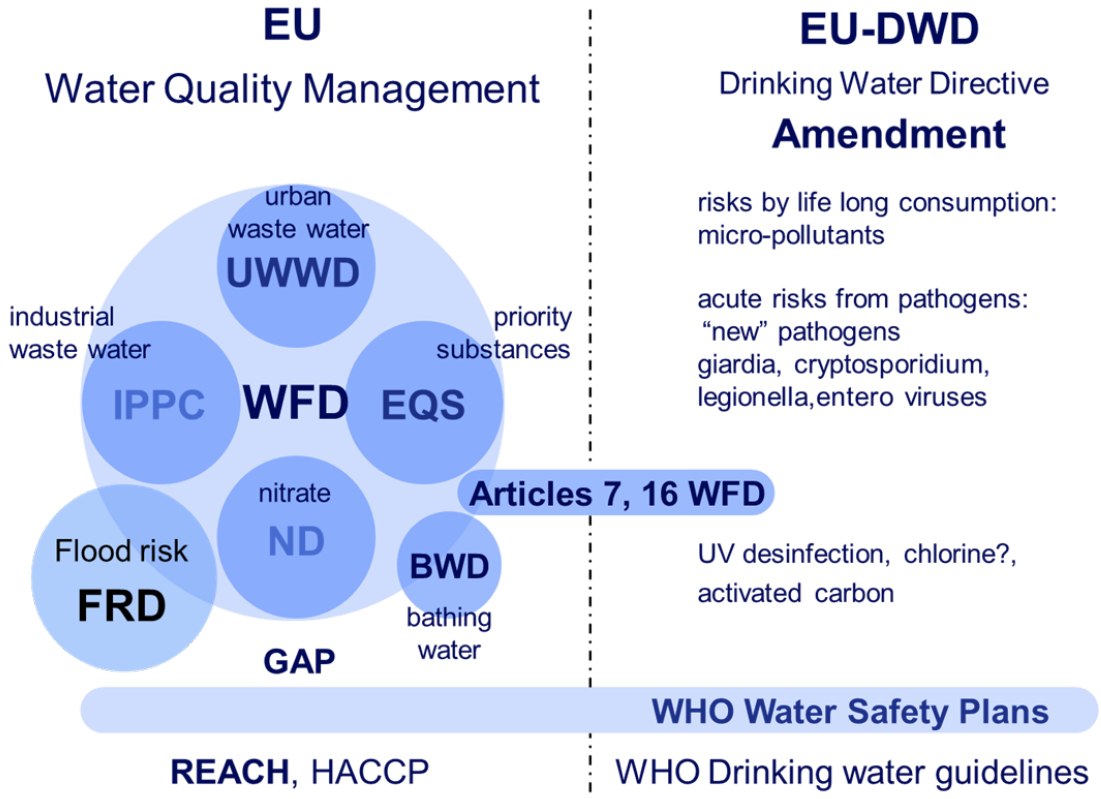

Figure 2: The European Union (EU) Water Framework Directive (WFD) within a conceptual framework of EU water-related Directives and the WHO Drinking-water Quality Guidelines - UWWD (Urban Waste Water Directive); EQS (Environmental Quality Standards); BWD (Bathing Water Directive); ND (Nitrate Directive); FRD (Flood Risk Directive); IPPC (Industrial Pollution Prevention and Control); DWD (Drinking Water Directive); REACH (European Community Regulation on chemicals and their safe use); and HACCP (Hazard Analysis and Critical Control Points).

3.1.4. South African Water Quality Guidelines

The South African Water Quality Guidelines are used as the basis for informed decisions about the physical, chemical, biological and aesthetic properties of water. Essentially, the guidelines consist of water quality criteria, in particular, the Target Water Quality Range (TWQR), and supporting information such as the occurrence of the constituent in the aquatic environment,

its effects on water uses, how these effects can be mitigated and possible treatment options. All the different TWQR for all the different water use sectors are dealt with in volumes one to seven of the guidelines. Volume 8, which can be used as a field guide, is a quick and easy reference volume for comparison of the TWQRs for different water use sectors to determine the fitness of use for water. Figure 3 illustrates the themes of the different volumes of the South African Water Quality Guidelines.

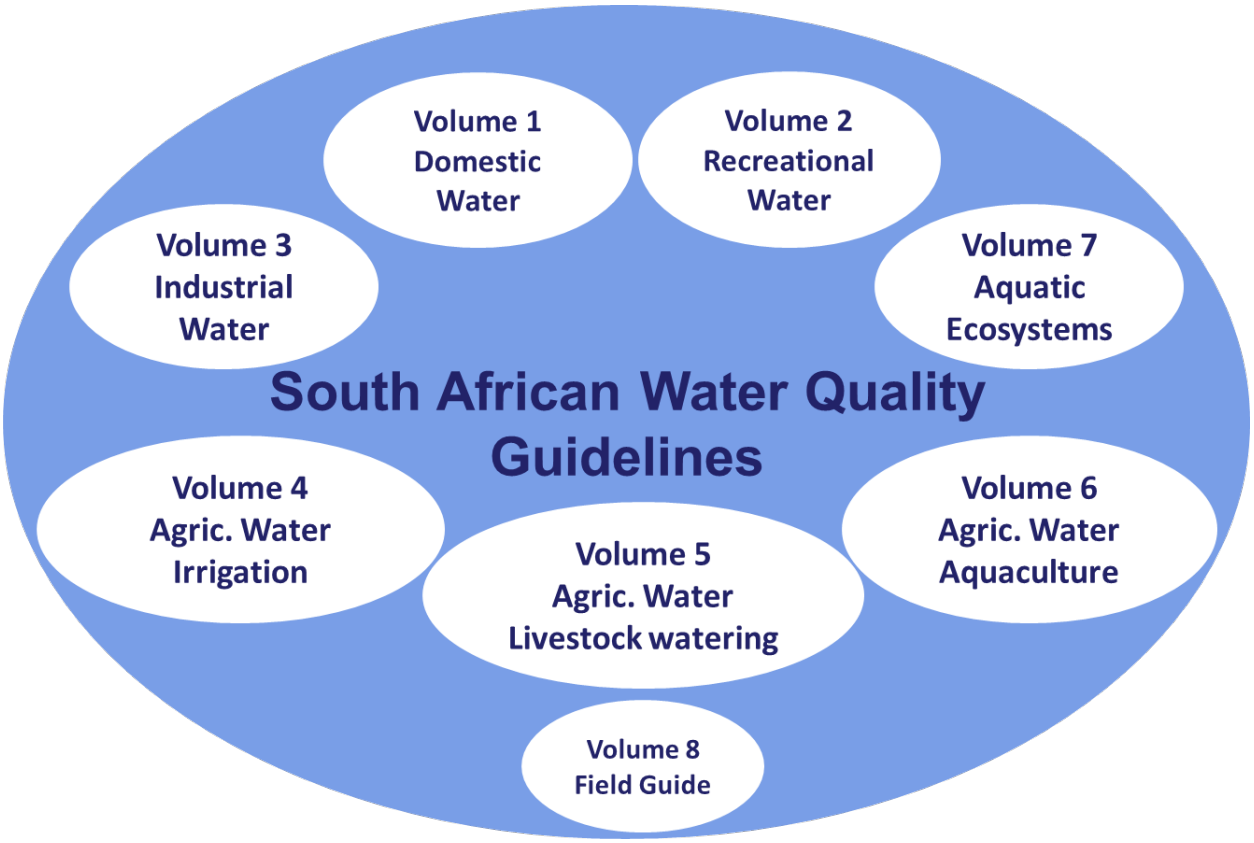

Figure 3: Previewing the South African Water Quality Guidelines – Volume 1 – 8.

Volume 8 (Guidelines for Aquatic Ecosystems) of the South African Water Quality Guidelines are used as the primary source of reference information and decision support required for the management and protection of aquatic ecosystems. Aquatic ecosystems in the guidelines are understood as the abiotic and biotic components, habitats and ecological processes contained within rivers and their riparian zones, reservoirs, lakes and wetlands and their vegetation. Since these aquatic ecosystems serve as the resource base, it is stated that they must be effectively protected and managed to ensure that water resources remain fit for agricultural, domestic, recreational and industrial uses on a sustainable basis. The guidelines are designed primarily for

use by water quality managers, educators and other interested members of the general public for whom it may serve as a valuable source of information. The document is a specification of: i) the surface water quality required to protect freshwater aquatic ecosystems; ii) quantitative and qualitative criteria for chronic and acute toxic effects for toxic constituents; iii) quantitative and qualitative criteria to protect ecosystem structure and functioning, for non-toxic constituents and system variables; iv) quantitative and qualitative criteria to protect aquatic ecosystems against changes in trophic status in the case of nutrients and; v) modifications that can be made to water quality criteria on a site-specific basis, whilst still providing the same level of protection as the original criteria.

3.1.5. United States Clean Water Act

The compilation of national recommended water quality criteria developed by the Environmental Protection Authority (EPA) contains recommended water quality criteria for the protection of aquatic life and human health in surface waters in the US for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards. The Federal Water Pollution Control Amendments of 1972 or simply the Clean Water Act as it is often called is the primary federal regulation that governs water pollution in the United States. The act was originally enacted in 1948 (i.e. the Federal Water Pollution Control Amendments of 1948). It was significantly reorganized and expanded in 1972 by further amendments (i.e. the Federal Water Pollution Control Amendments of 1972). The sweeping amendments in 1972 gave the act its current form, making it the principal body of law for water in the United States, with ambitious programs for water quality improvement that have since been expanded and implemented across the country. The US Congress made fine-tuning amendments in 1977, revised portions of the law in 1981, and enacted further amendments in 1987. Over the years, many other laws have changed parts of the Act and several bills have been enacted to reauthorize and modify a number of individual provisions in the law. However, none comprehensively addressed major programmes or requirements since the 1987 amendments.

The Act establishes the basic structure for regulating discharges of pollutants in surface waters and maintaining Water quality standards. In the US, water quality standards are risk-based requirements which set site-specific allowable pollutant levels for individual water bodies, such as rivers, lakes, streams and wetlands. States can set water quality standards autonomously by designating uses for the water body (e.g., recreation, water supply, aquatic life, agriculture) and applying water quality criteria to protect the designated uses in addition to issuing an antidegradation policy to maintain and protect existing uses and high quality waters. The goal is

to eliminate the release of high amounts of toxic substances into water bodies, eliminating additional water pollution, and ensuring that surface waters meet standards necessary for recreation under deadlines specified in the law.

The Act consists of two major parts: i) provisions which authorize federal financial assistance for municipal sewage treatment plant construction; ii) regulatory requirements that apply to industrial and municipal dischargers. Due to stringent demands placed on those who are regulated by it (in particular industries and municipalities) to achieve significant levels of pollution abatement, the Act has been termed a technology-forcing statute. In the beginning the emphasis was mainly on controlling discharges of conventional pollutants (e.g., suspended solids or organic pollution that occur naturally in the aquatic environment). In recent times, however, the key focus of water quality programmes has been the control of toxic pollutant discharges. To achieve its objectives, the Act embodies the concept that all discharges into water bodies are unlawful, unless specifically authorized by a permit, which is considered the Act's principal enforcement tool. The Act has provisions for civil, criminal, and administrative enforcement and, in addition, it permits citizen suit enforcement. It requires the Environmental Protection Agency (EPA) to review new and revised standards, approve or disapprove them, and issue federal replacement standards to correct deficiencies where necessary.

3.1.6. Other Countries

China: Water quality criteria (WQC) for surface waters in China have been formulated for the purpose of implementing the Environmental Protection Law of the People's Republic of China and the Law of the People's Republic of China on Prevention and Control of Water Pollution. The management objective is to prevent water pollution, protect surface water quality and human health and maintaining sound ecosystem functions. The standards/criteria provide legal limits needed to control surface water pollution in the country. They also include analytical methods for water quality assessment, as well as legal instruments for supervision and enforcement. They apply to all useable surface waters within the territory of the People's Republic of China, including rivers, lakes, canals, channels and water reservoirs. In recent years, various research institutions in China have undertaken standard eco-toxicity tests with native aquatic species and evaluated and advanced methods for deriving numerical water quality standards/criteria for a selection of priority substances. The results of the research efforts provide sound scientific bases for prevention, control and management of chemical pollution in river basins in China. Actually, recent research progress in the derivation of water quality criteria for various chemicals is particularly promising. The research efforts successfully led to the establishment of a technical system for environmental risk assessment of chemicals present

in aquatic ecosystems. In particular, theoretical and methodological systems have been established for deriving basin-specific water quality criteria. For example, the Interim Regulations on the Prevention of Water Pollution in the Huai River Valley aims to strengthen the water pollution prevention and control of Huai River basin, protect and improve the water quality, guarantee the people's health and ensure the water requirement for living and production. In the regulation, waters with specific functions shall apply specific water quality standards/criteria accordingly.

Notwithstanding these achievements, Chinese researchers, like many others in developing and middle income countries, are learning from well-established methods and systems currently being employed in various developed countries. By applying those methods, they are able to understand the limitations and shortcomings, and make further amendments and improvements that will eventually develop their own derivation methods and systems. In reality, some progress has been made already. For instance, a set water quality criteria for some metals, e.g. cadmium, lead and mercury have been developed for some freshwater ecosystems. Also detailed studies have been conducted on the physicochemical properties of some river systems such as Liao River and the data generated has been used to develop site-specific criteria, and also to refine the country wide interim WQC that was developed based on non-native freshwater species in China. The experience has been promoted throughout the country, with knowledge exchange and research collaboration including local and non-local scientists.

India: In India, the Central Pollution Control Board (CPCB) has developed a designated best use concept to establish water quality criteria. Five water quality classes have been designated (A-E). This was achieved on the basis of the water quality requirements for a particular use, namely: Class A - waters for use as drinking water source without conventional treatment but after disinfection; Class B - waters for use for organized outdoor bathing; Class C - waters for use as drinking water source with conventional treatment followed by disinfection; Class D - waters to maintain aquatic life (including wildlife and fisheries); and finally Class E - waters for use for irrigation, industrial cooling and controlled waste disposal. These five classes have been used to set water quality objectives for stretches of 14 major river systems in India. In the river basins of the Yamuna and Ganga, for example, site specific surveys have been carried out to compare the actual river-quality classification with that required to sustain the designated best use using water quality classes and zonation of the basins. Where a river has multiple uses, the quality objectives are set for the most stringent (best) use requirements. After comparing ambient water quality with the designated water quality objective, any deficiencies will require appropriate pollution control measures on the discharges, including discharges in upstream

stretches. The categorization of water quality management objectives based on human uses is also helpful for the planning and siting of industry. For example, no industry is permitted to discharge any effluent in stretches of rivers classified in Class A.

Japan: Different regulations exist in Japan for the conservation of aquatic life. For instance the Water Pollution Control Law aims to prevent pollution in public water areas, to protect human health and to conserve the living environment by regulating effluents discharged to public waters from factories and businesses. The water pollution control law prohibits discharge of wastewater that does not meet the effluent water quality standards and provides for punishment of those who violate the standards. The Law protects the victims of such discharge by assessing liability against factory and business owners who are responsible. Aquatic systems under control are generally public water bodies, i.e. rivers, lakes, ponds, ports, coastal areas and their connecting channels used for public purposes. There are also other related laws, e.g. the River Law, the Water Supply Law and the Law Related to the Prevention of Marine Pollution and Maritime Disaster. The River Law, in particular, covers aspects of effluent discharge and river administration, namely flood control, damage mitigation, water resources utilization and development, land and river water administration, including river zone and water user permission systems, and fluvial environment conservation. The ultimate goal of the River Law is to contribute to land conservation and the development of the country by administering rivers properly and maintain the normal functions of the river water to protect public security and promote public welfare. The recent amendment or reinforcement of the River Law also includes fluvial environment conservation as a clear objective of the river administration. The River Law is supported by corresponding government ordinances, Ministry of Land, Infrastructure and Transport ordinances and other orders and regulations. The term “river” as used in the Law comprises facilities of the river, which include a dam, weir, sluice, levee, revetment, groundsill fluvial woods or any other facility which increasing public benefits or cause public losses that may be caused by a river. The regulatory frameworks for ecological risk assessment and management of chemicals in Japan have been introduced since 2003 with the establishment of Environmental Quality Standards (EQS) for aquatic ecosystems. Using the existing framework for "conservation of the living environment," fish and shellfish are identified as major targets for conservation and other organisms such as invertebrates (other than shellfish) and algae should also be conserved as their "food" organisms. Criteria values for three types of water-bodies and for special areas for breeding have been derived based on ecotoxicological studies. For setting standards to prevent harms to aquatic organisms, acute effects of chemicals on fish, invertebrates and algae have been examined since 2005 and the standards have been updated regularly as additional information on water quality becomes available. While maintaining the

fundamental framework, possible improvements to the protocol for deriving criteria have been discussed. In August 2010, the Central Environment Council was asked to consider the establishment of criteria that includes additional priority substances. Since then eight new substances have been considered as priority substance, including nonyphenols and octylphenols, and additional criteria values have been established for them.

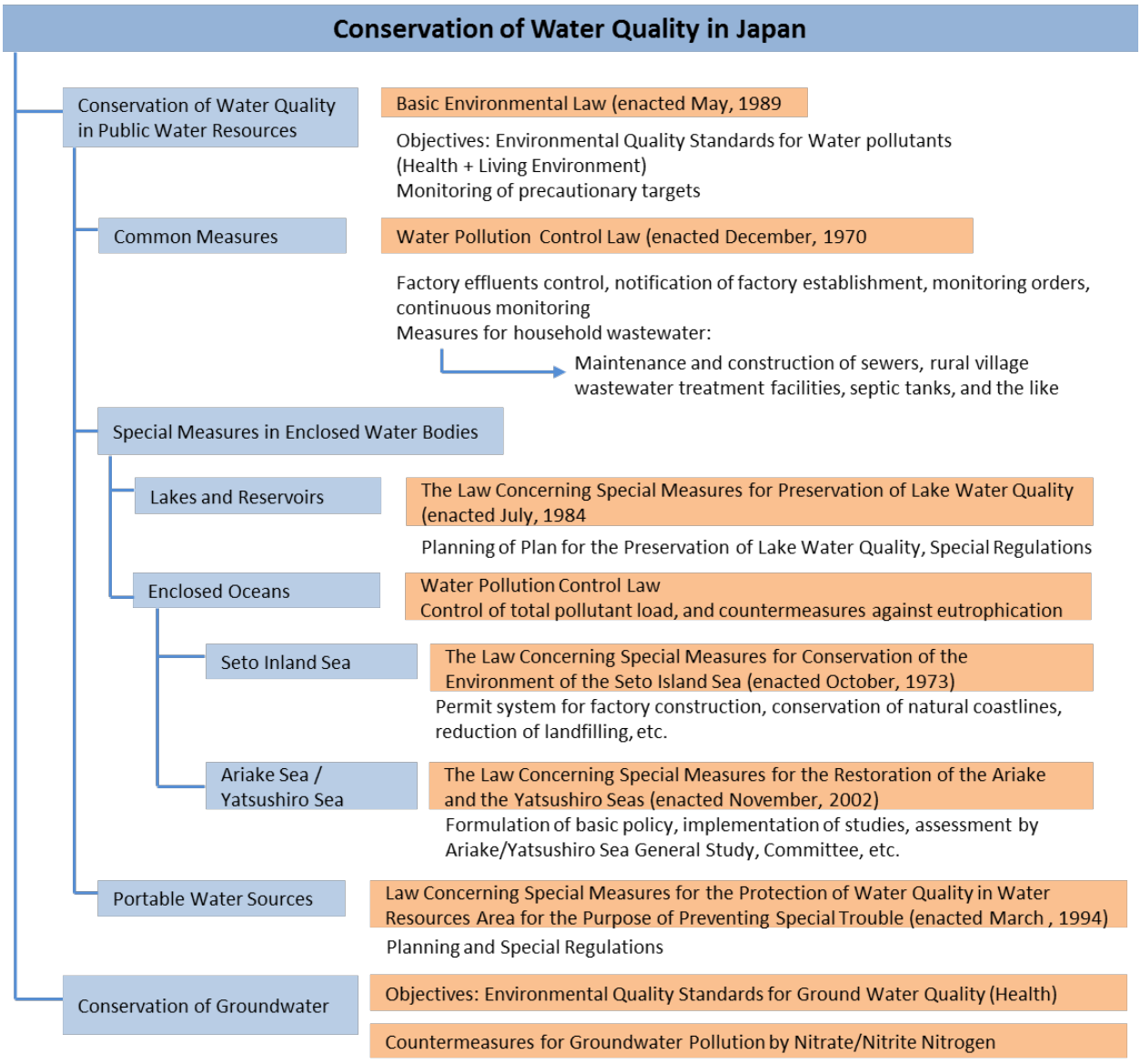

Figure 4: An illustration of state regulatory mechanisms for water quality management in Japan; Source: http://www.wepa-db.net/policies/measures/currentsystem/japan.htm

Malaysia: In Malaysia, environmental acts and regulations were established in the 1970's. "Environmental Quality Act 1974" is a state regulation related to the prevention, abatement, control of pollution and enhancement of the environment. Under this act, the Minister after consultation with the Environmental Quality Council elaborates regulations for prescribing ambient water quality standards which are applied to surface waters and marine waters. "The Environmental Quality (Sewage and Industrial Effluents) Regulations 1979" was also established under the act to prescribe discharge standards. Updated in 2008, the National Water Quality Standards, which is applied to surface waters, ordains standard values of 72 parameters in six water-use classes, whereas the Interim Marine Water Quality Standards for Malaysia list ten substances only. The six water use classes designated in the National Water Quality Standards are: CLASS I: conservation of natural environment, water supply 1 - practically no treatment necessary, and Fishery 1 - very sensitive aquatic species; CLASS IIA: Water Supply 2 - conventional treatment required, and Fishery 2 - sensitive aquatic species; CLASS IIB: Recreational use with body contact; CLASS III Water Supply 3 - extensive treatment required, and Fishery 3 – common species of economic value, and tolerant species, also livestock drinking; CLASS IV - Irrigation and; CLASS V - None of the above. The goal is not to meet the standards of any particular water class in all surface waters, but to improve water quality gradually in order to meet the standards of a better water class than the actual. The Ground Water Quality Standards is still not established. A national groundwater monitoring programme to determine the status of groundwater quality has been initiated considering the potential of groundwater as an alternative source for surface water. For the time being, the groundwater quality status is determined based on the National Guidelines for Raw Water Quality as the benchmark.

Nigeria: In 1988, the Federal Environmental Protection Agency (FEPA) issued a specific decree to protect, restore and preserve the ecosystem of the Nigerian environment. The decree also empowered the agency to set water quality standards to protect public health and to enhance the quality of the country's aquatic ecosystems. In the absence of national comprehensive scientific data, FEPA approached the task by reviewing water quality guidelines and standards from developed and developing countries, as well as from international organizations and, subsequently, by comparing them with data available on water quality in Nigeria. The standards considered included those of Australia, Brazil, Canada, India, Tanzania, the United States and the World Health Organization (WHO). These sets of data were harmonized and used to generate the Interim National Water Quality Guidelines and Standards for Nigeria. These address drinking water, recreational use of water, freshwater aquatic life, agricultural (irrigation and livestock watering) and industrial water uses. The guidelines are expected to become the

maximum allowable limits for inland surface waters and groundwater resources, as well as for non-tidal coastal waters. They also apply to Nigeria's transboundary watercourses, the rivers Niger, Benue and Cross River, which are major sources of water supply in the country. The first set of guidelines was subject to revision by interested parties and the general public. A Technical Committee comprising experts from Federal ministries, State Governments, private sector organizations, higher educational institutions, nongovernmental organizations and individuals reviews the guidelines from time to time.

Republic of Korea: The first Korean Water Quality Standards (WQS) for the protection of human health and aquatic ecosystems were first issued in 1991. Previously, the WQS included only 9 substances, which did not efficiently reflect the overall range of contaminants that are continuously increasing over time. This led to the expansion of the list of substances in the WQS to 17 substances in 2009 to address the concern of a broad range of hazardous chemicals in aquatic environments. The Korean Ministry of Environment has plans to further expand the current list of substances in the WQS to 30 substances by the Year 2015. For this reason, extensive water quality monitoring has been conducted in the main rivers and related research is actively being undertaken. The Korean WQS are listed as follows:

1. Water Quality Standards
    - Water Quality Standards for Conservation of the living Environment (Rivers)
    - Water Quality Standards for Conservation of the living Environment (Lakes)
    - Water Quality Standards for Protecting Human Health (Rivers and Lakes)
2. Ground Water Quality Standards
3. Coastal Water Quality Standard
    - Costal Water Quality Standards for Conservation of the Living Environment
    - Costal Water Quality Standards for the Protection of Human Health
4. Drinking Water Quality Standards

Currently, there are 1,476 water quality monitoring stations in operation throughout the country, including 697 stations for rivers and 185 for lakes and marshes; 49 of the monitoring stations are automatically operating online monitoring stations. Monitoring categories include 34 substances for river, and 35 for lakes and marshes. The water quality is being monitored by measuring 5 common parameters such as DO, TOC, pH and other optional parameters, including volatile organic compounds. The procedure for deriving the Korean WQS follows a

tiered approach with consideration for current analytical techniques, best available treatment technology, economic aspects and relations with current drinking water standards. Exposure data are collected from the major rivers in Korea through a nationwide monitoring of surface water quality, which is done in a chronological manner to collect more exposure data. A chemical ranking and scoring system called CRAFT (Chemical RAnking of surFacewater polluTants) was recently proposed. It was applied to 161 chemicals to derive a list of priority toxic chemicals for the protection of human health and aquatic ecosystems. For surface waters, in particular, e.g. rivers, lake and reservoirs, water quality management objectives are based on a system of water quality classes, namely, Class I - Water Supply Class 1, plus Conservation of the Natural Environment; Class II - Water Supply Class 2 plus Fisheries Water Class 1 and Swimming Water; Class III - Water Supply Class 3 plus Fisheries Water Class 2 and Industrial Water Class 1; Class IV - Industrial Water Class 2 plus Agricultural Water; Class V - Industrial Water Class 3 plus Conservation of the Environment. The grading system takes into account biochemical oxygen demand (BOD) as its key variable, but also considers variables such as pH, suspended solids, dissolved oxygen, total phosphorus and nitrogen, and total *Escherichia coli* count. Recently, Korea slightly revised its Green Vision 21 river quality targets and the share of rivers assigned Class I and II was reduced from 95 to 87%. This, nevertheless, is still considered as being very ambitious. Out of 114 watersheds (rivers and streams located in the four major basins of the Han, Nakdong, Geum and Yongsan), Korea has assigned a Class I quality objective to 36 catchments and a Class II objective to a further 46 catchments. Of the 49 graded lakes/reservoirs, 26 have been assigned a Class I objective, 16 a Class II objective and 4 a Class III objective.

Thailand: The Water Pollution Management Plan in Thailand has four objectives: i) to increase clean water resources; ii) to decrease water resource conflicts; iii) to provide solutions for water pollution in the critical and/or risky areas and; iv) to efficiently develop water pollution management system by involving public participations. In the Plan, there are short-term (2004-2008) and long-term (2004-2016) water quality management goals. Short-term goals are mainly focused on improving the deteriorated water resources, whereas the long-term goal aims to improve and maintain inland and coastal water quality for the sustainable usage and environmental quality. The objectives of setting water quality requirements and standards in Thailand are to control and maintain water quality at a level that suits the activities of all concerned, to protect public health, and to conserve natural resources and the natural environment. There are many forms of legislation on water quality control and management in Thailand, including laws, acts, regulations and ministerial notifications established by various agencies, depending on the areas of responsibility. For example, the Ministry of Agriculture and

Cooperatives is responsible for defining the water quality requirements of receiving waters, as well as for setting quality standards for fresh-waters, domestic effluents and effluents from agricultural point sources. These standards are based on a set of water quality classes for defined uses. For example, in order to protect commercial fishing, ONEB has set allowable concentrations of the following pesticides in aquatic organisms: DDT, endrin, lindane, heptachlor and parathion. Other variables, especially, those characterizing the oxygen and nutrient regimes, the status of coliform bacteria, phenols, metals, pesticides and radioactivity have also been considered.

Viet Nam: In Viet Nam, the water management policy highlights the need for availability of water, adequate in quantity and quality for all beneficial uses, as well as for the control of point and non-point pollution sources. The Government is expected to draw up and to update a comprehensive long-term plan for the development and management of water resources. Moreover, an expected reduction in adverse impacts from pollution sources in upstream riparian countries on the water quality within the Mekong River delta is based on joint studies and definitions of criteria for water use among riparian countries of the river. A set of national water quality criteria for drinking-water use, as well as criteria for fish and aquatic life, and irrigation have been established. Criteria for aquatic life include: pH, dissolved oxygen, NH4-N, copper, cadmium, lead and total dissolved solids. More recently, allowable concentrations of pesticides in the freshwater of the Mekong delta have been established for DDT, heptachlor, and lindane.

3.2. Lessons from Guidelines Development and Implementation

3.2.1. Guidelines Development

Guidelines development is resource intensive undertaking: Guidelines development is a consultative process with the involvement of a large number of water quality specialists, policy makers and natural resources managers. Consultation is very important to establish a firm basis for development and implementation. In South Africa, for example, consultation was a comprehensive process, involving a large number of water quality specialists, which stimulated and improved the understanding of some basic principles for developing guidelines among aquatic scientists and resource managers in the country. It also involved the contribution of technical reviewers and a distribution list of experts within and outside the country. The draft text, for instance, was posted for public comments on the World Wide Web. The revised text

and the comments were discussed at a task force meeting to complete the final version. The input of those who provided comments and of participants in the meeting is gratefully reflected in the final text. For member states within the European Union, guidelines development is generally initiated by constituting a joint task force, which is delegated with the responsibility of establishing water quality objectives and developing relevant criteria. Typically, this task force comprised scientists and water managers appointed by the state, relevant stakeholders and water management authorities responsible for water management at various levels. Throughout the process, consultation is undertaken to achieve common objectives. Given that the proposed guidelines for aquatic ecosystems must be developed through international participation that is based on scientific consensus and best available evidence, the importance of comprehensive consultations is even more justifiable. For every step of the process, collaboration will be crucial to secure resources in time as evident with the following example. In 1988, a decision was taken within the WHO to initiate a revision of the first edition of the drinking-water quality guidelines. The work was shared between WHO headquarters and WHO Regional Office for Europe (EURO). The two organizations had jointly participated in the development and publication in 1984 and 1985 of the first edition. Both the unit for the Prevention of Environmental Pollution (PEP) and the ILO/UNEP/WHO International Programme on Chemical Safety (IPCS) within WHO were involved in the process of developing the guidelines. The preparation of the second edition involved the participation of numerous institutions, over 200 experts from nearly 40 different developing and developed countries and 18 meetings of several coordination and review groups over a period of four years. The work of several institutions and scientists was central to the completion of the guidelines, all of which occurring through strong collaborative efforts at the international level. In very much the same way, subsequent editions and addenda of the WHO Drinking-water Quality Guidelines have been the product of substantial consultations and collaboration among various drinking-water experts, with revisions to clarify and elaborate their recommendations in updated editions, and financial and technical support from development agencies and partners, some of which were governmental institutions. For example, the preparation of the third edition of the Guidelines was made possible through the generous support of the Ministry of Health of Italy; the Ministry of Health, Labour and Welfare of Japan; the National Health and Medical Research Council, Australia; the Swedish International Development Cooperation Agency, Sweden; and the United States Environmental Protection Agency.

Guidelines development is a lengthy process: Guidelines development takes a considerable length of time. For example, the need to develop more comprehensive European water legislation, namely the Water Framework Directive, in the EU was initiated way back in 1988. It took nearly 10 years, with several interim steps until the European Commission finally

published its first proposal in February 1997. The decision making process was quite intensive and somewhat complicated, with several key political developments. Final adoption of the Directive took place through a joint decision making process, i.e. the so-called "co-decision procedure", by the European Parliament and the Council of Ministers in October 2000 after a conciliation procedure. Similarly, i.e. when the duration is taken into account, the preparation of the fourth edition of the WHO Guidelines for Drinking-water Quality and supporting documentation covered a period of eight years and involved the participation of over 490 experts from 90 developing and developed countries. The work of the following Working Groups was crucial to the development of the third edition of the Guidelines for Drinking-water Quality: i) Microbial aspects working group; ii) Chemical aspects working group; iii) Protection and control working group. Consultants were hired to provide technical input within the Working Groups that were constituted but coordination was done within WHO Headquarters at the Programme on Water Sanitation and Health, with administrative support throughout the process and to individual meetings and liaison between the Working Groups and WHO Headquarters. This proved to be an efficient way of using resources since a permanent secretariat with both administrative and technical functions would have been much costlier.

Guidelines development can be expensive: It is unclear exactly how much money can go into guidelines development but rough approximations indicate that the process can be costly. The elaboration of water quality criteria for hazardous substances, for example, can be a lengthy and resource-intensive undertaking when one considers the multitude of chemicals present in the environment today. Even after prioritization, comprehensive laboratory studies with sensitive aquatic organisms often need to be carried out, in addition to a general search and analysis of published literature. In Canada, for example, it is estimated that the average cost of developing a criterion for a single substance by means of a literature search and analysis is in the order of 50,000 Canadian Dollars (49,700 US Dollars). In some countries, joint programmes have been undertaken to share the costs and the workload for developing water quality criteria amongst their regional and national agencies. For example, the Canadian Council of Resource and Environment Ministers (CCREM) established a task force, consisting of specialists from the federal, provincial and territorial governments, to develop a joint set of Canadian water quality criteria. Another advantage is that it has also ended the confusion caused by the use of different criteria by each provincial government. There are also some very good examples joint efforts between nations with respect to sharing costs and the workload for developing water quality criteria amongst regional and national agencies. For example, to address limited research and financial capacity, New Zealand and Australia have partnered to develop joint water quality guidelines for various uses. This has enabled them to produce, at moderate costs, much more comprehensive sets of criteria than would have hardly been possible by individual

efforts, most especially for New Zealand. Given the relatively small size of the New Zealand science community and research resources, New Zealand has gained significant benefits from continued partnership with Australian counterparts to develop and revise their water quality guidelines. This continued cooperation on guidelines development and implementation has contributed to an established and mutually beneficial relationship between the two countries in sharing scientific and resource management knowledge for water quality management.

Data requirements and challenges related to research infrastructure: When developing criteria for the protection of aquatic life, ideally there should be sufficient data on the fate of chemicals in organisms and their exposure-effect relationships, especially, for toxic substances. To overcome the constraint of data requirements, some countries apply water quality guidelines which have been derived in other countries while others use data from developed countries. Of course, a major limitation with this approach is that external data are used to infer negative effects aquatic communities to address local water quality challenges that are usually different. Foreign data must be used cautiously by ensuring that the original criteria were developed for similar environmental conditions and that at least some of the ecosystems for which studies were carried out occur in the country that is considering the adoption of foreign criteria. More recently, attempts have been made to derive criteria that indicate healthy aquatic ecosystem conditions within the concept of the ecosystem approach to water management. For example, in the member states of the European Union, water quality criteria for the protection of aquatic ecosystems are now being based on an ecological quality index. This approach is a promising even if it demands huge data requirements and resources as the derived criteria must account for the state of resident species and the structure and/or function of ecosystems as a whole.

Guidelines development is an evolving process – continuous revision is necessary: Guidelines development does not stop after the first planning cycle. In reality, the process should be seen as dynamic and iterative. This means the guidelines once developed, should be further revised and improved on the basis of experience and emerging challenges. So guidelines development is an evolving process requiring regular appraisals. For instance, periodic review is necessary to update the guidelines for constituents currently included as relevant new information becomes available on the water quality status as a whole or for a particular constituent. It could be that the information available on the effects of some constituents is either very limited, or there may be unresolved differences in opinion as to the effects of those constituents. Also water quality management objectives and environmental values have to be reviewed periodically to ensure that community expectations are being satisfied. Water quality management must be seen as an interactive and ongoing process that should be adaptive and responsive to changes in community expectations. Therefore, it is essential to upgrade the guidelines as new

information becomes available. The current revision of the Australia/New Zealand water quality guidelines (i.e. the ANZECC, 2000 version) is motivated by these facts. They have not been updated since 2000. Yet substantial new data, information and methods have become available since then, while some errors in the document have also been identified but not corrected. Revision applies to supporting documents as well, in particular, procedures for applying the guidelines, monitoring, assessment and reporting. This is important to keep all documents up-to-date and ensure they retain their value as a best practice tool for water quality management. In the same way, revisions of the WHO Guidelines for Drinking-water Quality was built on more than 50 years of guidance by WHO through numerous experts on drinking-water quality with the support of state and non-state actors. The 4th edition which was recently published is the product of systematic revisions notwithstanding the success of the 3rd edition. Major revisions was undertaken to clarify and elaborate a broad spectrum of issues, including emerging contaminants, hazard identification and risk management, catchment-to-consumer water safety plans, as well as independent surveillance. Hence, the 4th edition expands on key concepts like health-based targets and water safety planning and presents new risk assessments on microbial, chemical and radiological hazards, and it addresses emerging issues of public health concern like pharmaceuticals in drinking-water. All of this required over more than five years of extensive consultation with hundreds of experts in many part of the world.

3.2.2. Guidelines Implementation

Water quality guidelines - a decision support tool for water quality managers: Guidelines help water quality managers to define water quality management objectives and measures that are required to protect various environmental values/uses. Water quality guidelines can be an important source document used by state authorities, consultants and water resources management practitioners to guide water management decision-making. In essence, guidelines are decision support tools that make ambient water quality management an important element in decision-making for environment protection, land use planning and natural resource management. Guidelines provide a logical framework for assessing water quality, and can be used to evaluate whether physical, chemical and biological characteristics of aquatic ecosystems support water quality management. For these reasons, water guidelines are implemented in various parts of the world as reference tools for catchment management plans and policies. Usually, when a given water quality value or range of values at monitoring sites are exceeded, management response is triggered to address the anomaly. In some countries, legal action may be taken to prosecute those responsible. In other countries, guidelines have no statutory status. Instead they are widely used to develop water quality objectives (e.g. in

regional/local water quality management plans) and make decisions on contaminant concentrations for discharge permits.

Community participation – the case of Australia and New Zealand: In Australia and New Zealand, the process of implementing/adapting the national guidelines includes setting state, regional and local water quality objectives and developing and implementing action plans to achieve those objectives. The extent of community involvement varies depending on the approach taken at the local level (i.e. State, Territory and local government authorities). Typically, the water quality management plan is coordinated by a lead agent, which is usually a government department or agency. For some catchments, the local government or a community based group have acted as the lead agent. As many agencies will have an interest or responsibility for issues considered within the management plan, they will usually co-ordinate a whole of government approach. The lead agent is responsible for establishing working groups to develop the plan. Typically, the lead agent supports all interested parties who wish to participate in the process, which should be made as transparent as possible from the very beginning. This usually involves hearing and considering a wide selection of views from different stakeholders after raising awareness of water issues in the local community using various communication channels. After this, working groups will normally be established for a particular geographical area, a catchment, aquifer, bay or estuary. The way they are formed varies in different States and Territories depending on specific legislative and administrative structures and there are instances where local governments set water quality objectives without establishing local working groups. Working group membership, ideally, are limited to 8-12 people and may include representatives of organizations listed in Box 1.

Box 1: Community organizations involved in setting water quality objectives in Australia

- Research bodies
- Land owners
- Community interests
- Service clubs
- Sporting clubs
- Churches
- Community based groups
- Education institutions
  - Schools
  - Colleges
  - Universities
- Local, State, Commonwealth governments
  - Departments
  - Agencies
  - Utilities
- Public users
- Environmental interests
- Primary industry
  - Land care groups
  - Farmers' organization
  - Irrigation corporations
  - Mining groups
  - Forestry organizations
  - Fishing organizations
- Secondary industry
  - Industry associations
- Water industry
- Inter-governmental bodies
  - Murray-Darling Basin Commission etc.
- Tourist Industry

Groups of this size are recommended in the Implementation Guidelines for the ANZECC Guidelines (ANZECC/ARMCANZ, 1998). Experience indicates that outcomes are achieved more readily where the task is split among a small number of active members. Working groups are advised to identify and include a broad range of stakeholders and ensure good communications and liaison with key stakeholders. Usually this is done by allowing representation according to local needs, which should not be dominated by sectional interests. Where a large number of interest groups exist, mechanisms are put in place for different views to be expressed and feedback provided on the process as it evolves. Stakeholder advisory committees are established to bring together all major interests in one forum to discuss ideas, issues and proposals. The lead agent (community and local government representatives) must have the ability to contribute directly to managing the process and show eagerness and ability to represent a wide variety of community views, a familiarity with water quality management issues and common-sense and ability to work with all members of the community. On their part, working groups assist local communities and interested people in the process of developing local water quality objectives.

3.3. Guiding Concepts for Developing Guidelines/Standards

3.3.1. Philosophical Basis for Standard Setting

Modern practices for water quality management are built on the merits of regulatory and market based approaches to achieve sustainable use of water resources. Regulatory measure could include setting limits on the quantity of effluent an industry or a municipality may produce, or setting limits on the nature and extent of any impact on the environment as a result of effluent disposal. On the other hand, market-based measures can be used to influence decisions on production methods and waste management. For example, the Polluter-Pays Principle can ensure that the cost of managing discharge from an industry is included in the production costs. In a similar way, water quality objectives and efficient use of resource can be promoted by trading in pollution permits. These principles are inherent in all water quality guidelines/standards even though the scope and dimension, as well as the level of application may vary. Usually, the best mix of regulatory and market-based instruments will depend significantly on the particular stage of the water cycle that is involved and the particular circumstances of time and place. In Canada, for example, two strategies are commonly used; the anti-degradation strategy and the use protection strategy. For water bodies with aquatic resources of national or regional significance, water quality objectives are established to avoid degradation of existing water quality. For other water bodies, the objectives are established to

protect the designated uses of the aquatic ecosystem. As long as the designated water uses are protected, some degradation of existing water quality may be acceptable in these water bodies, provided that all reasonable and preventative measures are taken to protect water quality conditions. Hence, water quality objectives are designed to target those impacting on water quality, e.g. manufacturing industries, agribusinesses and municipal wastewater treatment plants. For example, the US Clean Water Act tends to address pollution abatement at source. Preceding 1987, programmes were primarily directed at point source pollution, i.e. wastes discharged from discrete sources such as pipes and outfalls. However, the 1987 Amendments authorized measures to address non-point source pollution such as storm-water runoff from farm lands, forests, construction sites, and urban areas, which are now estimated to represent more than 50% of water pollution problems in the United States. In the EU, Member States are required by the WFD to address negative human impacts on aquatic ecosystems from specific places, such as manufacturing industries, and from widespread sources, such as road networks. They are required to develop a so-called 'Programme of Measures' to established and address all types of impacts, with a full economic analysis to ensure that charges are fairly apportioned and agreed upon by each sector through River Basin Management Plans with the participation of the public.

3.3.2. Environmental Values (EVs)

Water quality guidelines give recommended values for indicators and/or narrative requirements that are designed to ensure that Environmental Values (EV) of waters is protected. The term "Environmental Values" is applied to particular values or uses of the environment. "Environmental Values" are those values or uses of water that the community believes are important for a healthy ecosystem – for public benefit, welfare, safety or health. The process of setting water quality objectives and targets is facilitated by identifying the right environmental values for a given management area. Generally, many water quality objectives recognise the following environmental values: i) aquatic ecosystems; ii) primary industries (irrigation and general water uses, livestock drinking water, aquaculture and human consumers of aquatic foods); iii) recreation and aesthetics; iv) drinking-water; v) industrial and technical applications; and vi) cultural and spiritual values. The guiding principles are that: i) "Environmental Values" should be protected where they are being achieved for an aquatic ecosystem, and ii) all activities should work towards the achievement of "Environmental Values" over time where they are not being achieved. The desirable "Environmental Values" should be those which the local community wishes to protect and enjoy now and in the future. Ideally, these values should: receive support from the local community, interest groups and the

wider region; be consistent with the areas' sustainable needs; consider the needs of downstream communities. Associated with each “Environmental Value” in many guidelines documents are ‘guidelines’ or ‘criteria’ or ‘trigger values’ for substances that might potentially impair water quality, for example pesticides, metals or nutrients. In principle, if these values are exceeded, they may be used to trigger an investigation or initiate a management response. Typically, for each “Environmental Values”, guidelines identify particular water quality characteristics or ‘indicators’ that are used to assess whether the condition of the water supports that value. In Australia and New Zealand, cultural values are also taken into account to ensure that decisions that affect aquatic ecosystems protect these values and support intercultural understanding. However, even though the guidelines recognize indigenous cultural values, they do not yet provide specific criteria for management based on those rights.

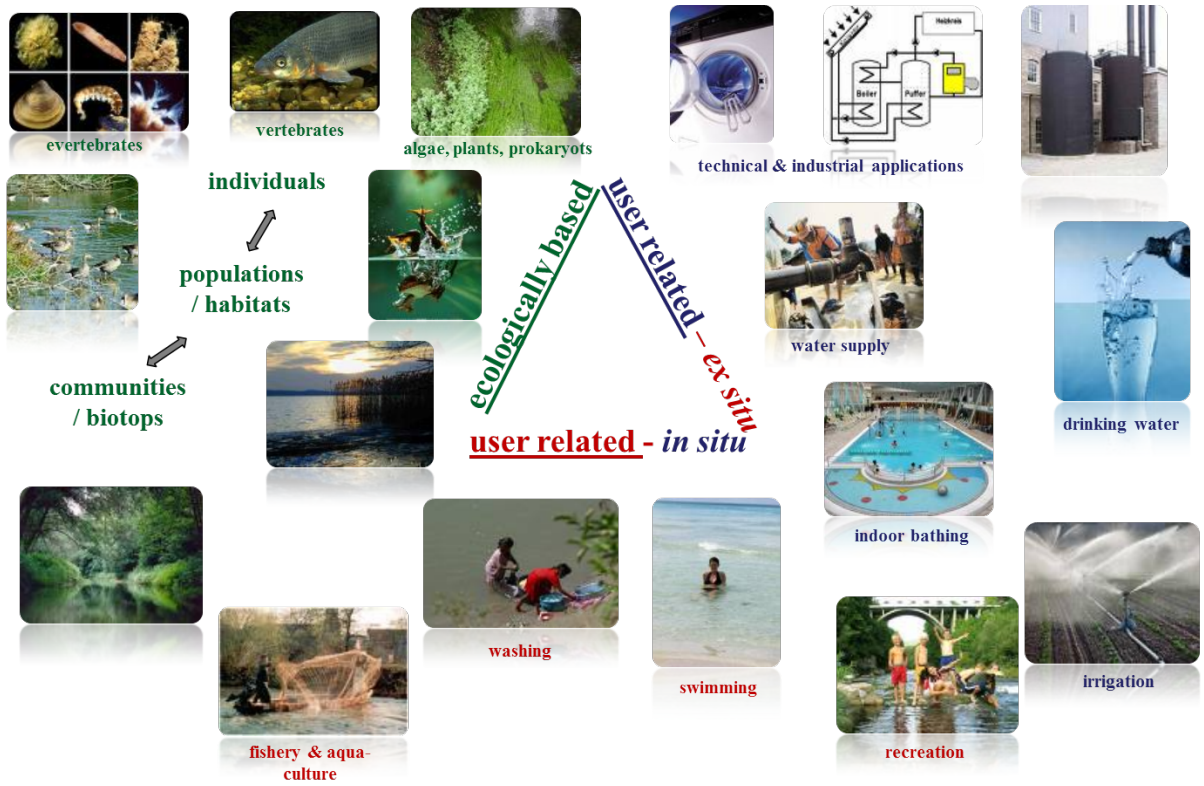

Figure 5: Ecologically based Environmental Values vis-à-vis human use Environmental Values for which management objectives and water quality guidelines can be developed. *Photos*: anonymous.

"Environmental Values" are important for a healthy ecosystem or for public benefit, welfare, safety or health. This is why they need to be protected from the effects of pollution and inappropriate land management practices. In general, where two or more agreed "Environmental Values" apply to a water body, the more conservative, or stringent, of the associated guidelines is selected as the water quality objective. These are the specific or detailed targets that managers will aim to meet in order to protect the agreed value of the water body. In the absence of a clear and agreed set of uses for a particular water resource, managers are advised to aim for a conservative approach and assume that all appropriate "Environmental Values" apply by default. For example, ecosystem protection and recreation would apply as a default "Environmental Value" for near shore marine waters, but drinking water would not apply. In principle, once the "Environmental Values" to be protected have been decided, the level of protection necessary to maintain each value must be determined.

3.3.3. Eco-regions and the Level of Protection

Aquatic ecosystems are quite complex and vary considerably. Hence standard setting to reflect all ecosystem types can be problematic. However, similarities within shared ecological regions provide excellent opportunity for developing common management objectives. Eco-regions are based on shared characteristic in terms of vegetation, geology, altitude and rainfall. In many cases, they provide a logical approach to watershed-level monitoring and assessment. As within variability of ecological factors is comparatively low, eco-regions provide a reasonable ecological framework for organizing environmental data and for defining ecosystem type-specific threshold values. In addition, they are independent of political boundaries and foster collaborative management strategies, allowing for shared resources and joint basin management on common issues such as pollution from pesticides in agricultural runoff, or oxygen depletion caused by eutrophication and organic loading. With this approach, natural difference within a single system can be integrated into water quality management objectives to achieve different levels of protection for the same water body or different water bodies in a similar eco-region. Within eco-regions, the type specific approach to standard setting can be used to derive specific water quality objectives to protect different uses and different levels of protection. Generally, guidelines specify multiple levels of protection. Typically, the level of protection corresponds to whether the conditions within a particular eco-region or water body within it is of: i) high conservation value, ii) slightly - moderately disturbed, or iii) highly disturbed. Ideally, the level of protection applied to most aquatic ecosystems is the one suggested for 'slightly - moderately disturbed' ecosystems. In Australia and New Zealand, rivers which flow through relatively undisturbed national parks or wetlands of outstanding ecological significance are designated as being of 'high conservation value'. In a highly disturbed system, a

reduced level of protection may be appropriate as a pragmatic short-term goal, with the aim of eventually restoring it to the status of a 'slightly - moderately disturbed'. Within the EU, the management goal for aquatic ecosystems is to achieve the so-called "good status" as stated in the Water Frame Work Directive, with "slight" deviation when natural reference conditions cannot be achieved whereas ecosystems in a "natural" state must be left intact.

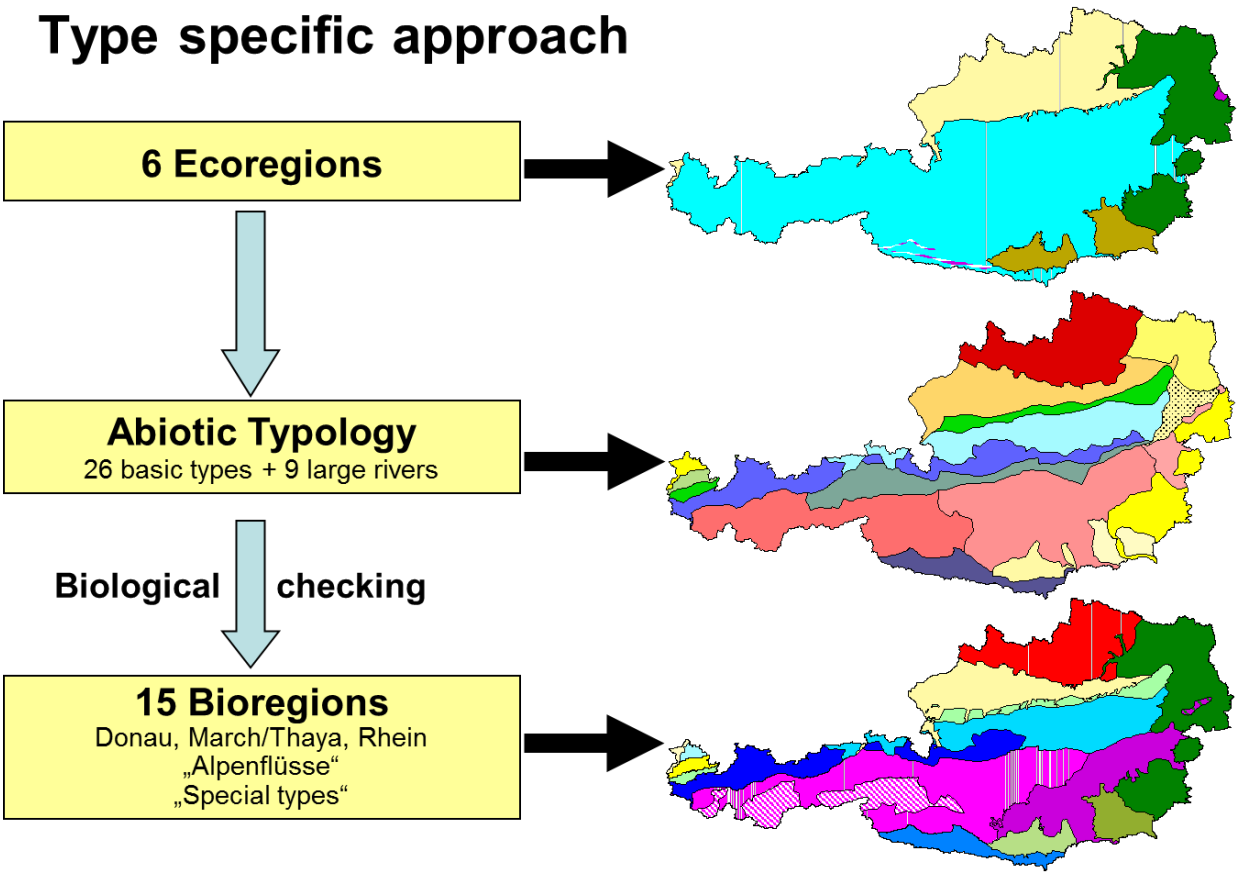

Figure 6: The Ecosystem type specific approach as illustrated in this example for Austria is used to manage aquatic ecosystems in the country

3.3.4. Criteria Presentation

Water quality guidelines/criteria are presented in the form of numeric and/or qualitative data of the biological, chemical and physical constituents. Some criteria specify maximum or minimum concentrations for constituents fit for use. For toxic contaminants, the ideal concentration of a constituent is defined, often with the inclusion of safety factors. However, depending on the guideline or criteria used to establish water quality requirements, it is

possible to arrive at values that could differ by a factor of hundred or even more. In South Africa, the derivation procedure employed for the water quality guidelines represents an integrated approach that is intended to provide broad protection. The criteria are based largely on the physiological effects of substances on aquatic organisms. Secondary effects, such as changes in ecosystem structure, composition and functioning, may arise from direct chronic or acute toxic effects, or from changes in behaviour of aquatic organisms.

The limitations associated with the use of constituent-specific criteria may include the following: i) the criteria address the water column only, which forms but one compartment of aquatic ecosystems; ii) the criteria ignore interactions between constituents which could result in additive, synergistic or antagonistic effects; iii) the criteria do not fully account for environmental partitioning under various chemical and physical water conditions, which may induce change in the bio-availability of a constituent; iv) the procedure for deriving criteria makes use of data from a limited number of species, often determined by their ease of laboratory culturing; and v) the criteria often rely on single-species dose-response data, rather than multi-species or community response data.

Three broad classes of water quality criteria are recognized for aquatic ecosystems in the South African Water Quality Guidelines:

i. Constituent-specific guidelines: For constituent-specific criteria, a numerical value or range for each constituent is used to represent a level of ecological risk associated with the presence of that constituent in the water;
ii. Guidelines for complex mixtures: For this type of criteria, a whole-effluent toxicity testing approach is followed to evaluate the toxicity of complex mixtures containing several constituents. This may be required where the individual effects of each constituent cannot be resolved or where synergistic and antagonistic effects may occur;
iii. Biological criteria: Biological criteria may be either quantitative or qualitative data that describe the biological status of aquatic systems. Biological criteria are typically site-specific or region-specific. They are based on reference conditions, usually the near natural (least impacted) conditions of the biological communities inhabiting a specific geographical region or site. This is the perceived "good status" in the EU Water Framework Directive;

3.3.5. Some Norms in Use

Norms are the perceived "yardsticks" that are used to evaluate the effects of a water quality constituent for a particular use. The following are some examples of norms that are in use for aquatic ecosystem guidelines:

- Total Maximum Daily Load (TMDL) - A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards (WQS). It is determined after study of the specific properties of the water body and the pollutant sources that contribute to the non-compliant status. In the US, water bodies that do not meet applicable water quality standards with technology-based controls alone are placed on the so-called section 303(d) list. Water bodies on this list require development of a TMDL. The TMDL determines load based on a Waste Load Allocation (WLA), Load Allocation (LA), and Margin of Safety (MOS).
- Target Water Quality Range (TWQR) - The TWQR for a particular water use is defined as the range of concentrations or levels at which the presence of the constituent would have no known adverse or anticipated effects on the fitness on the water assuming long-term continuous use, and for safeguarding the health of aquatic ecosystems. In South Africa, the TWQR is used as a management objective to specify the desired or ideal concentration range and/or water quality requirements for a particular constituent.
- Acute Effect Value (AEV) - The AEV is a criterion used to identify those cases requiring urgent management attention because the aquatic environment is threatened, even if the situation persists only for a brief period. The AEV may also be used to identify those cases in need of urgent action for mitigation. For the South African Water Quality Guidelines, it is advised that the AEV should not be used for setting water quality requirements for aquatic ecosystems.
- Chronic Effect Value (CEV) - The CEV is a criterion that is used, in certain special cases where the TWQR is exceeded. The setting of water quality requirements or objectives at the CEV protects aquatic ecosystems from acute toxicity effects. Examples of where it would be appropriate for water quality requirements for aquatic ecosystems to be set at the CEV would be: i) within the mixing zone of an effluent discharge and ii) interim water quality objectives in those situations where remediation is required, but water quality cannot immediately, or in one step, be restored to the TWQR;

4. PREVIEWING THE GUIDELINES FOR AQUATIC ECOSYSTEMS

4.1. Placing the Proposed Outline in a Conceptual Framework

Figure 7 illustrates the framework within which the proposed guidelines can be placed. Developing aquatic ecosystem guidelines within a broad framework of water quality guidelines is important as most countries typically undertake comprehensive water quality management in the interest of safeguarding human use-related environmental values. An important aspect of this approach is the appropriation of guidelines for various Environmental Values, with specific water quality objectives for each use. For the current undertaking, use-related guidelines are not to be developed as some have already been developed at various levels, e.g. drinking-water, recreational use, agricultural use and aquaculture use, whereas others are under consideration. For example, cultural and spiritual values are seriously being considered in the revised Australia and New Zealand Water Quality Guidelines.

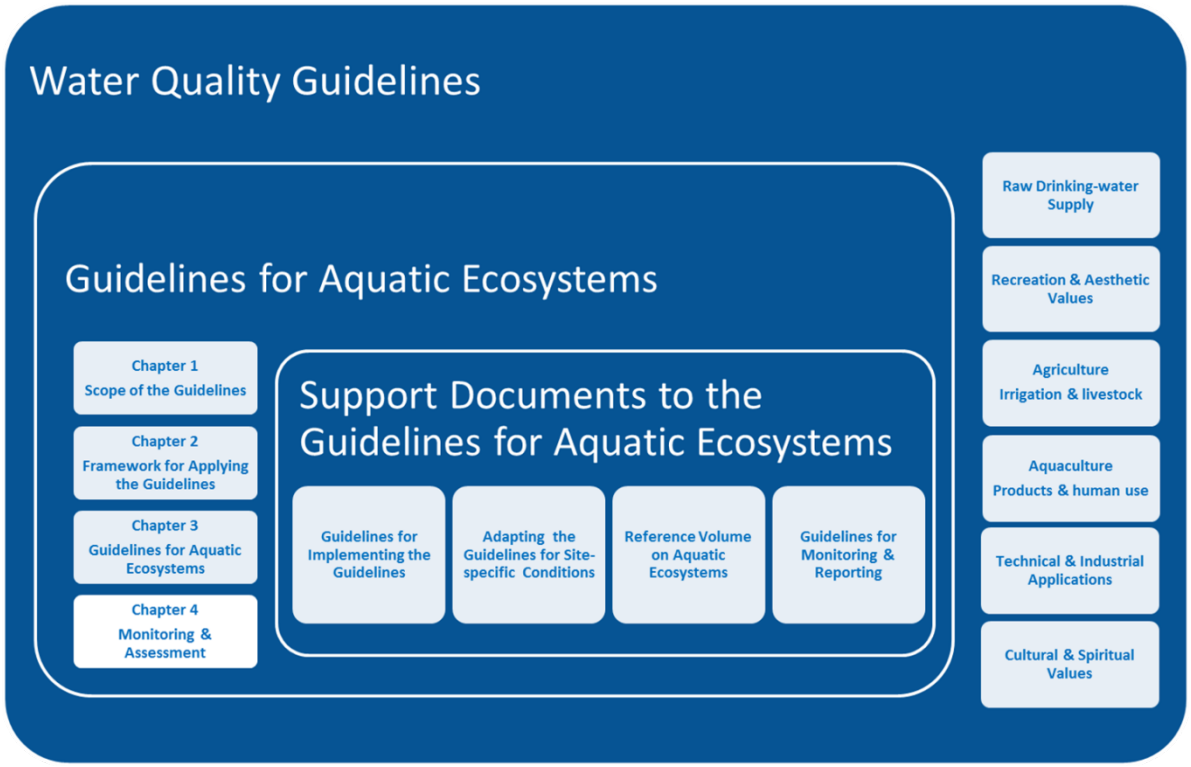

Figure 7: A conceptual framework of water quality guidelines within which the proposed outline of the guidelines for aquatic ecosystems can be placed

4.2. Guidelines for Aquatic Ecosystems – the Proposed Outline

As shown in the conceptual framework, the main features of the proposed guidelines for aquatic ecosystems can be displayed in interrelated chapters and supporting documents. The contents of the entire guidelines document can be summarized in the introduction to help readers understand and use the guidelines and supporting texts correctly. The introduction should describe the layout of the guidelines and supporting documents to ease user identification of various sections in the document and the relevant materials that are connected to it. The introduction could also provide details of how the guidelines were developed and guidance notes on how they can be used. The introduction can be created as a stand-alone document, accompanying chapters can be provided in Volume I (the main text) of the guidelines, and supporting documents to the chapters in Volume I may be released in a separate volume (Volume II).

4.2.1. Volume I: Guidelines for Aquatic Ecosystems

Volume I of the guidelines for aquatic ecosystems will be considered the main part of the document. It shall provide the framework for water resource management, and an outline of water quality guidelines for aquatic ecosystem values and the context within which they can be applied. This volume may consist of four chapters in total, with appendices of supporting information and glossaries of terminology, equations and units of measurement, for example.

Chapter 1: Scope of the Guidelines

This chapter will describe the scope of the guidelines for aquatic ecosystems in terms of:

- Rationale for developing the guidelines;
- Philosophical basis governing the guidelines;
- Approach/methodology used to develop the guidelines;

Chapter 2: Framework for Applying the Guidelines

This chapter will provide the water quality management framework required to apply the guidelines. The following issues can be considered:

- Fundamental environmental/water quality concepts including water quality objectives, environmental values, i.e. ecosystem use and human use; precautionary principle (PPP); best available technology (BAT);
- Outline of key steps in the water quality management framework;

- Involvement of stakeholders in the decision making process for water quality management;
- Overview of important matters that strengthen the application of guidelines
- Benefits of site-specific guidelines;
- Adapting guidelines to suit specific local conditions;

Chapter 3: Physical, Chemical and Biological Guidelines for Aquatic Ecosystems

Chapter 3 on the physical, chemical and biological guidelines for aquatic ecosystems will recommend different types of criteria for different types of aquatic ecosystem at different levels of protection. This could include guidelines for process parameters, toxicants, as well as and biocriteria to protect the integrity and functions of aquatic ecosystems. Chapter 3 shall include:

- Guidelines (trigger values, indices and/or narrative statements) for critical water quality indicators for different types of aquatic ecosystems and levels of protection;
- Data base requirements for the derivation of guidelines and procedures for calculating values used in the derivation of guidelines;
- Tailoring guidelines for local conditions, including advice on deriving site-specific guidelines;
- Basin-wide classification and/or ecosystem typology (eco-regions)

Chapter 4: Monitoring and Reporting

Chapter 4 will provide advice on experimentation, collecting and analyzing data for water quality indicators, which could be chemical, biological, physical, and hydrological or morphological characteristics. Recommendations on the number, as well as the combination of indicator types that should be considered for a range of scenarios when monitoring aquatic ecosystems will be presented. Holistic assessment of water and sediment quality, including the use of biological indicators will be considered. Also important is the related data requirements for climatic conditions, land use, population density, slopes, geology, soil conditions, economic development, demographic development, climate change effects, etc.

4.2.2. Volume II: Supporting Documents to the Guidelines

Supporting documents will be developed as accompanying texts to facilitate understanding and usage of Volume I. The supporting documents may include the following:

- Protocol for implementing the guidelines, - linked to Chapter 2 of the guidelines (framework for applying the guidelines); i.e. basic provisions in national water laws/acts have to be available to apply/adapt 'international' guidelines.
- Reference volume on aquatic ecosystems - linked to Chapter 3 of the guidelines (the guidelines for aquatic ecosystems);
- Adapting the guidelines for site-specific conditions - linked to Chapter 3 of the guidelines (the guidelines for aquatic ecosystems); description of specific local situation; which parameters and indicators are necessary to describe a specific local/regional situation for water quality management; important to consider differences in climatic conditions, land use, population density, slopes, geology, soil conditions, economic development, demographic growth, effects of climate change and local response to it; dominating problems/pressures for groundwater, international river basins and coastal waters
- Guidelines for monitoring and reporting - linked to Chapter 4 of the guidelines (monitoring, assessment)

5. PLAN FOR DEVELOPING THE GUIDELINES

5.1. Proposed Plan for the Development Process

A multitier approach with several simultaneous undertakings is proposed (Figure 8). Part I (Pre-development Phase) will start with an initiation period. A guidelines secretariat and an interim expert committee can be constituted during this period to initiate the process. The expert committee will coordinate technical matters during the initiation period, whereas the secretariat will mobilize resources and international support and administer the development process. Part II (Development Phase) will focus exclusively on guidelines development (i.e. the first cycle leading to the first edition of the guidelines). Part III (Post-development Phase) will entail promotion of the guidelines for their application and/or adaptation. Once this is complete, the second cycle/edition to upgrade the guidelines can be initiated.

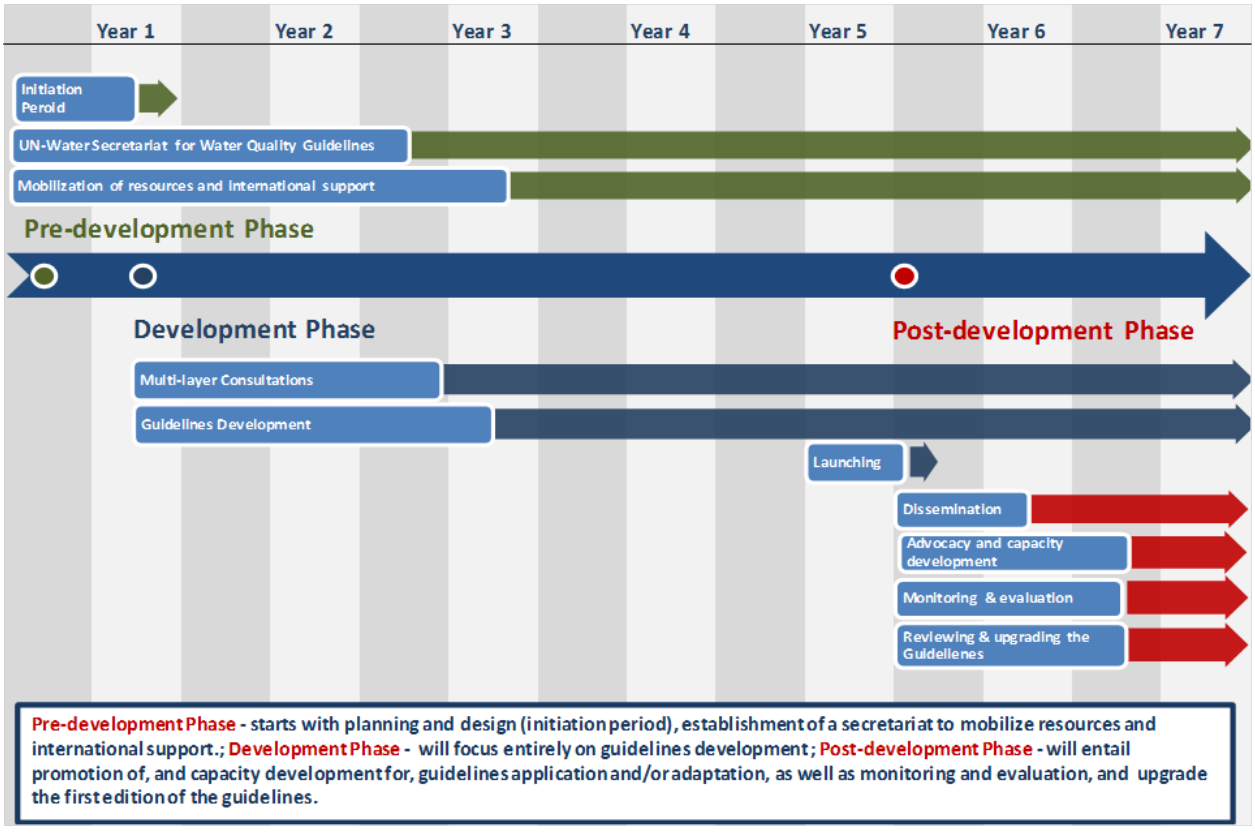

Figure 8: The proposed multitier approach with simultaneous undertakings for developing the guidelines

5.1.1. Part I: Pre-development Phase

Initiation Period (Planning and Design)

During the initiation period, the guidelines development strategy will be elaborated. This will include any follow-up action(s) of the UN-Water TPA on Water Quality. The main purpose of the initiation period is to plan for the use of resources, including personnel, time and cost adequately, and to approximate the work load during the guidelines development and implementation periods. Planning and design will ensure that all necessary arrangements are fully in place for the commencement of the guidelines development process.

- Activities

  Planning and design will include:

  i. constituting an interim coordination body, namely, UN-Water Committee of Experts on Guidelines for Aquatic Ecosystems to initiate and coordinate technical matters during the Initiation Period;
  ii. constituting the guidelines development committees and agreeing on the roles and responsibilities, preparing a detailed terms of reference including tasks, deliverables and schedule, and identifying the activities needed to achieve deliverables;
  iii. organizing the kick-off conferences/meetings; the primary purpose of the conference is to bring together experts and practitioners from government, private sector, academia and development agencies to share their knowledge and expertise on the latest advancements in guidelines development for water quality management. Among other things, participants will discuss: i) the importance of setting guidelines/standards; ii) scientific derivation of water quality guidelines and highlight the weaknesses of current approaches; iii) knowledge gaps and priority areas for research and implementation.
  iv. developing strategies for resources mobilization; identifying supporting partners/development agencies to provide financial and/or material support
  v. estimating the resource requirements for the activities and agreeing on the work schedule, including a detailed budget;

- Interim Results

  i. UN-Water Committee of Experts on Guidelines for Aquatic Ecosystems
  ii. detailed plan for guidelines development;
  iii. committees (names of experts and their affiliations);

iv. names, description and tasks (including terms of reference) of Technical Working Groups, Technical Advisory Committee, UN-Water Steering Committee; Reviewers and Editors;
v. detailed work schedule (terms of reference) with timeframe to develop the guidelines and;
vi. detailed budget for guidelines development;

- Duration
  Six months (maximum)
- Estimated cost: $ 155,000.00

Formation of Guidelines Secretariat

A bureau entrusted with coordinating the development and adaptation/application of the guidelines will be required for administrative duties and maintaining records. A suitable name will be found. For example, it may be called "UN-Water Secretariat for Water Quality Guidelines" or simply Guidelines Secretariat. The Secretariat may be hosted by a UN-Water member/partner, especially those members/partners of the UN-Water TPA on Water Quality. The Secretariat shall support the goals of the TPA on Water Quality and serve as an international focal point for initiatives on water quality management and improvement at the global level. Its principal functions will include; to prepare and facilitate meetings/conferences of the specialist/experts committees and to coordinate with relevant international entities and governmental organizations/agencies. Other functions may include mobilization of resources and international support, promotion of guidelines adaptation/application and facilitating capacity development for guidelines adaptation/application, monitoring and evaluation, and initiation of subsequent cycles to upgrade the guidelines. The Secretariat shall be responsible for all legal, contractual, ethical, financial and administrative management of the process and a lean management structure will be maintained for effective management and co-ordination. This arrangement will ensure strong cohesion, maximum involvement, cost efficiency and programme effectiveness to achieve desired outputs.

- Activities
  i. coordinate the development and application of the guidelines;
  ii. establish contacts with the resource persons constituted from the initiation period for guidelines development;
  iii. organize meetings of various expert committees, e.g. Steering Committee; Technical Working Groups, etc.;
  iv. develop detailed annual work plan and prepare reports;
  v. consolidate the report

vi. refine the procedure for the guidelines development and application;

- Interim Results
  i. detailed work plan;
  ii. procedure for applying the guidelines, including monitoring and evaluation;
  iii. programme for initiating the second cycle/edition of the guidelines;
  iv. guidelines development and application process undertaken smoothly;
- Staff requirement
  a lean structure is proposed for the Secretariat. The Secretariat could consist of three staff members drawn from personnel within the members of the TPA during Phase I and II of the guidelines development process. The staff may include a Senior Programme Officer and two Programme Officers (one for resource management and conference services, and another for scientific and technical matters). The composition and number of staff at the secretariat during Phase III may change.
- Duration
  On-going – starts during (or immediately) after the initiation period
- Expected cost: $ 1,871,000.00

Mobilization of Resources and International Support

The objective is to create awareness at the global level and mobilize resources and international support for the development and application of the guidelines.

- Activities
  i. Implementing strategy for resources mobilization;
  ii. Contacting development agencies/partners to provide financial and/or material support;
  iii. global, regional and local consultations through workshops/meetings with governments, scientists, stakeholders and water quality managers;
- Interim Results
  i. communication on progress throughout the process
  ii. a working strategy for resources mobilization,
  iii. multiple consultations and structured discussions among water quality specialists/practitioners, development agencies, international organizations, governmental and non-governmental organization, stakeholders, water quality managers and other interested parties to obtain information, views, and ideas about the structure and content of the guidelines, its relevance and the developmental process and procedure required;

iv. several institutions, organization and development agencies committed to guidelines development identified;
v. several workshops in selected countries where first edition of guidelines will be promoted;

- Duration
  On-going process before and during guidelines development
- Expected cost: Costs are included the operational cost for running the Secretariat

5.1.2. Part II: Development Phase

Guidelines Development Process

The aim is to produce guidelines for aquatic ecosystems with supporting documents that will facilitate the application of the guidelines at the global level;

- Technical Working Groups
  five main Working Groups and an unspecified number of sub-working groups will focus on specific and sub-specific themes for guidelines development have been identified. The Working Groups are:
  - Working Group I (Guidelines Coordination Committee) – Scope and Framework, Coordination and Integration, Delivery of the Guidelines;
  - Working Group II – Water Quality Monitoring and Assessment;
  - Working Group III – Physical and Chemical Criteria for Aquatic Ecosystems (with distinct sub-working groups on, for example, toxicants, non-toxicants and nutrients for different types of aquatic ecosystems, including groundwater and sediments);
  - Working Group IV – Biological Criteria for Aquatic Ecosystems;
  - Working Group V – Supporting Documents to the Guidelines;

Each Working Group shall appoint a group coordinator at its first meeting. The group coordinators shall constitute Working Group I, i.e. the Guidelines Coordination Committee. Section 4.3 provides the terms of reference for the various Working Groups. Other committees include the Technical Advisory Committee and the UN-Water Steering Committee.

- Activities
  i. establishing critical parameters and recommending qualitative and quantitative guidelines/criteria for the respective thematic areas (Working Groups II-VI);
  ii. preparations of specific chapters and supporting documents for thematic areas (Working Groups);

iii. coordination and integration of thematic areas, compilation of chapters and supporting documents to produce the first draft of the guidelines (Working Group I);
iv. circulation of the first draft guidelines to the Reviewers (Secretariat);
v. reviewing the first draft guidelines (Reviewers);
vi. revision of draft guidelines to incorporate comments and suggestions of the Reviewers (Working Groups);
vii. production of the second draft (Working Group I);
viii. regional/sub-region conferences to endorse the second draft (coordinated by the Secretariat);
ix. circulation of the second draft to the Reviewers (Secretariat);
x. reviewing the second draft guidelines (Reviewers);
xi. revision of second draft guidelines and production of the final draft (Working Group I);
xii. Multi-stakeholder forums with government representatives, meeting of Technical Advisory Committee to discuss the final draft (facilitated by the Secretariat);
xiii. open call for comments, overseeing the review process, editing the final draft, and finalization (Working Group I);
xiv. publication of the first edition of the guidelines (facilitated by the Secretariat).

- Interim Result
  i. Recommended guidelines/criteria for aquatic ecosystems;
  ii. Draft guidelines documents;
  iii. Approval of draft documents by multi-stakeholder forums
- Working Group meetings

  A minimum of four workshop sessions for Working Group II-V is proposed;
  i. 1st Working Group Workshop (Induction Workshop) to assign roles and responsibilities,
  ii. 2nd Working Group Workshop to compile specific chapters and supporting documents from each thematic area, and
  iii. 3rd Working Group Workshop after 1st revision;
  iv. 4th Working Group Workshop after 2nd revision

During each workshop, the Working Groups, including the Coordination Committee and the Technical Advisory Committee shall meet in plenary. Separately, the Technical Advisory Committee shall meet four times during the guidelines development process. A breakdown of all the workshops/meetings is shown in Table 1.

- International conferences

  At least ten conferences are envisaged, i.e. at least one in each region/sub-region to endorse the second draft. The following regions/sub-regions are proposed

  i. North Africa and the Middle East (Arab speaking countries),
  ii. Sub-Saharan Africa,
  iii. Asia-Pacific (East Asia, Central and South Asia, South East Asia and Oceania),
  iv. Europe (Eastern Europe, Western & Central Europe),
  v. North America,
  vi. South America, including Central America and the Caribbean island states
- Output
  i. International Guidelines for Aquatic Ecosystems;
- Duration

  4 years (minimum). The timeline is shown in Table 1 below.
- Expected cost – $ 5,603,800.00

Launching the Guidelines

The official launch of the guidelines will take place at several major international conference/event, preferably on World Water Day following the publication of the first edition.

- Activities
  i. workshop with government agencies and development partners on the guidelines;
  ii. official launching ceremony;
  iii. distribution of copies of the guidelines;
- Interim Results
  iv. official launch of guidelines;
  v. distribution of hard copies of the guidelines;
- Expected cost – $ 500,000.00

Table 1. Timeline for guidelines development, including deliverables and key milestones

Task	Responsibility	Period	Duration
Constituting Working Groups, Reviewers and Technical Advisory Committee	Consultant	Start: Oct. 2011 End: Mar. 2012	6 months
1st Working Group Workshop; 1st meeting of Technical Advisory Committee	Secretariat	March, 2012	-
Establishing guidelines protocol/trigger values and preparation of chapters	Working Group	Start: Apr. 2012 End: Mar. 2013	12 months
2nd Working Group Workshop 2nd meeting of Technical Advisory Committee	Secretariat	March 22, 2013	-
Compilation of chapters and supporting documents to produce the 1st draft	Working Group	Start: Apr. 2013 End: Jun. 2013	3 months
Reviewing the 1st draft guidelines	Reviewers	Start: Jul. 2013 End: Sept. 2013	3 months
Revision of 1st draft to incorporate comments and suggestions	Working Group	Start: Oct. 2013 End: Mar. 2014	6 months
3nd Working Group Workshop; 3rd meeting of Technical Advisory Committee Regional/sub-region conferences	Secretariat	March, 2014	-
Compilation of chapters and supporting documents to produce the 2nd draft	Working Group	Start: Apr. 2014 End: Jun. 2014	3 months
Reviewing the 2nd draft guidelines	Reviewers	Start: Jul. 2014 End: Sept. 2014	3 months
Revision of the 2nd draft to incorporate comments and suggestions	Working Group	Start: Oct. 2014 End: Mar. 2015	6 months
4th Working Group Workshop; 4th meeting of Technical Advisory Committee	Secretariat	March, 2015	-
Compilation of chapters and supporting documents to produce the final draft	Working Group	Start: Apr. 2015 End: Jun. 2015	3 months
Open call for comments; Editing the final draft; Publication of the 1st Edition	Secretariat Editors	Start: Jul. 2015 End: Mar. 2016	9 months
Launching the guidelines	Secretariat	March, 2016	-

5.1.3. Part III: Post-development Phase

Dissemination and Awareness Creation

The Secretariat will ensure a broad international distribution of the guidelines to ensure its widest possible availability and use. Promotion and dissemination will create awareness of the existence and relevance of water quality guidelines for aquatic ecosystems. It will enhance collaboration at various levels (national, regional and international) among scientists, practitioners, NGOs, civil society, environmental experts and consultants, policy makers and government authorities working in the field of water quality management. In this way, the guidelines and its supporting documents will be distributed worldwide.

- Activities
    i. distribute copies of the document at major international water events;
    ii. display copies of the documents and its appendages online;
    iii. national/regional/international workshops/conferences with governments, scientists and practitioners to disseminate and apply the guidelines;
    iv. translations of the guidelines into several languages
    v. providing update on new developments.
- Outputs
    i. widespread distribution of the guidelines and its supporting documents;
- Duration:
  Ongoing (starts immediately after publication and launch of first edition);
- Expected cost – $ 1,000,000.00

Application and Capacity Development

Capacity development will aim at creating and enhancing the enabling environment to apply and/or adapt the guidelines at regional, national or local scale. Capacity development will foster knowledge transfer and exchange of ideas, regarding the procedures for guidelines development, as well as their adaptation and application in different parts of the world. This undertaking will be facilitated by the Secretariat.

- Activities
    i. mobilizing resources, including finance, institutional and technical capacity;
    ii. developing communication and capacity development strategy for guidelines adaptation and application;
    iii. knowledge transfer for capacity development
    iv. conferences and training workshops with governments, scientists and practitioners on guidelines application;

v. building national capacities that will enable guidelines adaptation and application;
vi. inter-governmental workshops to exchange and share knowledge on guidelines adaptation and application.

- Outputs
  i. widespread application/adaptation of the guidelines;
  ii. knowledge transfer centers for guidelines application;
- Duration
  On-going process after publication of the guidelines;
- Expected cost – $ 6,300,000.00

Evaluation and Reporting

Evaluation will check and assess the progress on guidelines application/adaptation and provide feedback for improvements, effectiveness and impact. The aim will be to resolve some of the pressing practical issues in adapting/application of the guidelines and to identify any knowledge gaps that may impede adaptation/application. The Secretariat will be supported by a group of consultants for this undertaking;

- Activities
  i. monitor uptake and user experience on application/adaptation of the guidelines;
  ii. assessing the effectiveness of the guidelines, i.e. impact in improving the water quality status of aquatic ecosystem;
  iii. asking for feedback from around the world about the elements in the guidelines that may be difficult to apply;
  iv. identifying knowledge gaps and prioritize incipient research areas;
- Outputs
  i. monitoring and evaluation report;
  ii. good practice recommendations to improve subsequent editions/versions;
  iii. action to improve guidelines application and adaptation;
  iv. knowledge gaps and priority research areas
- Duration
  On-going process, beginning 1-2 years after publication of the first edition of guidelines;
- Expected cost – $ 1,000,000.00

Upgrading the Guidelines

Periodic reviews will be undertaken through a 'rolling' process to add guidelines for constituents that are not yet included in the previous editions and to update the guidelines for

included constituents as relevant new information is made available. Upgrading the guidelines will enable its use by regions, countries and local water quality management authorities that may find the first edition difficult to use or put into practice. In addition, upgrading will clarify any misunderstandings that may arise from the application of the first edition of the guidelines.

- Activities
    i. global and region consultations with governments, scientists and practitioners, as well as development partners/agencies to support review process to upgrade the guidelines;
    ii. Working Group on Guidelines Evaluation and Revision makes recommendations on respective thematic areas;
    iii. preparations of specific chapters and supporting documents;
    iv. compilation of chapters and supporting documents and circulation of draft revised guidelines to panel of reviewers;
    v. reviewing the draft of the revised guidelines by the review panel; vi) meetings of the technical review committee to incorporate comments and suggestions received from the reviewers;
    vi. editing the final revised text of the guidelines (with supporting documents), finalization and publication of the revised guidelines;
- Working groups required
  Working Group on Guidelines Evaluation and Revision shall comprise the experts in Technical Working Group I; independent consultants;
- Outputs
    i. revised edition of the water quality guidelines for aquatic ecosystems;
    ii. system of documentation for continuous improvement of the guidelines;
- Duration
  On-going process to be initiated 1-2 years after application/adaptation of the first edition;
- Expected cost– $ 1,350,000.00

5.2. Terms of Reference for the Committees

The Terms of Reference provides a description of the specific roles and responsibilities of various committees for the guidelines development process. In addition, it provides a framework for coordination among the various committees and the Secretariat and for decision making during the development process.

5.2.1. Technical Working Groups

The Working Groups shall be constituted of experts, mostly professionals and researchers, from various water quality-related disciplines. Each Working Group shall appoint a Group Coordinator at its first meeting. The Group Coordinators are the contact persons for their respective Working Groups. Coordinators shall be responsible for progress in their respective Working Groups. The Working Groups shall be responsible for creating the guidelines document. Five Technical Working Groups have been identified, namely:

i. Working Group I (Coordination Committee)
   Introduction and Framework, Monitoring and Reporting, Delivery of Guidelines, Coordination and Integration Group Coordinators shall constitute Working Group I, i.e. the committee responsible for coordination and management. In addition to defining the scope and framework of the guidelines, Working Group I shall coordinate the activities of the Technical Working Groups, integrating outcomes from their respective themes and achieving the milestones and deliverable. The Coordination Committee shall meet regularly to discuss developments in their respective areas to review progress and discuss future strategies and options.
ii. Working Group II (Water Quality Monitoring and Assessment)
   Working Group II shall provide guidance on collecting and analyzing data for water quality indicators. They will provide recommendations on the number, as well as the combination of indicator types that should be considered when monitoring aquatic ecosystems. This will include holistic assessment of water and sediment quality, as well as the use of biological indicators;
iii. Working Group III (Physical and Chemical Criteria for Aquatic Ecosystems)
   This Working Group shall be responsible for developing guidelines/criteria for physical and chemical criteria. Ideally, these will be two sub-working groups; one on process parameters and another on toxicants. The sub-working group on process parameters shall, for example, be concerned with issues such nutrients for various types of aquatic ecosystems, including groundwater and sediments, and for different levels of protection and pollution; Nitrogen (organic nitrogen, ammonia, nitrate plus nitrite and total

nitrogen); Phosphorus (filterable reactive phosphorus and total phosphorus); Phytoplankton biomass (chlorophyll-a); Water clarity (turbidity, suspended solids and Secchi depth); Dissolved oxygen. On the other hand, the sub-group on toxicants hall be responsible for developing guidelines/criteria for toxicants in water and sediments for various types of aquatic ecosystems, and for different levels of protection and pollution. Working Group III is expected to provide information on data requirements for the derivation of guidelines and establish the procedures for calculating values used in the derivation of guidelines, as well as information on tailoring them to suit specific local conditions;

iv. Working Group IV (Biological Criteria for Aquatic Ecosystems)
Biological Assessment; This Working Group shall be responsible for developing biological guidelines/criteria for various types of aquatic ecosystems for different levels of protection and pollution. Like Working Group III, this Working Groups shall provide information on data requirements and methods for the derivation of guidelines and establish the procedures for calculating values used in the derivation of guidelines, as well as information on tailoring them to suit specific local conditions;

v. Working Group V (Supporting Documents to the Guidelines)
Working Group V shall develop accompanying texts to facilitate understanding and usage of the guidelines. What will be considered a supporting document shall depend on the requirements of the guidelines that will be developed. But it is expected that Working Group V will be responsible for i) developing the framework for applying the guidelines, ii) reference materials on the various types of aquatic ecosystems, iii) adapting the guidelines for site-specific conditions and iv) information on monitoring, assessment and reporting. Working Group VI could also provide information on use-related water quality guidelines. Those documents will serve as reference materials only, listing national, regional and international use-related guidelines, with brief descriptions showing vital links to those documents to assist countries adapt them for local use.

5.2.2. Technical Advisory Committee (TAC)

The Technical Advisory Committee (TAC) shall serve as the counseling body to the Secretariat and the Working Groups. It shall comprise of at most 5 senior scientists/water quality experts with outstanding careers in the field of water quality management and standard setting. They will be selected based on merit and geopolitical considerations. The TAC shall review progress

and ensure quality control by monitor performance and quality of the deliverables. The TAC will work closely with the Secretariat and the Coordination Committee in particular.

5.2.3. UN-Water Steering Committee

The Steering Committee shall comprise the membership of UN-Water TPA on Water Quality. The Steering Committee will act as the main advisory body to the Secretariat. It will steer and oversee the work of the Working Groups and the Advisory Committee, and provide procedural guidance to the Secretariat. It shall monitor any major decisions that are made during the guidelines development and implementation process.

5.2.4. Reviewers and Editors

An unspecified number of reviewers will be recruited from various organizations or institutions in different parts of the world. Reviewers will validate information and improve the quality of the guidelines documents. Reviewers' comments will be considered by the Technical Working Groups. To standardize the review process, a common format will be agreed upon by the Secretariat and the Coordination Committee. The report form will contain key elements of the review, addressing the points that will be outlined in the form for each of the sections of the guidelines. Reviewers will be expected to provide courteous but constructive commentaries on the draft guidelines and give insight into any deficiencies and improvement of the document. Editors should have long-standing and distinguished career in water quality and proven knowledge in guidelines development. One of them will be responsible as "Editor in Chief" for finalizing the guidelines document process through its publication and release. Because of the nature of the document, it will be advisable to have at least three editorial assistants who will assist the "Editor in Chief" to organize and manage the contributions/chapters of the various Working Groups/sub-working groups.

5.3. Estimated Budget

Amount required by the undertakings for each year (US Dollars)							
ar 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total Y1-Y7
5,000.00							$155,000.00
9,000.00	$249,000.00	$249,000.00	$249,000.00	$249,000.00	$273,000.00	$273,000.00	$1,871,000.00
	$600,000.00			$0.00	$600,000.00		$1,200,000.00
	$1,226,500.00	$1,226,500.00	$1,706,500.00	$1,269,400.00	$174,900.00		$5,603,800.00
					$500,000.00		$500,000.00
					$500,000.00	$500,000.00	$1,000,000.00
					$3,150,000.00	$3,150,000.00	$6,300,000.00
					$500,000.00	$500,000.00	$1,000,000.00
						$1,350,000.00	$1,350,000.00
4,000.00	$2,075,500.00	$1,475,500.00	$1,955,500.00	$1,518,400.00	$5,697,900.00	$5,773,000.00	$18,979,800.00

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Objectives of the Proposed Guidelines

- The guidelines should be intended for use as the basis for standard setting and developing local, national and regional approaches (including standards and regulations) to safeguard aquatic ecosystems. Even though guidelines of an international dimension may guarantee consistency, transparency, and scientific defensibility, the guideline should not be seen as blanket values for national/international water quality regulation. Instead, the guidelines should aim at providing a water quality management framework by assembling information and guiding principles to help managers and regulators establish water quality objectives at the local level. In this regard, countries should be encouraged to set national water quality guidelines within the framework of the 'international' guidelines and modify them based on what is achievable in each country, except, of course for transboundary systems, in which case regional/international consensus will be required.
- Continuous improvement of water quality everywhere should be the water quality management objective of the guidelines. For critically polluted aquatic ecosystems, countries or regions should be encouraged to establish intermediate levels of water quality targets/objectives until the required water quality objective is eventually achieved. Targets must be based on scientific data and the framework should permit countries or regions to move outside the trigger/default single-values that will be presented in the guidelines, and to develop site-specific guidelines that are refined according to relevant local conditions (including environmental, economic, sociocultural considerations) and financial, technical and institutional resources. This approach should be the key message for adapting and applying the guidelines.
- The guidelines should not be seen as a directive or standard with values that must be enforced or met by all means and dates by which its implementation must be completed by countries around the world. Current evidence suggests that it is not feasible to globally enforce this type of regulation. Therefore, the proposed guidelines should be designed in a way that they can be understood as an advisory decision support tool with the intention of encouraging countries to incorporate the principles and procedures into their national/regional laws. They should be interpreted as a guidance document only to support informed decision-making, or as reference material or checklist for development programmes and water quality management strategies

that will protect aquatic ecosystems and meet the needs of people in a sustainable way. This is important as the guidelines should be considered as an advisory framework for managing aquatic ecosystems whereas regulation at the local level will be based on local, national or regional laws and regulations.

6.2. Type, Structure and Composition of the Guidelines

- The guidelines could follow a framework approach with default generic guidelines and trigger values/descriptive statements for different aquatic ecosystems types and for different levels of protection. In addition, it should be a document that provides a water quality management agenda, which outlines key steps for safeguarding aquatic ecosystems, with supporting documents and reference information within it. Other documents may include additional links to related water quality guidelines, in particular, use-related water quality guidelines as specified for various uses by the WHO, for example. Countries/regions should be encouraged within the framework of the guidelines to set specific targets for various water quality constituents based on informed science to achieve specific water quality objectives and goals.
- The guidelines should consider a broad definition of the term aquatic ecosystems to include all water bodies such as rivers, coasts, estuaries, lakes, man-made structures and groundwater and sections within the document may focus on specific water types. The definition should include habitats and ecological processes contained within rivers and their riparian zones, reservoirs, lakes and wetlands and their fringing vegetation. With a broad definition, various types of aquatic ecosystems like marine and estuarine ecosystems are included and when required, guidelines for such systems may be developed by countries/regions separately. Because water quality, ecosystem health and the surrounding environment are all intimately connected, the guidelines should be broadened to include sediments and groundwater systems as well using the ecosystem type specific approach.
- Only a handful of countries have established water quality guidelines. It is advisable that the suggested scope of the guidelines reflect the needs of countries around the world. Hence the definitive criteria must be realistic and measurable to ensure effective protection and improvement of aquatic ecosystems and use-related values as may be required at the local level. As it is unlikely that any country will develop water quality guidelines for aquatic ecosystems alone without consideration for use-related environmental values, it is necessary to provide information on user-related water quality guidelines even if this is provided as links within supporting document.

- For truly integrated water quality objectives, broad scale issues must be considered across whole management unit, i.e. catchments/river basins where this is appropriate. In particular, as much as possible, the guidelines should provide recommendations that water managers can use to guide practice and formulate policy, taking into account local conditions and associated costs and benefits.

6.3. Guidelines Development Process

- Given that guidelines development is resource intensive with a strong need for partnership, it is important to involve interested development agencies/partners and international organizations from the very beginning. Collaboration is extremely important throughout the development process to secure resources in time and it is important to deal with the development process in short cycles that are manageable one at a time.
- Consultation is very important to establish a firm basis for guidelines development and implementation. As the proposed guidelines must be developed through broad international participation based on scientific consensus and best available evidence, the relevance of comprehensive consultations can be easily justified.
- Progressive innovation should be encouraged even though major departures from the fundamental concepts should be reviewed on a regular basis. In actual fact, periodic review through a so-called 'rolling process' is necessary either to address differences in opinion on unresolved issues or simply to update the guidelines for constituents currently included as relevant new information becomes available on the water quality status as a whole or for a particular constituent. In this way, the guidelines will be kept up-to-date.

To conclude, it should be highlighted that developing reference guidelines for aquatic ecosystems at the international level is a resource intensive undertaking considering the requirements for time, funding and human capacity. Nevertheless, it can be done and in many ways it can be argued that it has to be done given the current state of pollution in many aquatic ecosystems around the world. In reality, developing 'international' guidelines for aquatic ecosystems should be seen as an opportunity for scientists, policy makers and practitioners to dialogue and develop a common procedure to address water quality challenges from a global point of view. There is sufficient evidence to suggest that "international" water quality guidelines for aquatic ecosystems can mobilize the action needed to address water quality problems at the global level. The TPA should ensure that the right development partners are selected, and governments around the world are engaged in the process from the very

beginning. In this way, the mission of the TPA as a mechanism of UN-Water to enhance interagency collaboration and advocate international action on water quality can be fulfilled. Eventually, when the proposed guidelines are developed, they should reflect the needs of most (if not all) countries around the world. This means the feasibility of the guidelines and its guiding principles must be demonstrable under operational conditions. Therefore, it is essential that the guidelines and supporting documents are designed such that they can be adapted or refined to address specific local situations everywhere. Ultimately, when all is said and done, what should emerge are guidelines that can be applied in many parts of the world as the principal reference material and decision support instrument for regulators, water quality managers and others who are responsible for managing water quality at the local level.

The scoping study is a foundation for the TPA to build upon to move the process forward by building on its findings and recommendations. Perhaps, with the initiative, water quality managers and regulators, and all those involved in maintaining the integrity of aquatic ecosystems will find a common goal for water resources management, with globally accepted rules (minimum requirements) and quality criteria for a co-existence of human and natural systems, which do not compromise the development of future generations. This co-existence must be adapted to regional climatic and geologic conditions and historic developments. This means the rules/guidelines will have to be adapted continuously to the development of humans and nature based on the progress of scientific knowledge and sound monitoring results. Beside the different natural conditions, it is important during adaptation and/or implementation to consider appropriate levels of economic growth and priorities for different countries or regions. Operationally, 'international' guidelines for aquatic ecosystems can only have the character of a tool to support decision making as many problems will remain a matter of discussion and compromise at the local level. Therefore, as best as possible, basic rules must be kept simple, but in future, even those basic rules will be changed according to advancements of our understanding of the cause-effect relationships between our behaviour and natural response to it.

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Water Quality Guidelines in Japan - Includes aspects of the presentation of Kunihiko Yamazaki, EQSPAE – 2011 (International Conference on Deriving Environmental Quality Standards for the Protection of Aquatic Ecosystems), Hong Kong, China (3-7 December 2011; http://www.biosch.hku.hk/eqspae/speakers.html;

Water Quality Guidelines in Korea (South) - Culled from the presentations of Prof. Youn-Joo An and Prof. Seung-Woo Jeong , EQSPAE – 2011 (International Conference on Deriving Environmental Quality Standards for the Protection of Aquatic Ecosystems), Hong Kong, China (3-7 December 2011; http://www.biosch.hku.hk/eqspae/speakers.html

Web excerpts

Water Quality Guidelines in Japan – Extracted from the homepage of WEPA (Water Environment Partnership in Asia) - http://www.wepa-db.net/policies/measures/currentsystem/malaysia.htm;

Water Quality Guidelines in India - Source: Water Pollution Control - A Guide to the Use of Water Quality Management Principles, by Richard Helmer and Ivanildo Hespanhol on behalf of UNEP, WSSCC and WHO; http://www.who.int/water_sanitation_health/resourcesquality/wpcchap2.pdf)

Water Quality Guidelines in Korea (South) - Extracted from the homepage of WEPA (Water Environment Partnership in Asia) http://www.wepa-db.net/policies/measures/currentsystem/malaysia.htm;

Water Quality Guidelines in Malaysia - Extracted from the homepage of WEPA (Water Environment Partnership in Asia) - http://www.wepa-db.net/policies/measures/currentsystem/malaysia.htm

Water Quality Guidelines in Nigeria - Source: Water Pollution Control - A Guide to the Use of Water Quality Management Principles, by Richard Helmer and Ivanildo Hespanhol on behalf of UNEP, WSSCC and WHO; http://www.who.int/water_sanitation_health/resourcesquality/wpcchap2.pdf

Water Quality Guidelines in Thailand - Source: Water Pollution Control - A Guide to the Use of Water Quality Management Principles, by Richard Helmer and Ivanildo Hespanhol on behalf of UNEP, WSSCC and WHO; http://www.who.int/water_sanitation_health/resourcesquality/wpcchap2.pdf

Water Quality Guidelines in Viet Nam - Source: Water Pollution Control - A Guide to the Use of Water Quality Management Principles, by Richard Helmer and Ivanildo Hespanhol on behalf of UNEP, WSSCC and WHO; http://www.who.int/water_sanitation_health/resourcesquality/wpcchap2.pdf

8. APPENDICES

8.1. Appendix I: Terms of Reference – UN-Water Thematic Priority Area on Water Quality

Terms of Reference

for developing International Water Quality Standards/Guidelines for Ecosystems

November 2010

Title:	Water Quality Standards/Guidelines Consultant
Task:	Scoping study to develop international water quality standards/guidelines for ecosystems
Period:	45 person days over nine months
Supervision:	UNEP Division of Environmental Policy Implementation

I. Background

The UN-Water Thematic Priority Area (TPA) on Water Quality was established by UN-Water in September 2010. The TPA aims at enhancing interagency collaboration and coordination in water quality as well as support Governments and other stakeholders to address water quality challenges. The TPA will advocate for the prevention of pollution in water bodies and in the case of contaminated water, promote appropriate treatment, safe reuse and the restoration of ecosystems. The TPA will further assist UN-Water to monitor and report on water quality globally, identify emerging water quality challenges and propose relevant responses.

The purpose of this assignment is to develop international water quality standards/guidelines for ecosystems as an important input towards the improvement of global water quality monitoring; the development of legislation, policies, and regulations on water quality;

enhancing research and capacity building on water quality; and for raising global awareness about water quality.

The health of ecosystems and the services they provide are intrinsically linked to water and its quality. Due to increasing human activities, freshwater ecosystems are degrading rapidly and with this, their regulating services including the water purification function are declining. At the same time, water quality is deteriorating at an alarming rate. Cumulatively, this impacts on the benefits for humans and their health.

While international standards for drinking water quality have been developed and are well established, corresponding standards for ecosystems do not exist at the international level, representing a significant gap. This assignment attempts to develop international water quality standards/guidelines for ecosystems. This undertaking is complex given the diversity of ecosystems and therefore calls for the involvement of the entire UN system as well as of external experts and institutions.

The development of the standards and guidelines will be guided by the TPA on Water Quality, The active participation of the members of the TPA as well as other UN-Water members and partners and external experts and institutions, however, will be very important.

II. Overall goal

Acceptable water quality achieved through the adoption and application of internationally agreed water quality standards/guidelines for ecosystems.

III. Objective of the process

Internationally agreed water quality standards/guidelines for ecosystems developed and agreed.

IV. Specific expected result of this assignment

Consensus reached on the scope and nature of the international water quality standards/guidelines for ecosystems to be developed as well as on the process to do so.

V. Purpose of the TOR

The TOR serve the purpose of guiding the consultant to undertake a scoping study for developing the international water quality standards/guidelines for ecosystems.

VI. Specific tasks

Under the overall guidance of the Deputy Director of the Division of Environmental Policy Implementation (DEPI) and the direct supervision of the Head of the Freshwater Ecosystems Unit in DEPI, the consultant will undertake the following duties:

1. Consult with UNEP and all members of the TPA to get an in-depth understanding of their expectations in terms of the water quality standards/guidelines and their contribution and the process to develop them. Obtain a briefing by UNEP about the terms and scope of the assignment of developing international water quality standards/guidelines for ecosystems.
2. Based on 1. and preliminary research, prepare an inception report with own interpretation of the tasks of the ToR, the scope of the assignment in terms of content and process, a detailed work plan, and methods to be applied.
3. Present the inception report at a brainstorming meeting of selected experts to review and make further input. Incorporate the comments and recommendations from the brainstorming meeting into the inception report and submit a second draft.
4. Upon approval of the inception report, undertake a scoping study as outlined. Identify existing water quality standards/guidelines for the environment and ongoing and planned initiatives to develop such standards/ guidelines. Collect any other relevant literature as necessary. Interview key persons for additional information as and when relevant.
5. Analyse the information collected in particular on existing water quality standards/guidelines for ecosystems to get an overview of how well they meet the needs for monitoring and managing water quality for the environment.
6. Identify gaps and weaknesses of the existing water quality standards/guidelines.
7. Assess how well these standards/guidelines are supported by legislation and policies and enforceable on the ground.
8. Compile recommendations on how to develop international water quality standards/guidelines for ecosystems building on the existing ones, the literature review and the interviews carried out, to address the existing gaps, weaknesses and challenges.

9. Prepare a work plan on how to develop international water quality standards/guidelines for ecosystems outlining the process of developing such standards/guidelines; working group(s) and expert meetings required; a preliminary outline of the standards/guidelines; key indicators for water quality for ecosystems with targets; policy recommendations for improving the implementation of the standards: strengthening legislation and policies and enforcement, and knowledge and technology transfer, and capacity building.
10. Present the findings, conclusions and recommendations of the scoping study as well as the detailed work plan to the TPA.
11. Revise the outputs based on the comments and inputs received from the TPA and finalize the outputs.

VII. Deliverables

The consultant shall deliver the following outputs:

1. A finalized inception report, by March 2011.
2. A finalized scoping report including findings, conclusions and recommendations, by May 2011.
3. A finalized work plan on the development of international water quality standards/guidelines for ecosystems, by July 2011.

VIII. Timing of the assignment

The assignment shall be undertaken over a period of nine months. It shall commence 1 January 2011 and end by 30 September 2011.

A total of 45 person days are allocated for the assignment, broken down as follows:

1. Preparing and revising an inception report: 10 person days
2. Undertaking a scoping study: 20 person days
3. Preparing a work plan including review and finalization: 15 person days

IX. Qualification

The required expert shall posse an advanced university degree in water and environmental sciences and has relevant research and work experience. A strong scientific background and relevant work experience in the area of water quality will be an important asset.

The required expert shall have the following additional qualifications:

- Familiarity with the working environment of UN-Water and its members and partners.
- Very good research and analytical skills.
- Good IT knowledge in particular Microsoft office.
- Excellent communication skills.
- Proficiency in English with proven drafting ability.

X. Remuneration

The remuneration for this assignment will be US$ 20,000 (twenty thousand United States Dollars) payable in three tranches:

- 30% upon signing of contract,
- 30% on submission of the background study and the draft concept note, and
- 40% upon completion i.e. submission of the finalized concept note.

8.2. Appendix II: Implementation Plan

INTERNATIONAL WATER QUALITY STANDARDS/GUIDELINES FOR ECOSYSTEMS

SHORT IMPLEMENTATION PLAN FOR A SCOPING STUDY

Commissioning organization: United Nations Environment Programme (UNEP)

Implementing institution: Vienna University of Technology - Institute for Water Quality Resources and Waste Management (IWAG)

Activities (broken down into responsibilities):

T1.1: IWAG develop a short Implementation Plan based on current TOR; **February, 2011**

T1.2: UNEP prepare the contract; **February, 2011**

T1.3: IWAG and UNEP agree and sign the contract; **February, 2011**

T2.1: UNEP provide IWAG with contact details of UN-Water TPA members; **February, 2011**

T2.2: IWAG initiate consultations with members of UN-Water TPA; **February, 2011**

T2.3: UNEP brief IWAG ***(Travel)*** on the TOR and scope of the study; **February, 2011**

T3.1: IWAG undertake preliminary research on the scoping study based on: i) current TOR and ii) consultations with members of UN-Water TPA; **February - March, 2011**

T3.2: IWAG prepare a draft Inception Report on the scope of the study with own interpretation of the TOR, including content, processes, methods and detailed work plan; **March, 2011**

T3.3: IWAG ***(Travel)*** participate at UNEP convened workshop on water quality standards for ecosystems during 2011 World Water Day event in South Africa and present the Inception Report at a brainstorming session with a panel of experts selected by UNEP; **March, 2011**

T3.4: IWAG finalize the Inception Report, incorporating comments and recommendation from the workshop participants and the UNEP selected panel of experts; **March, 2011**

T3.5: UNEP approve the Inception Report; **March, 2011**

T4.1: IWAG undertake research on the scoping study (desktop study plus consultations with members and partners of UN-Water TPA, experts and institutions); **April - June, 2011**

T4.2: IWAG prepare a draft report with recommendations to address gaps, weaknesses and challenges; **June, 2011**

T4.3: IWAG prepare a draft work plan with procedure to develop international water quality standards/guidelines for ecosystems; **June - July, 2011**

T4.4: IWAG ***(Travel)*** present findings, with recommendations and a detailed work plan with procedure to develop water quality standards/guidelines for ecosystems; **July, 2011**

T4.5: IWAG review outputs and completes the scoping study based on input and feedback by UN-Water TPA during presentation and further consultation; **August - September, 2011**

T4.6: IWAG submit the final report – scoping study & work plan; **September, 2011**

Deliverables (with month of delivery):

D1: Implementation Plan; **February, 2011**

D2: Inception Report; **March, 2011**

D3: Scoping study (draft) – concept note with recommendations and procedure; **June, 2011**

D4: Work plan (draft) for developing international water quality standards; **July, 2011**

D5: Final report - scoping study & work plan; **September, 2011**