CHAPTER 2:
RESOURCE CLASSIFICATION FRAMEWORK

2.1 INTRODUCTION

The objectives of the NTMP are stated in the Background chapter. The "strategic management decisions" typically relate to the following kinds of issues:

- International responsibilities (overseas as well as neighbouring countries).
- Large scale (spatial and temporal) monitoring of the Department's management efforts.
- Capacity creation as a basis for further regional capacity creation.

The word strategic implies large in scale, both spatial (*e.g.* Water Management Areas and National) and temporal (*e.g.* annual or longer).

A particularly important focus of the objectives is on fitness for use and aquatic ecosystem integrity. National monitoring programmes to date have had similar objectives, although some have been less focussed on ecosystem integrity and more on fitness for use. In order to assess fitness for use they have typically developed their own guidelines against which monitoring data are assessed. The following are some examples:

- The microbial monitoring programme developed *E. coli* and faecal coliform guidelines that assessed the likely health risk associated with a number of sensitive water uses (like drinking untreated water, drinking partially treated water, irrigation of crops eaten raw and recreational use).
- The eutrophication monitoring programme assessed "trophic status" against chlorophyll *a* and total phosphorous concentrations (allowing a classification of impoundments from oligotrophic through to hypertrophic).
- The river health programme has developed indices that report the degree of departure of a water resource from natural (reference) conditions. This programme is primarily focussed on ecosystem integrity and not uses such as domestic, agricultural, industrial, etc.
- The inorganic chemical monitoring programme can assess its results against the South African water quality guidelines. If, for example, the livestock watering guidelines are used, then fitness for this particular use can be assessed.

A central question in the design of the NTMP is exactly what is most usefully and practically meant by "fitness for use". A question that is implied by this is "what guidelines should the NTMP be using to assess its monitoring data?".

The following sections recommend an approach to national status and trends monitoring that addresses these questions.

2.2 ASSESSING ECOSYSTEM INTEGRITY

The approach used in the development of the water quality component of the ecological Reserve [Rossouw, 2004] suggests a way forward. The purpose of this component of the ecological Reserve is to ensure that water of adequate quality is maintained in ecosystems to ensure a certain desired level of integrity.

2.2.1 Ecological category and the Ecological Reserve

The basic level of ecosystem integrity is defined on a resource-specific basis. In particular, an "ecological category" for which water resource managers should aim is defined as Fair, Good or Natural. A Poor state is regarded as unsustainable and is never a desired state. If the present state is Poor, then it should be managed in such a way as to improve it to the desired state.

Importantly, the ecological category need not always be Natural. It must necessarily ultimately relate to the formal classification of the resource unit in question. This also takes account of how stakeholders wish to use the resource. In other words, classifying a resource is equivalent to the stakeholders saying that they wish the resource to (a) maintain a certain degree of ecosystem integrity and (b) enable the water to be used for certain well-defined uses. The latter may vary from recreational, through industrial to various agricultural uses (like livestock watering, aquaculture, irrigation, etc.) and domestic use. The degree of ecosystem integrity and the nature of the uses must necessarily be compatible. For example, if the water is intended to be used for a purpose that inevitably impacts negatively on ecosystem integrity, it may be agreed that the latter may be sacrificed somewhat for the greater socio-economic advantages of the intended use.

It is these concepts that ultimately make the classification and the Reserve the first line of defence against unsustainable development.

2.2.2 Guidelines for the Ecological Reserve

The most fundamental concept to be applied in the determination of an ecological Reserve relating to guidelines is illustrated in the following table.

Table 2.1. Illustration of the most fundamental concept in the ecological Reserve determination relating to toxicants and toxicity. (NOEC = no observable effect concentration; LC_0 = maximum concentration that does not cause lethality.)

Ecological category	Criteria	Toxicity observed	Toxicant concentration (X) observed
Natural	No toxicity of any kind	None	$X < NOEC$
Fair & Good	No lethality (short- or long-term)	Sub-lethality	$NOEC < X < LC_0$
Poor (unsustainable)		Lethality	$X > LC_0$

The following should be noted:

- The original basic concept has been slightly refined and re-defined here to improve clarity and practicality.
- The original wording used the terms acute and chronic. These were defined as meaning lethality and sub-lethality respectively. In order to avoid potential confusion, the words acute and chronic are not used here.
- The ecological Reserve determination goes further than the basic concept illustrated in the table. It must also distinguish between the Fair and Good categories. However, it is recommended that for the NTMP these two categories are grouped together (for simplicity).
- The ecological Reserve concept referred to the terms chronic effect values and acute effect values. These have been re-defined as "no observable effect concentration" (NOEC) and LC_0 (maximum concentration that does not cause lethality) to be more consistent with the "no toxicity" and " no lethality" criteria.

Importantly, the ecological Reserve guidelines will ultimately achieve significant regulatory status in that they will be published in the *Government Gazette*. Accordingly, to be defensible, these values must be based on a significant amount of data and formal analysis [*e.g* Jooste and Rossouw, 2002].

2.2.3 Resource Quality Objectives

Resource Quality Objectives (RQOs) are objectives against which it can be assessed whether or not a water resource is presently in its desired state (or moving towards it). One numerical expression of these are Resource Water Quality Objectives (RWQOs) that may also be defined at a greater spatial and temporal resolution that RQOs. For example, a RQO may express where the resource should ultimately be. RWQOs may state explicitly where in the water resource (and when) certain targets should be achieved in order to ultimately achieve the overall RQO.

The RQOs and RWQOs will necessarily need to be compatible with the variables chosen to monitor the water quality component of the ecological Reserve (and the basic human needs Reserve).

Since RQOs will also be published in the *Government Gazette* (but not so with RWQOs), the RQOs will also have significant legal status and therefore will also necessarily have to be based on defendable data and analysis.

2.2.4 Applicability to the NTMP

2.2.4.1 Monitoring endpoint

The above suggests that, within the context of ecosystem integrity, the NTMP could use the same basic concept as illustrated in the table above (for both toxicants and toxicity). However, one critical and obvious difference would be that the NTMP would not use the same monitoring variables. Nevertheless, the ultimate purpose of the NTMP would still be to specifically assess the following question ("endpoint"):

Is the water resource in an acceptable ecological category?

An "acceptable ecological category" is defined for current purposes as follows:

Table 2.2. Definition of acceptable and unacceptable ecological categories.

Desired ecological category	Acceptable ecological category	Unacceptable ecological category
Natural	Natural	Poor, Fair or Good
Good	Fair, Good or Natural	Poor
Fair	Fair, Good or Natural	Poor

This is, in effect, the same issue addressed by monitoring variables specifically associated with the ecological Reserve. However, the latter monitoring would use the associated "Gazetted" variables while the NTMP would use other specially chosen variables.

2.2.4.2 Monitoring variables

The NTMP monitoring variables would need to have certain properties:

- The NTMP variables would need to complement the information obtained from the ecological Reserve and RQO monitoring variables. However, they need not be based on the same degree of data and formal analysis since "broad brush" national monitoring need

not be reporting with the same degree of certainty. (For example, identification of polluters is not an objective of national status and trends monitoring.)

- The NTMP variables can address other issues of national (and international) concern. For example, these variables can help keep abreast of the latest international trends and investigate their relevance to South Africa.

It is conceivable that as more data are collected over the years for NTMP monitoring variables that they may be "promoted" to the level of ecological Reserve monitoring variables or even RQOs. However, this is only likely to be done when the latter variables come up for revision and it is considered appropriate to include other variables to improve the quality and quantity of the more "formal" monitoring RQO-related information provided to resource managers.

The above endpoint suggests a very simple choice of monitoring variables (illustrated in the following tables). (This simplicity is one aspect of the currently proposed approach that makes it very attractive.)

Table 2.3. Choice of toxicity tests and interpretation of guidelines for ecosystem integrity.

		Is resource in an acceptable ecological category?	
Desired ecological category	**Recommended toxicity test**	**If toxicity detected**	**If toxicity NOT detected**
Natural	Sub-lethality	No	Yes
Fair or Good	Lethality	No	Yes

It is proposed that Fair and Good categories be combined into one category for the purposes of national status and trends monitoring. This is regarded primarily as a simplification.

An analogous approach can be used for the concentration of a toxicant based on its NOEC and LC_0:

Table 2.4. Interpretation of toxicant guidelines for ecosystem integrity.

		Is resource in an acceptable ecological category?	
Desired ecological category	**Recommended guideline**	**If concentration > guideline**	**If concentration <or= guideline**
Natural	NOEC	No	Yes
Fair or Good	LC_0	No	Yes

2.2.4.3 Reporting format

The above endpoint suggests a very simple reporting format. A map of an area could reflect each monitoring site and simply report whether or not the present state of the resource is within (or better than) the desired ecological category at each site. If the answer is "yes" a green icon can be used. If the answer is ""no", a red icon is used.

2.3 ASSESSING FITNESS FOR USE

2.3.1 Introduction

An equivalent approach to the above can be adopted for assessing fitness for specific uses. The endpoint in each case could be as follows:

Is the water resource in an acceptable water use class?

An important issue here will be the choice of test organism. It should ideally be one that is representative of target organisms appropriate to the nature of the use, *i.e.* those to be afforded some degree of protection. The table of typical target organisms is reproduced here for convenience.

Table 2.5. Target groups associated with standard water uses [based on Slabbert and Murray, 2004].

Protective context	Most obvious direct target groups	Most obvious indirect target groups
Aquatic ecosystem integrity	Microbes, Fish, Invertebrates, Birds, Mammals, Amphibians, Reptiles, Molluscs, Crustaceans, Plants	Humans
Domestic use	Humans	
Recreational use	Humans	
Industrial use*	Humans	
Agriculture use - irrigation	Plants	Humans, Mammals
Agriculture use - livestock watering	Mammals, Birds	Humans
Agriculture use - aquaculture	Fish, Reptiles, Plants	Humans, Mammals

* Regarded as equivalent to domestic use in the current context.

2.3.2 Water use class

Categories such as Unacceptable, Tolerable, Acceptable and Ideal are used to categorise the degree to which a water resource is suitable for specific uses. These are conceptually equivalent to the above ecological categories. The NTMP will need to recommend guideline values that distinguish (a) Unacceptable from Tolerable and (b) Acceptable from Ideal. As above (and again for simplicity), it is recommended that the categories Tolerable and Acceptable be grouped together. That is, for the purposes of the NTMP, no attempt should be made to distinguish between these two.

For toxicity tests, exactly the same general guidelines could be used as for ecosystem integrity above. That is, the equivalent of the unsustainable Poor ecological state would be assumed to exist if lethality is detected in an appropriate target organism. Similarly, a Natural state would be assumed to exist if no toxicity of any kind is detected.

For toxicants, again the same approach can be adopted. For the specific target organism relevant to the chosen use, a NOEC and LC_0 can be chosen and assessed in the same way as above. To be explicit, the following tables relating to water use class are the equivalent tables to those above for ecosystem integrity.

An "acceptable water use class" is defined as follows:

Table 2.6. Definition of acceptable and unacceptable water use classes.

Desired water use class	Acceptable water use class	Unacceptable water use class
Ideal	Ideal	Unacceptable, Tolerable or Acceptable
Acceptable	Tolerable, Acceptable or Ideal	Unacceptable
Tolerable	Tolerable, Acceptable or Ideal	Unacceptable

Table 2.7. Choice of toxicity tests and interpretation of guidelines for fitness for use.

		Is resource in an acceptable water use class?	
Desired water use class	**Recommended toxicity test**	**If toxicity detected**	**If toxicity NOT detected**
Ideal	Sub-lethality	No	Yes
Tolerable or Acceptable	Lethality	No	Yes

Table 2.8. Interpretation of toxicant guidelines for fitness for use.

		Is resource in an acceptable water use class?	
Desired water use class	**Recommended guideline**	**If concentration > guideline**	**If concentration <or= guideline**
Ideal	NOEC	No	Yes
Tolerable or Acceptable	LC_0	No	Yes

2.4 IN THE ABSENCE OF A CLASSIFICATION

Until the classification system is formally finalised and has been widely applied around the country, resources will not be formally classified. It may take many years before a significant percentage of the nation's water resources are formally classified in respect of both ecological category and water use.

In the interim, either desktop or rapid methods are likely to be necessary. Such methods are being developed. Specifically, guidelines are under development for the determination of Resource Water Quality Objectives [DWAF, 2004b] that can potentially also be defined as formal Resource Quality Objectives. The procedure specifically involves determining an appropriate ecological category and water use class. It is proposed that these procedures be used for the NTMP until formal classification is possible.

2.5 ADVANTAGES

It has been proposed that the ecological state, water use class and management class be related in the following way [DWAF, 2004b] (although this may be revised when the classification system is finalised).

Table 2.6. Potential relationship between ecological category, water use class and management class.

Ecological category	Water Use Class	Management Class
Natural	Ideal	Excellent
Good	Acceptable	Good
Fair	Tolerable	Fair

By linking the NTMP to the ecological category and the water use class, as described above, the NTMP is implicitly linked to the most fundamental of initiatives within the Department, namely the classification system and the Reserve. These are well recognised as being the most revolutionary concepts of the National Water Act that provide the first line of defence against unsustainable development.

Linking this national status and trends monitoring programme to the classification has the following advantages, and is accordingly strongly recommended:

- It provides unambiguous information that will "support strategic management decisions in the context of fitness for use … and aquatic ecosystem integrity" (the fundamental objective of the NTMP), since the management class is an implicit statement of what is desired for the resource in these two respects.
- It standardises how fitness for use and ecosystem integrity are interpreted in different contexts (specifically the Reserve, classification and national status and trends monitoring). In particular, this approach ensures this by adopting the same basic definition as that used for the ecological Reserve. In other words, the NTMP need not (and arguably should not) develop a different basic philosophy for choosing guidelines (as has been the case in other national status and trends monitoring programmes). Doing so has the danger of introducing inconsistency with the Reserve and the classification system.
- It provides clear guidance on the broad choice of NTMP monitoring variables (*e.g.* when to use lethality or sub-lethality toxicity tests and how to choose guidelines against which to assess monitoring data for toxicants).
- It provides a clear dividing line between variables chosen for the NTMP and those for monitoring the Reserve and Resource Quality Objectives (called "performance monitoring"). This is done by:
    - Explicitly choosing NTMP variables that complement, *i.e.* are not equal to, those chosen for performance monitoring, and
    - Allowing NTMP variables to be chosen that do not necessarily need extensive data availability and formal analysis (since national monitoring programmes need not report with the same demanding degree of confidence as the Reserve and RQOs), and
    - Allowing variables to be chosen that can address national (and international) issues not regarded as the immediate concern of the formal ecological class and water use class (though they may be of potential future concern). That is, there is greater flexibility in choice of monitoring variables in a national status and trends monitoring programme.
- It provides a natural approach to identifying priority resources upon which the NTMP should focus, particularly in the initialisation phase. For example, those water resources whose present state is worse than the management class are ideal initial candidates for the NTMP. These are, by definition, the resources in greatest need of attention and improvement. The more monitoring information that can be obtained about their status and trends the more informed management responses can be.

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