WRC/DWA framework document for the revision of Water Quality Guidelines: Facilitation of Workshops for the Risk-Based Water Quality Guidelines Update

Report to the
Water Research Commission

by

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EXECUTIVE SUMMARY

In 2007 a number of specific issues came to the fore that made it necessary to re-examine the philosophical basis used for determining and using the South Africa Water Quality Guidelines (SAWQG) published in 1996. These included, inter alia, the classification of water resources under the National Water Act (Act 36 of 1998) which will ultimately result in the determination of Resource Quality Objectives. The concept of risk was also seen as potential common basis for decision-making in various contexts. At the time it was also noted that there had been advances in guideline determination internationally and that the 1996 guidelines were not necessarily based on the latest, most appropriate science and practice. In addition there were water quality variables, such as organic substances that were not included in the 1996 guidelines. Site specificity was another aspect that was lacking as the 1996 SAWQG were very generic in nature.

At the time of the 2007 project initiation three phases were planned, however only phase 1 was implemented.

- Phase 1: Project delineation and development of philosophy;
- Phase 2: Application of philosophy and development of prototype guidelines; and
- Phase 3: Development of tools for higher-tier site-specific guidelines.

To resuscitate the project, the WRC through Dr Jennifer Molwantwa commissioned a Short Term Research Project focused on interactive workshops. The purpose of the workshops was to get a common understanding of the risk-based guideline theory as is reported in the Phase 1 study within the research community and within the WRC and DWS; and to align the approved irrigation water quality guideline project with the future guideline review and update projects.

The approach that was followed included an initial workshop with the irrigation guideline project team (4 August 2014), internal discussions, a second meeting with the irrigation project team (September 2014) and then a broader specialist workshop was held with a wider stakeholder group in February 2015.

The outcomes of the workshops and discussions are summarised below.

It is important to review the need for each guideline, existing or possibly new water use sectors, by asking questions such as:

- Why do we need a guideline for a particular use;
- Who will use the guideline;
- How will the guideline affect the way in which we manage water resources; and
- How will the guidelines link to existing legislation and regulations, such as SANS 241, Water Resource Classification and setting of Resource Quality Objectives?

Once the need for each guideline has been justified, the gaps in the current guidelines should then be determined in respect of aspects such as application, probability of exposure, additional variables and new science and approaches.

In deriving risk based water quality guidelines for the various sectors the following critical steps must then be considered.

1. Select suitable candidate end-points and by iteration (if necessary) select a suitable common end-point for all stressors and target combinations (for example, crop yield). An end-point must, at least in principle, be quantifiable, but not necessarily unique to a stressor;
2. Set up a fault tree for each stressor-endpoint combination that describes the salient environmental and target processes;
3. Evaluate the state of knowledge about each process: uncertainties, variability and quantitation of relationships as well as interactions with other stressors;
4. Formulate a suitable hazard expression for each stressor;
5. Consider the stressor exposure model – these models do not necessarily have to be numeric/ mathematical models at first but should be amenable to quantitative output;
6. Consider:
    a. How best to approach the numerical expression of risk, i.e. probabilistic versus possibilistic expression.
    b. How the main user output requirements (fitness for use-class versus class-related stressor profile) can be generated – this involves considering what risk numbers would reasonably correspond to expected outputs; and
    c. How stressor time series inputs must be handled.
7. Consider various realistic exposure scenarios and how they could be quantified;
8. For the Tier II and III guideline, formulate a risk assessment protocol for each stressor-target combination. Of importance is the description of the input and output quality, important calculation aids such as algorithms and models, caveats and skills requirements.
9. From the risk assessment protocol, select key exposure and hazard variables with known typical values that can be used in the risk calculation. The exposure scenarios in 6 above might be used as basis to obtain inputs from the user to generate more generic but still workable site-specific risk calculations. This is the Tier II guideline.
10. Consider what combination of stressor, target and water use scenarios would generate the highest risk values. Use these to generate the Tier I output.
11. Consider what qualitative or quantitative outputs would be most useful at each tier to guide the user to a sensible decision (for example: danger signs, water treatment or improvement options, further guidance via internet links and reference material).

The results from the above must then be packaged into a Decision Support System (DSS). When developing the DSS as part of the update for each guideline it is proposed that a demonstrator/ prototype system is developed that would include a user manual. Each developer will need to consider IP issues and controlled access to tiers; as well as putting forward recommendations on guideline updating issues and (perhaps) protocols.

It is recommended that the various demonstrator/ prototype systems be integrated by an independent team to develop an overarching DSS and user manual.

In considering the DSS some important questions to be answered are:

- Should there be one database, or one per sector;
- Who will maintain the database; and
- Who will be the ultimate owner of the DSS?

Collaboration with DWS is essential so that the department endorses the product to create a statutory environment to use as part of water resource management. In addition to this collaboration and the steps described above the following aspects need to be taken in to consideration as part of each guideline volume update.

- Assess how the guideline will link to existing standards, for example in the domestic sector SANS 241 must be considered and any update must not be in contradiction to the standard. In this respect collaboration with the relevant teams or organisations developing standards in any of the sectors must be take place;
- The guidelines therefore need to refer to the standards relevant to that sector and clearly state that the guidelines themselves are not standards;
- Application on how to use the guidelines is of utmost importance. Capacity building initiatives for this aspect will need to be clearly thought through and programmes developed and presented to the various uses of the guidelines including sector users and regulators, who would need to know how to integrate the guidelines from a resource manager perspective.

The update of the guidelines and the development of the DSS should be seen as a long term project over the next 12 years with the following proposed timeframes per project.

Task	**Proposed timeframe**
Technical review and risk assessment, including prototype/ demonstrator DSS per sector	2 years
International review	1 year but can be initiated in the second year of the technical review and risk assessment process
Overall DSS integration and roll-out of integrated system	2 years
Tier 1 adoption and implementation	Immediate as guidelines are reviewed and finalised

ACKNOWLEDGEMENTS

The authors would like to thank the Workshop participants, a list of whom is included in Appendix C and the Project Team developing the risk-based water quality guidelines for the Irrigation Sector for the constructive discussions during the duration of the project.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

APPENDICES

LIST OF ABBREVIATIONS

DSS	Decision Support System
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
NWA	National Water Act
SAWQG	South Africa Water Quality Guidelines
SSAWQG	Site-specific South Africa Water Quality Guidelines
STReP	Short Term Research Project

1 INTRODUCTION

1.1 Background to the project

The Department of Water Affairs' South African Water Quality Guidelines published in 1996 comprise the following fresh water and coastal marine water volumes:

Fresh Water:

- Volume 1: Domestic Water Use;
- Volume 2: Recreational Water Use;
- Volume 3: Industrial Water Use;
- Volume 4: Agricultural Water Use: Irrigation;
- Volume 5: Agricultural Water Use: Livestock Watering;
- Volume 6: Agricultural Water Use: Aquaculture;
- Volume 7: Aquatic Ecosystems; and
- Volume 8: Field Guide.

Coastal Marine Waters

- Volume 1: Natural Environment;
- Volume 2: Recreational Use;
- Volume 3: Industrial Use; and
- Volume 4: Mariculture.

The then Minister of the Department of Water Affairs & Forestry (DWAF), Kader Asmal, noted in the foreword to each volume that DWAF's mission was "to ensure that the quality of water resources remains fit for recognised water uses and that the viability of aquatic ecosystems are maintained and protected". The guidelines were intended as the primary source of information and decision-support to judge fitness of water for use and for other water quality management purposes. The guidelines have been widely used over the years providing information on the ideal water quality for water uses and background information to help users of the guidelines make informed judgements about fitness for use.

In 2007 a number of specific issues came to the fore that made it necessary to re-examine the philosophical basis used for determining and using such guidelines. These included:

- **The National Water Act (Act 36 of 1998) (NWA):** the approach to water resource management within Department of Water Affairs (DWA) (then Department of Water Affairs and Forestry (DWAF)) had changed fundamentally as a result of the promulgation of the NWA and it was felt that it would be beneficial that a single philosophical basis was used for detailed decision making throughout the Department. A number of specific issues relating to catchment management were relevant:
  - Classification of water resources: one of the most important changes was the use of a water resource classification system. This involves the determination of a "management class" representing a future desired state. Water resource management must be such that resources not

in this state must be managed towards it, or resources corresponding to this state must be maintained in that state. The limits of each class will be described, quantitatively and/or narratively, by Resource Quality Objectives (RQOs). The determination of RQOS in several catchments is now underway. In 2007 it was felt that the proposed updated water quality guidelines should be suitable for use as RQOs. In essence, sustaining the management class in a particular catchment is regarded as a 'first line of defence' that facilitates sustainable development (DWAF, 2007);

  - Ecological and Basic Human Needs Reserve;
  - Minimum requirements for waste discharge; and
  - Remediation of water resources.

- **Risk as a common basis:** the concept of "risk" could potentially provide the common philosophical basis for decision making in different contexts. The development of guidelines based on risk would therefore serve to coherently link such guidelines with risk-based approaches in other management areas.
- **Latest science and practice**: the approaches used as a basis for developing the 1996 guidelines were based on international best practice. In 2007 it was noted that the assessment of recent advances in guideline determination, both international and local, was necessary to ensure that South African water quality guidelines were based on the latest and most appropriate science and practice.
- **Limited water uses and water quality variables:** it was noted in 2007 that the "recognised" water uses would possibly need to be rationalised and extended to include other uses. Furthermore, it was noted that within the existing water uses, the inclusion of additional water quality variables such as organic substances would extend the usefulness of the guidelines.
- **Site specificity:** it was noted in 2007 that the 1996 guidelines provided generic guideline values (meaning that local site-specific conditions were not considered). In specific scenarios this could result in a guideline that could either be too lenient (and therefore possibly not sufficiently protective) or too stringent (and therefore possibly costly). Including protocols that would account for site-specificity addresses these problems. Inherently these site-specific protocols can also consider other kinds of risks, in alignment with the integrative nature of sustainable development.

In this respect the project team put together in 2007 consisted of a number of risk assessment and guideline development experts who had experience in a number of fields including human health and drinking water, animal watering, irrigation and aquatic ecosystems. These experts summarised the current situation in respect of guidelines both in South Africa and abroad. They also provided expert assessments of such issues as new variables for which guidelines are required and underlying philosophies for guideline development and use.

A decision was made during the project that the final product should consist of a software decisions support system as well as hard copy manuals. A decision was made during the project that the final product should consist of a software decisions support system as well as hard copy manuals. Accordingly, a primitive software interface was developed that presented some of the themes likely to exist in the ultimate decision support software. This interface was developed to:

- Help the project team identify issues; and

- Help potential users, especially regional DWA users, better understand the concepts involved.

In addition, the then DWAF also held many internal workshops attended by stakeholders from those directorates likely to be affected by new guidelines and who could provide guidance on the way forward. A series of workshops was also held with representatives of the DWAF regional offices as it was noted that these are the individuals who were actively using the 1996 water quality guidelines. The concepts relating to the envisaged guidelines were presented based on the philosophy developed during the project and using the primitive interface. Very useful insights into their use of guidelines and their specific requirements of new guidelines were obtained.

At the time of the 2007 project initiation the following phases were planned:

- Phase 1: Project delineation and development of philosophy which included:
    a. Definition of scope;
    b. Literature review;
    c. Distilling the needs of the target users;
    d. Philosophy and protocol development; and
    e. Needs analysis.
- Phase 2: Application of philosophy and development of prototype guidelines; and
- Phase 3: Development of tools for higher-tier site-specific guidelines.

However, only Phase 1 of the project was completed in 2008, hence the need to get back on track and assess the need for further phases in the project. In this respect the WRC has been in discussion with DWA Resource Quality Services (RQS) regarding the review and update of the SA WQ guidelines (1996) which started when Dr Kevin Murray was still the Research Manager (RM) at the WRC. Dr Jennifer Molwantwa then took over from Dr Murray in January 2014 and, together with Dr Nonhlanhla Kalebaila, has continued the discussion with Dr Sebastian Jooste and Dr Nadine Slabbert on taking the development of risk based water quality guidelines forward. It also emerged that after the restructuring at the DWA, the review and update of the guidelines will now fall within the portfolio of Ms Ndileka Mohapi (Director: Ecosystem Services) and Mr Kganetsi Mosefowa (Director: Resource Protection and Waste).

In order to revive the discussions and determine a concise way forward for the initiation of the development of the risk based water quality guidelines, the WRC through Dr Jennifer Molwantwa has commissioned a Short Term Research Project focused on a series of discussion workshops.

1.2 Objectives of the project

The objectives of the Short Term Research Project (STReP) are therefore to guide the formulation of the Terms of Reference for an update of the water quality guidelines taking into consideration the work undertaken by the Project team in 2007 and the 2008 Report entitled: *Development of SA Risk-based Water Quality Guidelines: Phase 1, Needs Assessment and Philosophy*. The STReP must be informed by the following issues:

- There needs to be a common understanding of the risk-based guideline theory as is reported in the Phase 1 study completed by GAA within the research community and within the WRC and DWA; and

- There needs to be a link, and to a large extent alignment, of the approved irrigation water quality guideline project with the future guideline review and update project.

2 APPROACH FOLLOWED

The approach that was followed included:

- An initial workshop held with the irrigation guideline project team to develop a common understanding on the risk based guideline theory documented in the Phase 1 report;
- An internal discussion session was held at Golder where the concepts from the 2008 report as well as the notes from the discussion with the irrigation project team were presented and discussed;
- A second meeting was then held with the irrigation project team to put forward the proposed ‘concepts.’
- A broader workshop was held with a wider stakeholder group was held; and
- A final report to the WRC for further discussion and engagement with the relevant DWS personnel was compiled.

3 OUTCOMES FROM MEETINGS AND WORKSHOPS

The outcomes of the meetings and workshops held with the project team undertaking the risk based water quality guidelines for the irrigation sector as well as a broader stakeholder base are described below.

3.1 Alignment Workshop: 04th August 2014

A full copy of the minutes of the meeting and the attendance register are included as Appendix A.

In summary the following points of discussion were noted:

- Sebastian Jooste (DWA, Resource Quality Services) provided the context to the Phase 1 of the study on the SA risked based water quality guidelines. He explained that the final deliverable focused on the philosophy and principles of the risk based guidelines and provided a framework for the development of the actual guidelines. He explained the difficulty in the conceptualisation of the components and the differences in opinion.
- John Annandale (Irrigation water quality guidelines research team leader) explained that the irrigation team had just completed the inception report for the study. Developing the guidelines was fairly scientific/technical process. It has been largely based on the principles and philosophy of the Phase 1 outcomes. He however highlighted that the team was having difficulty defining the concept/approach of 'risk based' guidelines.
- Lee Boyd (STReP Project Manager) explained that the purpose of the short term WRC project was to address this issue. The intention was to run either user specific workshops or an integrated workshop to unpack the concept of the risk approach. The group agreed that this would be fairly difficult to arrive at a consensus due to the varying opinions and viewpoints of the "sector leaders".
- Further discussion by the meeting focussed on the other two aspects of the proposed SA risked based water quality guidelines *viz*. the tiers and the user interface. There was much debate about the tiers and what they would encompass. It was agreed that this also needed to be discussed and agreed upon, and a uniform approach be applied for the water quality guidelines of all user groups.
- The meeting agreed that small workshop should be held with this group on firming down on the approach of risk based water quality guidelines and what this actually meant. Once the concept "risk based guidelines" has been clarified, this could be extended to the other water quality user groups. The meeting agreed that the underlying principles, concepts and general approach should be uniformly applied and form the basis for each of the user specific guidelines. It was also important that the tier structure of the guidelines be unpacked and clarified, providing a clear definition, for each of the user groups to build upon.
- Smaller workshops could then be held with specialists from each user group, where the generic principles and approach could be discussed and then be adapted to suit the needs of the specific user water quality guidelines.
- It was agreed that a position paper to conceptualise the thinking and approach was needed to keep the discussions and future envisaged workshops streamlined and structured.
- It was suggested that Dr Kevin Murray, the project manager of Phase 1, be contacted to possibly get involved in developing the paper and assist in aligning the risk based thinking.

- The group discussed the importance of the user interface and the coding that supported it. It was important that it was aligned across the 5 user groups and that it met the needs of the end-user. It is still unclear if the user interface needs to be integrated into one system or 5 separate systems are needed. This aspect still requires further discussion. However due to the fact that the development of the irrigation guidelines are underway, a user interface would be a deliverable of the project. How the other systems will be aligned/integrated to this is still unclear, if they should at all?
- The group also discussed the structure to the guidelines. Three possible categories were proposed per water quality variable – each limit range associated with the respective risks. This could be linked to colour coding. The irrigation group was working along this approach however nothing concrete had been defined.
- There was a discussion around who the custodian of the SA risked water quality guidelines is/should be. Dr Jooste indicated that this is not clear within DWS. It was important to some extent to know this so that someone takes ownership of the final products/SA WQGs. This would link to the integration of the interfaces and the needs of the end-user. In addition the future maintenance and updating of the guidelines would be important. In this respect it was important that Ms Ndileka Mohapi from DWS is involved.
- John Annandale further raised the question around the development of water quality objectives for irrigation. This had been included in the terms of reference for the development of the irrigation guidelines. However it is believed that this may be a separate process that would need to be undertaken outside the development of the water quality guidelines (scientific process). Dr Jooste indicated that the objectives were needed and formed a key component of the completing the cycle but greed that where its development takes place is still open for discussion. He highlighted that the sector objectives were required by the water quality user group during the discussions on the setting of resource water quality objectives/resource quality objectives. It was also needed by the catchment manager.

3.2 Meeting 2: 17th September 2014

After the meeting of the 4th August 2014 discussion sessions were held with specialists within Golder to come up with a conceptual idea on how to take the risk-based approach forward and present it in a meaningful manner to broader stakeholders. The ideas were subsequently presented to the WRC, DWS and the Irrigation project team on the 17th September 2014. A copy of the presentation is included as Appendix B.

The following aspects were discussed:

- Slide 2: The project team referred to the word ‘target’ in respect of the specific intake water quality that is required by the user type. There was a query whether the following was true in the use of the word:

Acceptable = target = no risk?

There was a discussion as to whether the revised updated water quality guidelines should include a category range of “no-risk”/ideal range which was equal to the “target water quality range” (TWQR) in the current (1996) SA water quality guidelines. This point still requires resolution and is particularly

relevant to users of the “print copy” of the risk based water quality guidelines. An “ideal baseline” water quality may be required. .

- Slide 3: There was confusion about the colours used; however the project team noted that the colours did not represent anything;

- Terminology needs to be standardised throughout the guideline volumes;
- The project team noted that there are essentially two levels of Risk:
    - Level 1 (equates to Tier 1): risk ranges/categories based on the consequence of using less than ideal water quality (The actual risk based water quality guidelines – of specific relevance to the print copy guidelines. To serve as a reference of all the documented science and actual risk categories and ranges);
    - Level 2 (equates to Tier 2): risk rating of using in-stream water quality based on site location and the actual water quality profile; (considers what water quality is actually is available in the water resource, the probability of occurrence and rates the risk)
- In this respect the project team had a query of whether there should in fact be three tiers as described in the 2008 report or whether two tiers would adequately address what is required from the risk based water quality guidelines:
    - What these tiers should comprise in terms of providing a “risk perspective” to the user; and
    - What would be the outputs based on the inputs envisaged and what the value a user of the DSS would gain from each tier.

Tier 3 proposed in the July 2008 document was based on allowing assessments and objectives setting to be carried out in site-specific contexts not covered by Tier 2 and would also not be covered by the DSS. In this respect it was felt that a third tier was perhaps unnecessary and not possible to include within the water quality guidelines development process. Tier 3 would require the application of risk based approaches and assessment that did not require the application of the water quality guidelines *per se*. The guideline risk category ranges would be used as a reference point.

Slide 9 of the presentation gives an example of how the project team envisaged the tiers linking together.

Some recommendations that the project team put forward in the presentation are:

- Tier 1:
    - The risk matrix and analysis and how it relates/links to the probability of occurrence of the prevailing water quality needs to defined and understood; and
    - An integrated risk approach must be developed.
    - Tier 2 needs to be developed in a 2nd phase by one group (consider representative from each user group) for all users:High risk variables per user;
    - Water quality river profiles;
    - Spatial; and
    - Output will be a risk rating
- DSS
    - Must incorporate in the software to link tiers 1 and 2

The project team put forward the following in respect of two tiers:

TIER 1: defined or developed based on risk-based science (***Water quality guidelines and risk categorisation):***

- Definition of water quality requirements per user group;
- Definition of the Target water quality guidelines (based on latest science, research, international practice);
- Conservative; precautionary approach; most sensitive receptor in the different user groups;
- Definition of risks in the absence of target water quality range;
- Risk assessment (based on applicable risk methodology for the user group);
- Risk categories (Numeric values ranges with background and supporting info to define risk levels (H; M; L proposed);
- Generic; applicable to all water resources;
- Developed independently for domestic, recreational, animal watering, industrial processes. aquaculture, irrigation;
- Aquatic ecosystems? what should guideline development entail; triggers; sensitive species; – needs a different SOW for the scientific knowledge development; consider regionalising at Tier 1; and
- Components required per user group (e.g. irrigation – crop type, soil type)

TIER 2: actual risk present for the user group based on specific catchment context ***(Risk rating based on the in-stream water quality profile)***

- Quaternary catchment based;
- Water quality profiles (percentiles over defined period);
- Probability of occurrence of the water quality risk – link to risk assessment matrix of Tier 1;
- Definition of risk rating of prevailing in-stream water quality for the specific user group; and
- Mitigatory measures specified if medium or high rated.

Each tier would be linked to a high, medium or low risk (H, M or L).

The risk criteria ranges discussed and agreed upon in principle at the meeting were:

- 0: Target/acceptable = no risk;
- 1: Low risk (L);
- 2: Medium risk (M);
- 3: High risk (H); and
- 4: Unacceptable

Each team per sector would define these levels and as long as there was a 0 and 4 which needed to be defined by the latest science and sound risk methodology, the in between ranges would need to defined by the specialists concerned, and these may be based on a number of assumptions.

It was noted by Dr Jooste that one of the primary objectives of the guidelines was to support the development of Resource Quality Objectives (RQOs).

The Irrigation project team members noted that they had understood from their reference group meetings to date that the 3 tier option was not negotiable and had been working on the following:

- *Tier 1:*
    - fix all to worst case (most conservative values)
    - can only add WQ detail;
    - specialists will define what the typical acceptable (based on known science or precautionary approach) and unacceptable ranges will be;
- *Tier 2:*
    - predefined selectable data options that are relevant to specific users (predefined selectable factors/options); and
    - can input water quality data
- *Tier 3:*
    - Could consider specific models and specific parameters relevant to a specific context (default options that can be changed to suit site specific circumstances); therefore this tier may not be relevant to all users.

It was agreed that the above tier approach of the irrigation research group was not fundamentally different from that proposed by the project team. The difference was related to whether the “documented” science and source information has a place in the DSS. It would be contained in the software but not explicitly presented on an interface screen.

The project team then presented their thoughts on the risk methodology that would be applied to each of the user groups stating that the methodology would be critical to the linkage between Tier 1 and Tier 2. The risk based approach should incorporate a risk assessment task with the following objectives:

- To identify categories or themes for that specific user group that is dependent on water quality;
- To identify risks of low quality water associated with these categories or themes;
- To determine and rate the probability of occurrence of the specific risk based on a certain defined scale;
- To determine and rate the exposure level of the contaminated water to the water user;
- To identify the consequence category and describe the consequence related to the probability of the risk and the exposure level; and
- Finally to describe mitigatory and/or further actions that may be required to rectify or reduced the risk identified.

Figure 1: Risk methodology approach presented

As part of the approach the team proposed that a risk matrix be used. Dr S Jooste felt that this may not be the best option for all the users but said that essentially the output should be the same. He proposed a methodology where the following aspects would be brought in for all of the user groups:

- Frequency of occurrence;
- Exposure;
- Expectation of critical concern (end points, often by assumption, related to the H; M; L risks); and
- Consequence.

It was agreed that in essence these aspects comprised the crux of risk methodology. This will be further explained in the final report after inputs from Dr S Jooste.

In conclusion consensus was reached that central to the development of the risk based water quality guidelines per water user group was the definition of the risk methodology and how it would be applied. This would have to be technically sound and scientifically credible and ensure that there was some degree of consensus and uniformity among each of the development teams.

3.3 Specialist workshop 25th February 2015

3.3.1 Setting the scene: risk based water quality guidelines

Dr Sebastian Jooste of the DWS provided the context to the development of the risk based water quality guidelines. The presentation covered the 'Decision context'; 'Guidelines as a knowledge product' and the 'Presentation and Specification' (of the product) (presentation included as Appendix C).

The followed was discussed:

- Standards vs Guidelines
- Context
- Fitness use
- Regulatory user/ water user
- Guideline tool
- Scientific domain
- Resource use domain
- Resource Management domain

In terms of the decision context Dr Jooste addressed (1) Why Risk based and (2) Why new Guidelines?'

The philosophy, principles and approach behind 'a knowledge product' was presented.

The following aspects were highlighted:

- Acceptable risk is an important feature for all the user based guidelines. Acceptable risk (defined for each class) = Risk criterion
- Decision needs to be made on what the numbers/ end points should be
- Guidelines must present what is known – not what is unknown
- Precautionary is a management principle not scientific principle
- Don't squander local knowledge – this must be used where available and applicable.

Discussion/ Questions

Ms Carin Bosman raised/ noted/ proposed the following:

- In the instance of poorer data – a safety factor could be built in (does not cater for decisions)
- Why not use the Environmental definition of risk? Dr Jooste pointed out that there were differences in terms of the water quality and the proposed guidelines. However this definition could be considered and refined.
- What do the WRC guidelines have do with water resource classification? This deals with the practicalities – relates to validity of assumptions and application; there seems to be a disconnect.
- In terms of the decision context – guidelines for decision making, the tool – management support – would not only focus on science. This extends beyond the science.
- Various types of management systems were presented and discussed based on varying degrees and types of qualitative and quantitative risk assessment.
- The current approach does not consider what the law the says – the law makes provisions

The above points were noted and will be considered. Dr Peter Wade commented that the regulator has a type of management style in place and this should be considered in the development of the product.

Dr Neels Kleyhans highlighted that from an environmental point of view there is insufficient resources to do it all. Expert knowledge, qualitative assessment and a Bayesian system would have to be relied upon. This is needed to set resource quality objectives for the ecology.

Ms Swart raised her concern that what is needed is an implementation of the law. How much more value will the additional guidelines provide? More focus is needed on licensing and water use regulation. It is important that more Departmental officials be included in the process. The current special limits and general authorization should be reviewed and applicability addressed. Licenses and how their conditions are applied is an important issue.

Ms Bosman highlighted that key issue lies in the use of the guidelines correctly. The following was recommended:

- Integration for water use licensing
- Review of the guidelines – for certain values
- 1996 guidelines focused on surface water – guidelines need to be extended to address users of groundwater
- 1996 guidelines were developed just prior to the promulgation of the new National Water Act – definition of pollution (harmful or potentially) must be addressed as a gap. The revision must look at groundwater, the user groups and must be translatable

Dr Jooste responded that the guidelines are not written for the law.

Mr Mjikisile said that it was important however that the law informed the guideline. This would support implementation at a certain level. Interpretation of guideline and risk of the environment was important. One cannot separate ecosystem and environment. Mr Mjikisile indicated that new science, new knowledge and the wealth of data must be used and applied. Interpretation will also be important.

Dr Meyer highlighted the following:

- The 2008 Phase 1 document had been circulated for comment. This had links to the EDC projects. The risk based approach was discussed and the philosophy presented.
- It is important that we do not lose sight of the requirement – people need it.
- 1996 guidelines are based on international practice and science but it does need to be updated.
- Recognition that water resources do not/ will not comply with the guideline – guidelines are meant to support how we use the water.
- Risk approach will support use of water resources.
- The guidelines would provide guiding advice on what should be done.
- 1996 SA Water Quality Guidelines exhibits deficiencies. Norms decided in 1996 need revision based on current developments and science.
- Workshop on Section 21 is required. It is a key issue – need to ‘somehow’ get the various departments to integrate risk based to all users.

Dr Norman Casey highlighted that risk based water quality guidelines could be developed by the scientific community however the role of government is critical to create an enabling environment and to support

statutory mechanisms. The hard copy guidelines' is a straight forward exercise however the decision support system and the application thereof raise many complications. The development of the guidelines by the WRC and DWS is required to create an 'owner' to take responsibility for the intellectual property.

Mr Jan Pietersen noted that while the law is in place, there is a scientific basis of the rationale that must be applied.

Dr Jooste stated that the thinking needs to be aligned and integrated.

- Two types of data
- Knowledge tool – what do we know, how to capture it, best way to capture, how do we set specifications, how do we present to audiences.
- Decision on interfaces
- Alive, capture and application.

Dr Kleynhans highlighted that in terms of the gazetted RQOs the guidelines are required to support this process.

Ms Bosman said that the team should consider the approach of risk harmonization in the development process going forward.

3.3.2 Principles

At the workshop the principles (tabled below) included in the 2008 report were circulated.

Table 1: Principles included in the 2008 Report

PRINCIPLE	DEFINITION	COMMENT
Accessibility	The protocols, guidelines and supporting documentation should be physically readily accessible to all potential users of the guidelines.	Current thinking favours the production of a software decision support system (DSS) as the main vehicle to present the revised Site-specific South African Water Quality Guidelines (SSAWQG).
Communicability	The protocols, guidelines and supporting documentation, their conceptual and philosophical basis, and how they should be used, must be easy to explain.	In the first place the SAWQG is a management- and assessment tool and, as such, has a technically literate audience. However, reasonable effort will be applied to make it understandable to the wider user public.
Cost-effectiveness	The protocols, guidelines and supporting documentation must be able to be (a) determined and used with the minimum of financial and human resources and (b) be effective (i.e. satisfactorily address all principles).	Implies that more work goes into preparation and presentation of the guidelines compared a simple list of numbers approach. This has significant implications for Tier 2 guidelines.
DWAF-wide consistency	The protocols, guidelines and supporting documentation must be consistent with approaches used currently or possibly in future in other DWS directorates.	The Department of Water and Sanitation (previously known as DWA, DWAF) is assumed the main user of these guidelines. Consistency with other intra-departmental initiatives needs to evolve through interaction during the development process. Attention also needs to be given to other extra-departmental users to strive to optimal consistency among users.
Exploitability of existing tools	The execution of the protocols and the use of the guidelines should use existing tools, if any (e.g. databases and software) and should not be developed locally if they already exist (either locally or internationally) and they can be obtained and used cost-effectively.	A fundamental principle is that the revision of the guidelines uses what is currently available. What is not available and considered crucial is identified as a research need. The feasibility of embedding software products and data bases in the DSS as opposed to creating suitable interfaces needs careful consideration. Intellectual property- and copyright issues must be dealt with on a case by case basis.
Government-wide consistency	The protocols, guidelines and supporting documentation must be consistent with approaches used currently or possibly in future in other government departments.	This would require wide governmental representation in project steering committees without losing focus on the primary guideline uses.
Honouring international obligations	The protocols, guidelines and supporting documentation must take appropriate account of the perceptions and management of risk in neighbouring countries.	Risk perception and communication require specific attention given that the term ‘risk’ can be used in a wide variety of colloquial contexts and other technical contexts .

PRINCIPLE	DEFINITION	COMMENT
Informativeness	The protocols, guidelines and supporting documentation must (a) be educational and (b) naturally facilitate their enlightened use. To achieve these ends, protocols and supporting documentation must also be completely transparent.	It is inevitable that increasing site-specificity will entail a greater application-specific knowledge. The Tier 1 guidelines, being the most conservative requires the least application specific-knowledge but also the greater number of implicit assumptions and is also likely to be the least informative.
Internal consistency	The protocols, guidelines and supporting documentation must be based on the same underlying philosophy when used in different contexts (e.g. ecological and human health, the various water users, different confidence levels, etc.).	
International consistency	The protocols, guidelines and supporting documentation must be consistent with approaches used in other countries.	This should not be interpreted as meaning that South Africa should adopt the exact numerical values of guidelines in other countries. The focus is more on the approaches being consistent. The protocols, guidelines and supporting documentation will be submitted to international peer review.
Local relevance	The protocols, guidelines and supporting documentation, and end-points upon which they may be based, must be appropriate to South African ecological, social, economic, legal, and political conditions.	The development of the protocols, guidelines and supporting documentation should be subjected to an on-going stakeholder participation process, at the very least to inform stakeholders on the latest developments but also to elicit comments from those who wish to do so. There should be awareness creation in respect of the general steps in the risk assessment process, acceptable levels of risk and the uncertainties and value judgements that may be inherent in risk management decisions. Stakeholders should also be made aware that the use of qualitative tools is integral to the risk assessment process.
Practicality	The protocols and guidelines must be realistic and easy to use.	Keep in mind practical issues like the limits of detection of current analytical methods when producing numerical guideline values.
Precautionary	The precautionary approach ensures that risk-averse and conservative decisions or actions are implemented to minimise these risks. Equivalently, this lack of certainty will not be used as a reason for postponing cost-effective measures to prevent the impacts.	This is a core water quality management principle. Already applied through the “hierarchy or decision making” (DWAF 2007): in order of decreasing priority: Pollution prevention, waste minimisation, differentiated approach and remediation. The degree of precaution applied in any particular situation should be primarily reflected in a lower acceptable risk than perhaps would otherwise be applied. It may also be reflected in safety factors chosen for the algorithms from which numerical guidelines are derived. It is also important that application of this principle is justifiably balanced with the principle of “scientific defensibility”. In other words, application of caution should not be used as an excuse for “sloppy” science. It should also not be applied when there is simply an unwillingness to motivate difficult decisions.

PRINCIPLE	DEFINITION	COMMENT
Requisite simplicity	The protocols, guidelines and supporting documentation must achieve the optimum level of simplicity (reflecting the least amount of detail) that maximises functionality.	It has been suggested that “Perfection is achieved, not when there is nothing more to add, but when there is nothing left to take away” (Antoine de Saint-Exupery quoted in Ward, 2005). Developers should constantly keep in mind the capacity of DWS personnel to use the ultimate product effectively, not only in terms of numbers of people but also their absolute abilities. Software interfaces should enable very easy, clear and unambiguous use of the guidelines.
Scientific defensibility	The protocols, guidelines and supporting documentation must be based on scientific understanding and knowledge that is satisfactorily justifiable.	
Site/ scenario specificity	The protocols must be able to be applied, and guidelines determined, that make the most of data that are relevant specifically to a selected site or scenario.	
Transparency	The data, protocols and assumptions upon which the calculated numerical guidelines are based should be accessible to those who need a better understanding of the derivation.	
Updatability	The protocols, guidelines and supporting documentation must be able to be easily updated when new data or protocols become available in future.	To enable this principle a degree of flexibility in design will be necessary.

3.3.3 Workshop Discussion: Risk Based Approach

The workshop attendees had some discussion on a framework for the risk based approach that each of the project teams would need to consider in the development of the specific user group guidelines. Based on the discussions the following was agreed/ proposed:

Requirements for guideline development (per user volume):

- Source – somewhere – commonality between guideline volumes, users is required;
- Source description – water quality constituents and parameters/ analytical methods have to be foundation from which all volumes are derived;
- Common platform (uncertainty component will be reduced) (step 1);
- Recommend what should be implemented;
- Relevance must be considered;
- Exposure routes from the source (multiple) – sensible measure of exposure to the scenario;
- Exposure pathways;
- Link to other systems – harmonize;
- Concentration based value (effect);
- Consideration of stream flow – how long and how often (exposure);
- EDCs – presence or absence;
- At tier 1 – this will be directed per discipline – how to deal with parameters that we know; however more uncertainty will exist at higher tiers;
- Consideration and context of existing guidelines/ standards e.g. SANS 241 – clear distinction must be created to remove uncertainty. There must be agreement among disciplines. Decision must be made on what applies to the user group guidelines (domestic user);
- Comparable interpretation among user volumes – incipient response; and
- What does the science say?

3.3.4 Workshop Discussion: Risk Based Assessment

Based on the workshop discussion the following was noted in terms of considerations for the risk assessment process and requirements for the higher tiers and DSS:

- How does the user generate the data he/ she needs;
- User platform – background, data, rules;
- Enable – input – concentration is assessment based on scenarios, site specificity;
- Data capturing guide (basic data);
- Water quality data – entry point;
- What would the exit point be;
- Type of user;
- Crucial questions user needs to answer about the scenario;
- USEP s
- Minimum requirements;
- User interface – facility designed; and
- Domestic water user – treatability of water for use?

An in-depth discussion on SANS 241 versus the domestic water quality guidelines was undertaken by workshop attendees. It was agreed that while the SANS 241 is the national standard for the water service providers (provision of treated drinking water) the risk to the domestic user is a threat and the risk/ hazard posed by poor quality water taken directly from the water resource must be addressed at some level in the guidelines. However, a clear distinction and boundaries for application must be highlighted.

It was agreed in principle that the departure point should be the SANS 241 limit – *de minimus* level/ no effect limit. Beyond that the effect will be at the next level (variation from SANS) which can be guided by the water quality guidelines. The key requirements for any updates to SANS limits would be to consider new science. Domestic guidelines that fall within SANS standards will be adopted in terms of the SANS guide and any additional risks could be addressed thereafter.

Dr Jooste suggested that the domestic user volume could adopt one of two options: either exclude everything that is in SANS 241 or incorporate SANS 241 into guidelines.

It was agreed that a recommendation be made in the terms of reference for the Domestic Use group guidelines development process that this aspect be interrogated and deliberated further to ensure that a clear way forward is defined.

4 PUTTING RISK BASED WATER QUALITY GUIDELINES INTO CONTEXT

The following section gives some background on the reasons for updating and considering the development of risk based water quality guidelines.

Decision context

If a water user is given a set of water analyses, what do they mean? What is the fitness for use of that water source? And if there is a target fitness for use what are the ranges in values of the different parameters and at the same time what targets should give effect to that target?

The outcome of the various discussions has indicated that while a set of water quality guidelines exist in those published in the 1996, and were developed with some degree of risk-assessment, they may be acceptable in certain cases however may be outdated in other cases and not reflect the current state of science.

The water quality guidelines need to be an expression of science supporting a decision

There has been debate around standards vs guidelines. It is important to note that guidelines reflect the scientific environment whereas standards reflect the regulatory environment. Most often standards are static while guidelines can be more flexible. The reason for this would be that regardless of whether there are standards in place, a water user may want to know the risk of using a particular water source for a particular use because that may be the only water source available; which is where the guidelines come into play for water users. While there is a space for both standards and guidelines they must not contradict each other and it must be clear that where a standard is legislated that obviously takes precedence over the guidelines.

An example of this is SANS 241, the legislated standard to which all drinking water should comply. Should there be case where a person for example abstracts water from a borehole for domestic use and consumption, the water may not comply fully with the requirements of SANS 241, however it may be the only source of water in an area and that user would then be able to use to the guidelines to get an understanding of the risk posed when consuming the water.

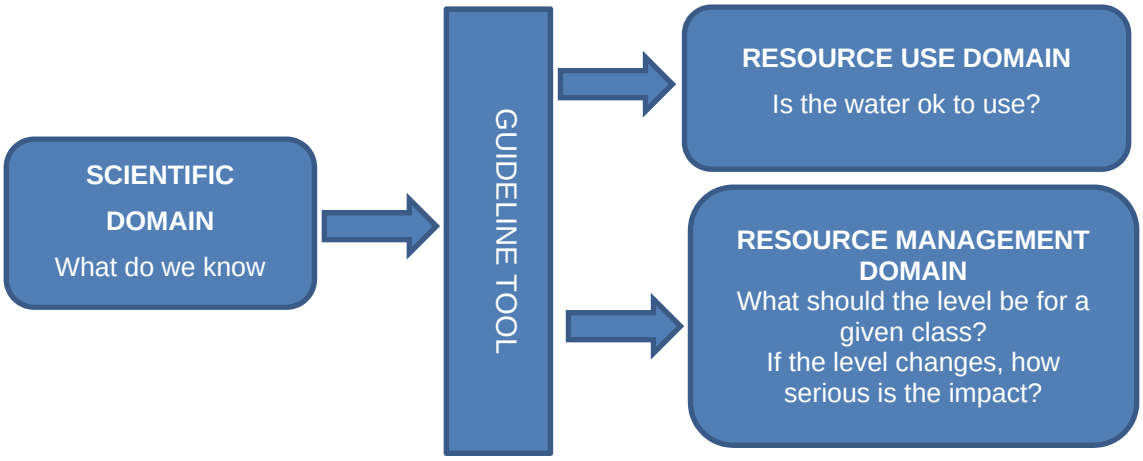

Figure 2: Decision context

It is important also to note that it is seldom possible to make a binary decision in an environmental assessment. How a constituent presents itself in the uptake process can have a critical impact on what one would expect to happen: presence does not necessarily mean availability. At the same time one constituent may enter the target through various pathways so it is important to recognise the use scenarios.

Why risk-based?

Risk can be defined as:

The quantitative or semi-quantitative, site- and/or situation- specific expectation that a given target organism will experience an unacceptable effect;

A risk is posed when there is a source, a potential exposure pathway and a receptor (receiving environment, for example, ecosystems and/ or humans). It is important to note that risk is not a concentration, dose, other value based point, or even non-value based levels. Risk is the probability that a particular adverse effect occurs during a stated period of time (DWAF, 2005). Risk-based can therefore be defined as recognising the risk factors in giving effect to risk objectives.

In using risk based guidelines expectation can be expressed mathematically on a continuous basis for example through probability or possibility. Risk based guidelines are already used in many regulatory applications such as when undertaking environmental impact assessments, and with a suitable end-point risk based guidelines will facilitate comparison.

Why new guidelines?

Subsequent to the promulgation of the National water Act in 1998 (Act 36 of 1998) the approach to water resource management has changed fundamentally and a number of specific issues relating to catchment management are relevant, including the need for classification of water resources which involves the determination of a “management class” of a water resource representing a future desired state. Water resource management must be such that resources not in this state must be managed towards it, or resources corresponding to this state must be maintained in that state. The limits of each class will be described, quantitatively and/or narratively, by Resource Quality Objectives (RQOs). The proposed updated water quality guidelines should be suitable for use within these processes.

In addition, a number of parameters not included in the previous water quality guidelines have come to the fore as Contaminants of Concern and should be integrated into the new guidelines.

Risk based water quality guidelines are beginning to be used amongst others in Canada, USA, Europe and Australia, so we should use and build on what has already been done.

A knowledge product

The guidelines need to be a knowledge product and must present the user with what is known, not what is unknown. The guidelines should not assume the decision makers role and should also learn from other guidelines’ data requirements but should not be confined to them. It is important to take local knowledge into account.

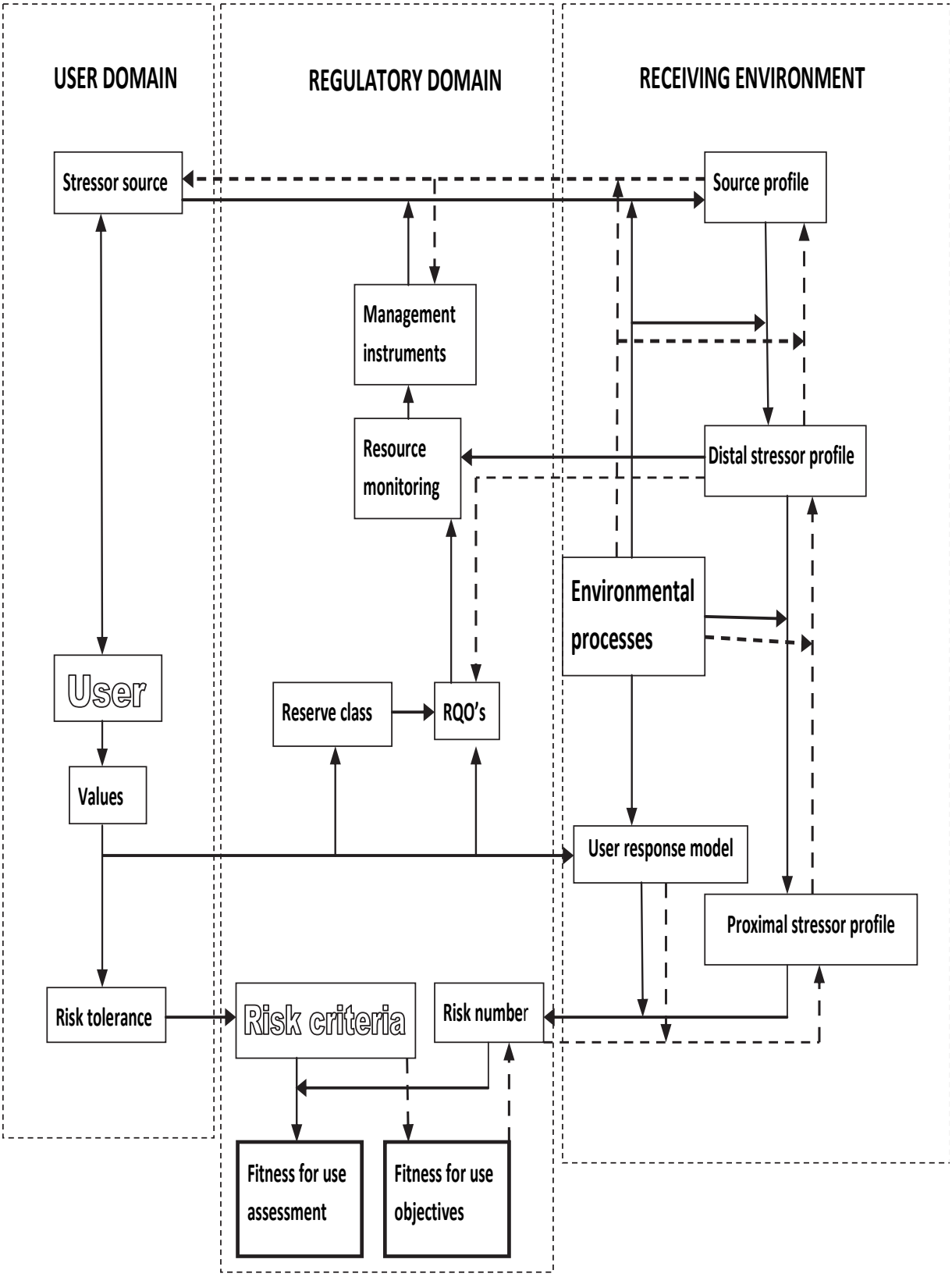

Figure 3: Framework representing the interactions between the use and regulatory domains and the receiving environment

Tiered Guidelines

The reason for tiered guidelines is that the extent of site-specificity in water quality assessment and objective setting varies among users. In the 2008 document three tiers were proposed as described in Section 0. Relooking at the tiers it is proposed that the following definitions are used as a guideline for developers of the various water quality guidelines and it is very likely that Tier III will seldom be used. Tier I can essentially be seen as the scientific domain which is in certain aspects already captured in the 1996 SAWQG, and which will need to be updated according to new science and to add the variables previously omitted.

Table 2: Tiers description

Tier III	**Tier II**	**Tier I**
The most site specific guidance – probably a risk assessment protocol, requiring highly skilled input- and output interpretation.	Moderately site-specific, requiring some skills, but largely uses pre-defined water use scenarios and limited site characterisation choices with common field observation and or measurement input required from the user for scenarios manipulation. Possibly rule-based output interpretation.	Most generic (and by implication the most conservative) approach to guidance. Minimum user input required and simple output provided; the current guidelines updated as required.

5 DERIVING RISK BASED GUIDELINES

It is important to review the need for each and every individual guideline, existing or possibly new water use sectors, by asking questions such as:

- Why do we need a guideline for a particular use;
- Who will use the guideline;
- How will the guideline affect the way in which we manage water resources; and
- How will the guidelines link to existing legislation and regulations, such as SANS 241, Water Resource Classification and setting of Resource Quality Objectives?

Once the need for each guideline has been justified, the gaps in the current guidelines should then be determined in respect of aspects such as application, probability of exposure, additional variables and new science.

In deriving risk based water quality guidelines for the various sectors the following critical steps must then be considered.

1. Select suitable candidate end-points and by iteration (if necessary) select a suitable common end-point for all stressors and target combinations (for example, crop yield). An end-point must, at least in principle, be quantifiable, but not necessarily unique to a stressor;
2. Set up a fault tree for each stressor-endpoint combination that describes the salient environmental and target processes;
3. Evaluate the state of knowledge about each process: uncertainties, variability and quantitation of relationships as well as interactions with other stressors;
4. Formulate a suitable hazard expression for each stressor;
5. Consider the stressor exposure model – these models do not necessarily have to be numeric/ mathematical models at first but should be amenable to quantitative output;
6. Consider:
    a. How best to approach the numerical expression of risk, i.e. probabilistic versus possibilistic expression.
    b. How the main user output requirements (fitness for use-class versus class-related stressor profile) can be generated – this involves considering what risk numbers would reasonably correspond to expected outputs; and
    c. How stressor time series inputs must be handled.
7. Consider various realistic exposure scenarios and how they could be quantified;
8. For the Tier II and III guideline, formulate a risk assessment protocol for each stressor-target combination. Of importance is the description of the input and output quality, important calculation aids such as algorithms and models, caveats and skills requirements.
9. From the risk assessment protocol, select key exposure and hazard variables with known typical values that can be used in the risk calculation. The exposure scenarios in 6 above might be used as basis to obtain inputs from the user to generate more generic but still workable site-specific risk calculations. This is the Tier II guideline.

10. Consider what combination of stressor, target and water use scenarios would generate the highest risk values. Use these to generate the Tier I output.
11. Consider what qualitative or quantitative outputs would be most useful at each tier to guide the user to a sensible decision (for example: danger signs, water treatment or improvement options, further guidance via internet links and reference material).

5.1 Decision Support System

The results from the above must then be packaged into a Decision Support System (DSS). When developing the DSS as part of the update for each guideline it is proposed that a demonstrator/ prototype system is developed that would include a user manual. Each developer will need to consider IP issues and controlled access to tiers; as well as putting forward recommendations on guideline updating issues and (perhaps) protocols.

The various demonstrator/ prototype systems should then be integrated by an independent team to develop the overarching DSS and user manual.

Some important questions that need to be answered are:

- Should there be one database, or one per sector;
- Who will maintain the database; and
- Who will be the ultimate owner of the DSS?

5.2 Other collaborations that need to be undertaken

Collaboration with DWS is essential so that the department endorses the product to create a statutory environment to use as part of water resource management. In addition to this collaboration and the steps described in Section 0 the following aspects need to be taken in to consideration as part of each guideline volume update.

- Assess how the guideline will link to existing standards, for example in the domestic sector SANS 241 must be considered and any update must not be in contradiction to the standard. In this respect collaboration with the relevant teams or organisations developing standards in any of the sectors must be take place;
- The guidelines therefore need to refer to the standards relevant to that sector and clearly state that the guidelines themselves are not standards;
- Application on how to use the guidelines is of utmost importance. Capacity building initiatives for this aspect will need to be clearly thought through and programmes developed and presented to the various uses of the guidelines including sector users and regulators, who would need to know how to integrate the guidelines from a resource manager perspective.

5.3 Timeframes for updating the guidelines and DSS development

The update of the guidelines and the development of the DSS should be seen as a long term project over the next 12 years with the following proposed timeframes per project.

Table 3: Proposed project timeframes

Task	Proposed timeframe
Technical review and risk assessment, including prototype/ demonstrator DSS per sector	2 years
International review	1 year but can be initiated in the second year of the technical review and risk assessment process
Overall DSS integration and roll-out of integrated system	2 years
Tier 1 adoption and implementation	Immediate as guidelines are reviewed and finalised

6 REFERENCES

R Heath, K Murray, J Meyer, P Moodley, K Hodgson, C du Preez, B Genthe and N Muller (2008) Development of SA Risk-Based Water Quality Guidelines: Phase 1, *Needs Assessment & Philosophy.* Draft Final Report to the Department of Water Affairs & Forestry

Department of Water Affairs and Forestry (2005) Towards Harmonised Regulatory Criteria for Water Resource Protection and Resource Quality Management, Internal Draft Discussion Document

APPENDIX A

Attendance Register and Minutes of the Meeting held on the 4th August 2014

1402450 (F).

ATTENDANCE REGISTER

DATE: 04 August 2014	TIME: 09h00	VENUE: University of Pretoria
PROJECT NO: 1402450	PROJECT: WRC WQ Guidelines workshops	DESCRIPTION: Facilitation of workshops related to the proposed risk based WQ Guidelines

NAME	REPRESENTING	TEL NO.	EMAIL	SIGNATURE
MICHAEL VAN DER LAAN	UP	076 793 3597	michael.vanderlaan@up.ac.za	
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John Annandale	UP	0823743706	john.annandale@up.ac.za	
Meiring du Plessis	UP	083 290 7239	meiringd@gmail.com	
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Nonhlanhla Kalebaila	WRC	083 268 7739	nonhlanhlak@wrc.org.za	

GOLDER ASSOCIATES AFRICA (PTY) LTD.

K8/1067/1

WATER RESEARCH COMMISSION

MEETING IN CONNECTION WITH THE SHORT TERM PROJECT ENTITLED: WRC/DWA FRAMEWORK DOCUMENT FOR THE REVISION OF WATER QUALITY GUIDELINES

HELD ON 04 August 2014 AT 09:00

PRESENT:

Name	**Organisation**	
Michael van der Laan	University of Pretoria (UP)	MvdL
Dr Sebastian Jooste	Department of Water and Sanitation (DW&S)	SJ
Dr Gerhard Backeberg	Water Research Commission (WRC)	GB
Prof John Annandale	University of Pretoria (UP)	JA
Meiring du Plessis	University of Pretoria (UP)	MdP
Dr Nonhlanla Kalebaila	Water Research Commission (WRC)	NK
Priya Moodley	Golder Associates Africa (GAA)	PM
Lee Boyd	Golder Associates Africa (GAA)	LB

1 CONSTITUTION OF THE MEETING

1.1 Apologies were received from Dr Jennifer Molwantwa (JM) of the WRC.

1.2 The attendees introduced themselves and the attendance register was circulated for signature.

1.3 JA welcomed the attendees and LB explained the reason for the meeting with the objectives of the short term research project being to facilitate a series of workshops on the risk-based guideline philosophy which resulted from the 2007 project entitled: "*Development of SA Risk-based Water Quality Guidelines: Phase 1, Needs Assessment and Philosophy*".

- To hold a workshop/ meeting with the research team appointed to develop the risk-based irrigation guidelines in order to ensure that that there is a common understanding of the risk-based guideline theory and template (product) as reported in the Phase 1 study;
- To hold a wider workshop with the researchers and the DWA to ensure that there is a common understanding on the risk-based guideline theory and template (product) as well as to identify the different data requirements, sources and gaps for

the follow-on work;

- To undertake a series of workshops/ meetings with specific water use stakeholder groupings for a discussion on the data requirements, availability and gaps;
- To formulate a costing of the water quality guideline update project; and
- To report the project findings to the irrigation guideline project team and the DWA directorate responsible for the update of the water quality guidelines.

1.4 As the irrigation water quality guidelines project was underway it is important to understand what has been done and the challenges being faced. Also to determine what could be taken forward and built upon for the development of the water quality guidelines for other user groups.

2 DISCUSSION

2.1

- Gerhard Backeberg provided some background to the WRC Irrigation guidelines project that was currently underway. The availability of the budget and the need of the irrigation sector for updated water quality guidelines resulted in the initiation of the project.
- Sebastian Jooste provided the context to the Phase 1 of the study on the SA risked based water quality guidelines. He explained that the final deliverable focused on the philosophy and principles of the risk based guidelines and provided a framework for the development of the actual guidelines. He explained the difficulty in the conceptualisation of the components and the differences in opinion.
- John Annandale explained that the irrigation team had just completed the inception report for the study. Developing the guidelines was fairly scientific/technical process. It has been largely based on the principles and philosophy of the Phase 1 outcomes. He however highlighted that the team was having difficulty defining the concept/approach of 'risk based' guidelines.
- Lee Boyd explained that the purpose of the short term WRC project was to address this issue. The intention was to run either user specific workshops or an integrated workshop to unpack the concept of the risk approach. The group agreed that this would be fairly difficult to arrive at a consensus due to the varying opinions and viewpoints of the "sector leaders".
- Further discussion by the meeting focussed on the other two aspects of the proposed SA risked based water quality guidelines *viz*. the tiers and the user interface. There was much debate about the tiers and what they would encompass. It was agreed that this also needed to be discussed and agreed upon, and a uniform approach be applied for the water quality guidelines of all user groups.

- The meeting agreed that small workshop should be held with this group on firming down on the approach of risk based water quality guidelines and what this actually meant. Once the concept “risk based guidelines” has been clarified, this could be extended to the other water quality user groups. The meeting agreed that the underlying principles, concepts and general approach should be uniformly applied and form the basis for each of the user specific guidelines. It was also important that the tier structure of the guidelines be unpacked and clarified, providing a clear definition, for each of the user groups to build upon. GAA
- Smaller workshops could then be held with specialists from each user group, where the generic principles and approach could be discussed and then be adapted to suit the needs of the specific user water quality guidelines.
- It was agreed that a position paper to conceptualise the thinking and approach was needed to keep the discussions and future envisaged workshops streamlined and structured. GAA
- It was suggested that Dr Kevin Murray, the project manager of Phase 1, be contacted to possibly get involved in developing the paper and assist in aligning the risk based thinking. WRC to please find out whether Kevin can be contacted
- The group discussed the importance of the user interface and the coding that supported it. It was important that it was aligned across the 5 user groups and that it met the needs of the end-user. It is still unclear if the user interface needs to be integrated into one system or 5 separate systems are needed. This aspect still requires further discussion. However due to the fact that the development of the irrigation guidelines are underway, a user interface would be a deliverable of the project. How the other systems will be aligned/integrated to this is still unclear, if they should at all?
- The group also discussed the structure to the guidelines. Three possible categories were proposed per water quality variable – each limit range associated with the respective risks. This could be linked to colour coding. The irrigation group was working along this approach however nothing concrete had been defined.
- There was a discussion around who the custodian of the SA risked water quality guidelines is/should be. Dr Jooste indicated that this is not clear within DWS. It was important to some extent to know this so that someone takes ownership of the final products/SA WQGs. This would link to the integration of the interfaces and the needs of the end-user. In addition the future maintenance and updating of the guidelines would be important. In this respect it was important that Ndileka Mohapi from DWS is involved. GAA
- John Annandale further raised the question around the development of water quality objectives for irrigation. This had been included in the terms of reference for the development of the irrigation guidelines. However it is believed that this may be a

separate process that would need to be undertaken outside the development of the water quality guidelines (scientific process). Dr Jooste indicated that the objectives were needed and formed a key component of the completing the cycle but greed that where its development takes place is still open for discussion. He highlighted that the sector objectives were required by the water quality user group during the discussions on the setting of resource water quality objectives/resource quality objectives. It was also needed by the catchment manager.

3 WAY FORWARD

3.1 In conclusion Lee Boyd indicated the way forward as follows: GAA

- An "internal" position paper on risk be developed; tease out a conceptual approach that can then be taken to the follow-up workshops; look at differences and commonalities;
- Dr Kevin Murray be approached to determine his availability/willingness to participate;
- A small focussed workshop, with the UP irrigation team, WRC project managers and GAA be held to define the risk approach and the tiers.

The position paper be refined and updated based on this workshop, and thereafter, individual workshops be held with specialists from each of the other water quality specific user groups to refine the approach per user.

9. DATE OF THE NEXT MEETING

17 September 2014

10. CONCLUSION OF THE MEETING

- LB closed the meeting and thanked the teams for a successful collaboration.

…… **……..**
CHAIRMAN **DATE**

DATE: 04/08/2014	**TIME:** 09h00	**VENUE:** University of Pretoria, Agricultural Sciences Building, Lunnon Road entrance, Room 4-28, Pretoria
WRC PROJECT:		**DESCRIPTION:** Facilitation of workshops related to the proposed risk based WQ Guidelines

NAME	**REPRESENTING**	**TEL NO.**	**EMAIL**
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Lee Boyd	Golder Associates Africa	082 885 1799	lboyd@golder.co.za

APPENDIX B

Attendance Register and Presentation given on the 17th September 2014

1402450 (F)

ATTENDANCE REGISTER

DATE: 17 September 2014	**TIME: 09h00**	**VENUE: University of Pretoria**
PROJECT NO:	**PROJECT: WRC WQ Guidelines workshops**	**DESCRIPTION: Facilitation of workshops related to the proposed risk based WQ Guidelines**

NAME	REPRESENTING	TEL NO.	EMAIL	SIGNATURE
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WRC Short Term Research Project

Facilitation of workshops for the risk based water quality guidelines –

CONCEPTUALISATION OF THE RISK BASED APPROACH

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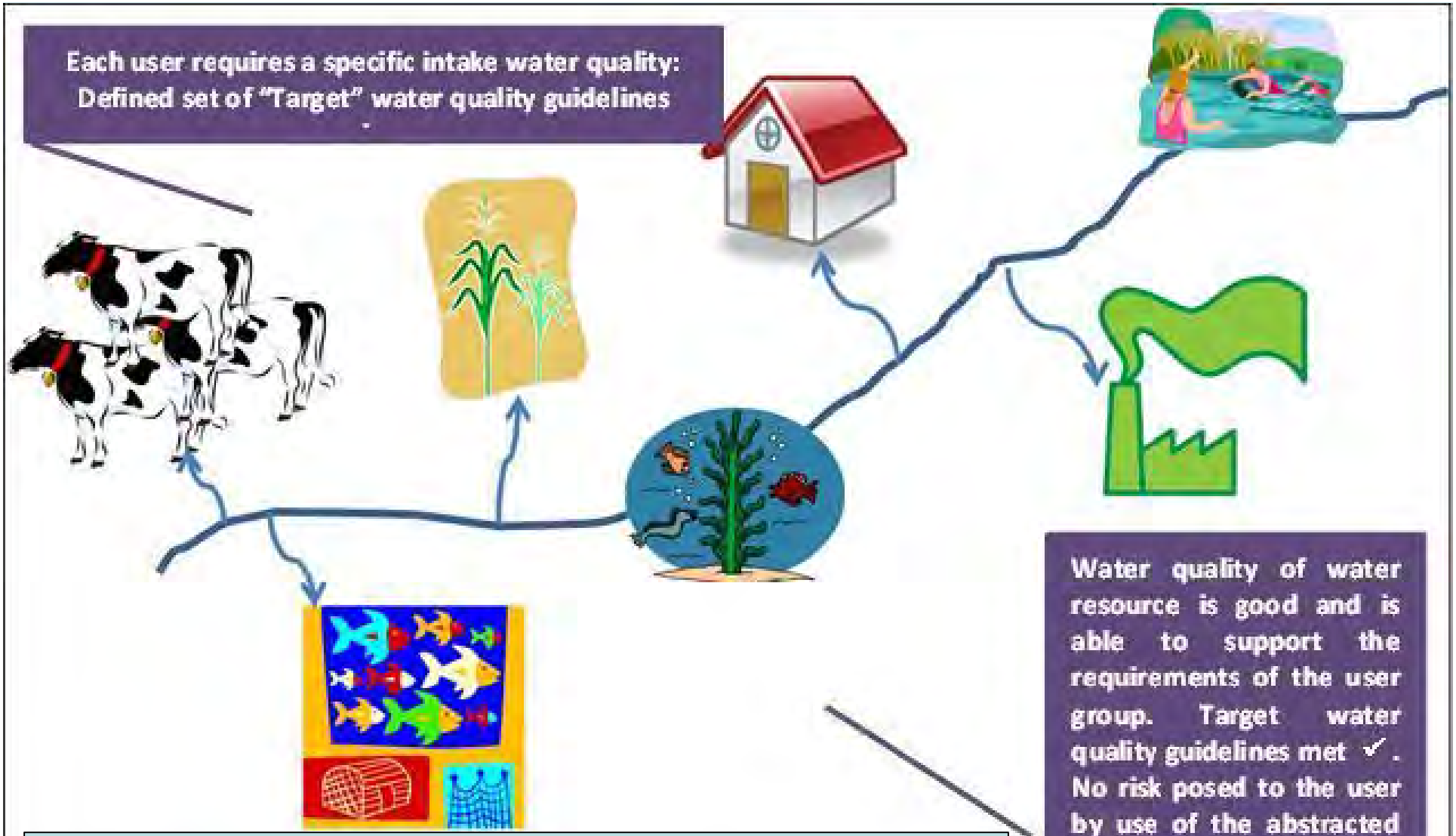

In the likelihood that this set of water quality requirements cannot be met, due to less than ideal water quality being available a risk exists that could result in an undesirable situation developing for the user; for example, a poor yield, contaminated product or health impacts.

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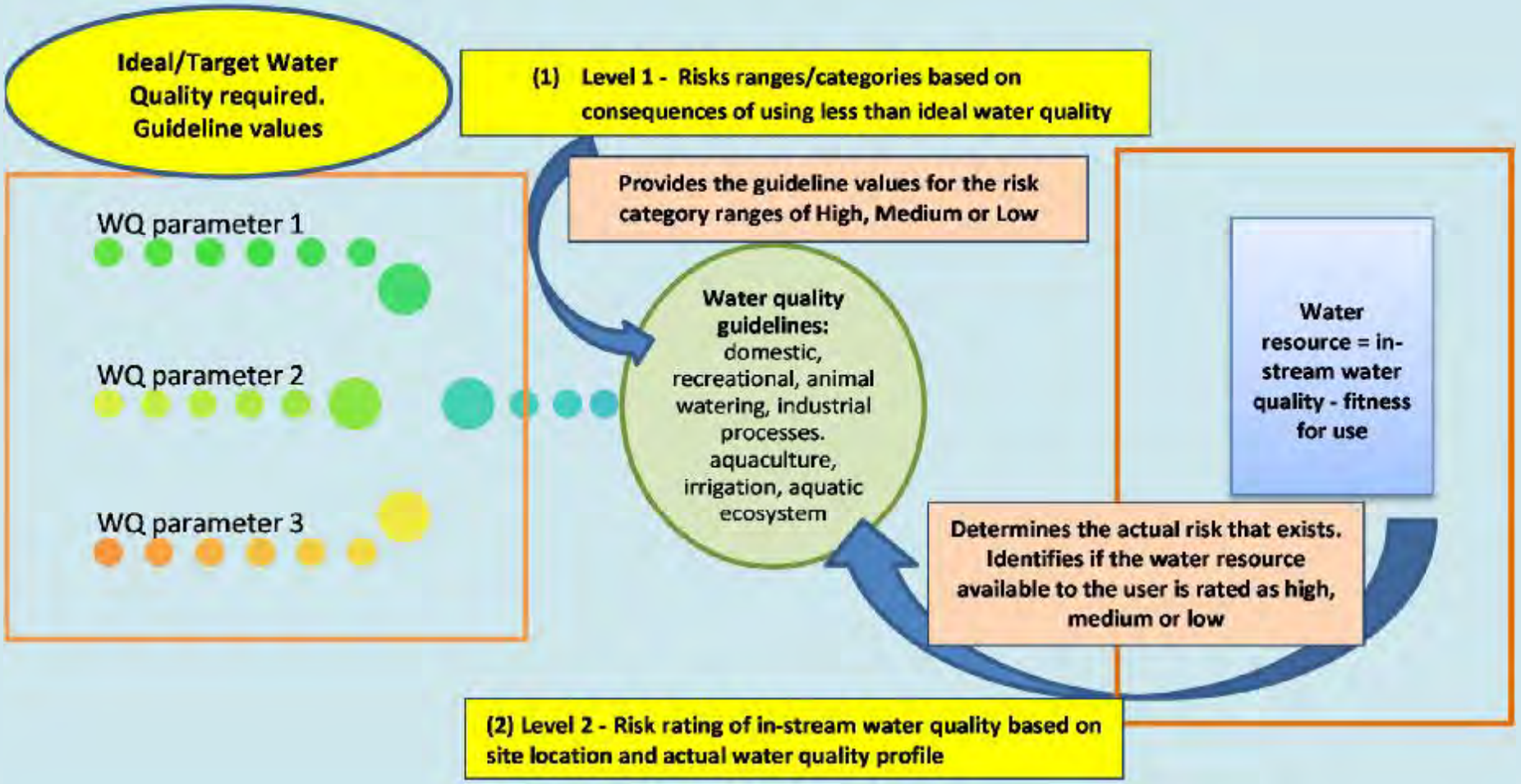
Two levels of risk



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Three tiers?

- Considering how the three tiers should be approached and included in the risk based water quality guidelines a process was followed in asking:
- what these tiers should comprise in terms of providing a “risk perspective” to the user,
- what would be the outputs based on the inputs envisaged and what the value a user of the DSS would gain from each tier.

Tier 3 proposed in the 2008 document was based on allowing assessments and objectives setting to be carried out in site-specific contexts not covered by Tier 2 and would also not be covered by the DSS. In this respect it was felt that a third tier was perhaps unnecessary and not possible to include within the water quality guidelines development process. Tier 3 would require the application of risk based approaches and assessment that did not require the application of the water quality guidelines *per se*. The guideline risk category ranges would be used as a reference point.

Two tiers proposed

TIER 1:

Defined or developed based on risk-based science

Water quality guidelines and risk categoristaion

- Definition of water quality requirements per user group;
- Definition of the Target water quality guidelines (based on lastest science, research, international practice);
- Conservative; precautionary approach; most sensitive receptor in the different user groups;
- Definition of risks in the absence of target water quality range
- Risk assessment (based on applicable risk methodology for the user group)
- Risk categories (Numeric values ranges with background and supporting info to define risk levels (H; M; L proposed)
- Generic ;applicable to all water resources;
- Developed independently for domestic, recreational, animal watering, industrial processes. aquaculture, irrigation,
- Aquatic ecosystems? what should guideline development entail; triggers; sensitive species; - needs a differnt SOW for the scientific knowledge development; consider regionalising at Tier 1
- Components required per user group (e.g. irrigation - crop type, soil type)

TIER 2:

Actual risk present for the user group based on specific catchment context

Risk rating based on the in-stream water quality profile

- Quartenary catchment based
- Water quality profiles (percentiles over defined period)
- Probability of oocurrence of the water quality risk - link to risk assessment matrix of Tier 1
- Definition of risk rating og prevailing in-stream water quality for the specific user group;
- Mitigatory measures specified if medium of hisk rated

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Risk methodology

Risk methodology that is applied to each of the user groups is critical to the linkage between Tier 1 and Tier 2. The risk based approach should incorporate a risk assessment task with the following objectives:

- To identify categories or themes for that specific user group that is dependent on water quality;
- To identify risks of low quality water associated with these categories or themes;
- To determine and rate the probability of occurrence of the specific risk based on a certain defined scale;
- To determine and rate the exposure level of the contaminated water to the water user;
- To identify the consequence category and describe the consequence related to the probability of the risk and the exposure level; and
- Finally to describe mitigatory and/or further actions that may be required to rectify or reduced the risk identified.

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Risk methodology

Risk matrix – proposed example

Concentration ranges					
5 – >15	5 (M)	10 (M)	15 (H)	20 (H)	25 (H)
4 – (12.6-15)	4 (L)	8 (M)	12 (M)	16 (H)	20 (H)
3 – (10.1-12.5)	3 (L)	6 (M)	9 (M)	12 (M)	15 (H)
2 – (5.1-10)	2 (L)	4 (L)	6 (M)	8 (M)	10 (M)
1 – (0-5)	1 (L)	2 (L)	3 (L)	4 (L)	5 (M)
Exposure	**1 - Once**	**2 – Short term**	**3 – Medium term**	**4 – Long term**	**5 - Permanent**

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TIER 1

Maize

Soil type

Parameter	Target value	Low risk	Med risk	High risk
Chloride				
Sodium				
Potassium				

List of water quality parameters specific to maize

Based on background science and risk assessment;

Will need to include the impacts for each risk level

Concentration ranges					
5 – >15	5 (M)	10 (M)	15 (H)	20 (H)	25 (H)
4 – (12.6-15)	4 (L)	8 (M)	12 (M)	16 (H)	20 (H)
3 – (10.1-12.5)	3 (L)	6 (M)	9 (M)	12 (M)	15 (H)
2 – (5.1-10)	2 (L)	4 (L)	6 (M)	8 (M)	10 (M)
1 – (0-5)	1 (L)	2 (L)	3 (L)	4 (L)	5 (M)
Exposure	1 - Once	2 – Short term	3 – Medium term	4 – Long term	5 - Permanent

TIER 2

Finer scale; data availability?

Quaternary where located

Links back to Tier 1 suite of variables that apply to maize

Domestic

Irrigation

Aquatic

Industry

Crop type (maize)

Data available for the quaternary

WMS data

No data available

Consider specifying minimum data range

Input own data

Algorithm

Profile of variables of current water quality (past 10 years)

Can we bring in a fatal flaw parameter?

Risk rating per variable (T; L; M; H) for that particular quat

Proposed mitigation

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Conclusions

- Integrated DSS (all user groups)
- Risk assessment methodology is central to the process
- Data requirements of Tier 2 (Water Quality data WQ per quat (WMS data); Ecological information (Reserves, PES, ECs)

Recommendations

- Tier 1:
  - The risk matrix and analysis and how it relates/links to the probability of occurrence of the prevailing water quality needs to defined and understood.
  - An integrated matrix must be developed.
- Tier 2 needs to be developed in a 2nd phase by one group (consider representative from each user group) for all users:
  - High risk variables per user;
  - WQ river profiles;
  - Spatial;
  - Output will be a risk rating
- DSS
  - Must incorporate in the software to link tiers 1 and 2

APPENDIX C

Attendance Register and Presentations given on the 25th February 2015

WRC PROJECT K8/1067

RISK BASED WATER QUALITY GUIDELINES

SPECIALIST STAKEHOLDER SESSION
Wednesday 25th February 2015 from 08h30 to 15h30
Venue: Golder Associates Africa, Midrand (see attached map for directions)

Background to the project

The Department of Water Affairs' South African Water Quality Guidelines published in 1996 comprise the following fresh water and coastal marine water volumes:

Fresh Water:

- Volume 1: Domestic Water Use;
- Volume 2: Recreational Water Use;
- Volume 3: Industrial Water Use;
- Volume 4: Agricultural Water Use: Irrigation;
- Volume 5: Agricultural Water Use: Livestock Watering;
- Volume 6: Agricultural Water Use: Aquaculture; and
- Volume 7: Aquatic Ecosystems.

Coastal Marine Waters

- Volume 1: Natural Environment;
- Volume 2: Recreational Use;
- Volume 3: Industrial Use; and
- Volume 4: Mariculture.

The then Minister of the Department of Water Affairs & Forestry (DWAF), Kader Asmal, noted in the foreword to each volume that DWAF's mission was "to ensure that the quality of water resources remains fit for recognised water uses and that the viability of aquatic ecosystems are maintained and protected". The guidelines were intended as the primary source of information and decision-support to judge fitness of water for use and for other water quality management purposes and have been widely used over the years providing information on the ideal water quality for water uses and background information to help users make informed judgments about fitness for use. In 2007 a number of specific issues came to the fore that made it necessary to re-examine the philosophical basis used for determining and using such guidelines. These included:

Promulgation of the National Water Act (Act 36 of 1998) (NWA), after which the approach to water resource management within Department of Water Affairs (DWA) (then Department of Water Affairs and Forestry (DWAF)) had changed fundamentally and it was felt that it would be beneficial to have a single philosophical basis for decision making throughout the Department. A number of specific issues relating to catchment management were relevant:

§ Classification of water resources involving the determination of a "management class" representing a future desired state for that water resource; where resources not in this state must be managed towards it, or resources corresponding to this state must be maintained in that state. The limits of each class will be described, quantitatively and/or narratively, by Resource Quality Objectives (RQOs).

§ Ecological and Basic Human Needs Reserve;

§ Minimum requirements for waste discharge; and

§ Remediation of water resources.

Risk as a common basis where the concept of "risk" could potentially provide the common philosophical basis for decision making in different contexts. The development of guidelines based on risk would therefore serve to coherently link such guidelines with risk-based approaches in other management areas.

Latest science and practice, considering that the approaches used as a basis for developing the 1996 guidelines were based on international best practice of the time, so that in 2007 it was noted that the assessment of recent advances in guideline determination, both international and local, was necessary to ensure that South African water quality guidelines were based on the latest and most appropriate science and practice. Specific constraints noted in noted in 2007 were:

- **Limited water uses and water quality variables:** the "recognised" water uses would possibly need to be rationalised and extended to

include other uses. Furthermore, it was noted that within the existing water uses, the inclusion of additional water quality variables such as organic substances would extend the usefulness of the guidelines; and

- **Site specificity:** where the 1996 guidelines provided generic guideline values meaning that local site-specific conditions were not considered. In specific scenarios this could result in a guideline that could either be too lenient (and therefore possibly not sufficiently protective) or too stringent (and therefore possibly costly). Including protocols that would account for site-specificity addresses these problems. Inherently these site-specific protocols can also consider other kinds of risks, in alignment with the integrative nature of sustainable development.

In light of the above, the DWA in 2007 initiated a review of the 1996 SAWQGs and the development of a philosophical basis for the risk based approach. In this respect the project team put together consisted of a number of risk assessment and guideline development experts who had experience in a number of fields including human health and drinking water, animal watering, irrigation, and aquatic ecosystems. These experts summarised the current situation in respect of guidelines both in South Africa and abroad. They also provided expert assessments of such issues as new variables for which guidelines are required and underlying philosophies for a risk based approach to guideline development and use.

A decision was made during the project that the final product should consist of a software decisions support system with a user friendly interface, as well as hard copy manuals. In addition, the then DWAF also held many internal workshops attended by stakeholders from those directorates likely to be affected by new guidelines including representatives from the Regional Offices who were actively using the 1996 guidelines and who could provide guidance on the way forward. The concepts relating to the envisaged guidelines were presented based on the philosophy developed during the project and using a primitive interface developed. Very useful insights into their use of guidelines and their specific requirements of new guidelines were obtained. At the time of the 2007 project initiation the following phases were planned:

- Phase 1: Project delineation and development of philosophy which included a definition of scope; literature review; distilling the needs of the target users; a philosophy and protocol development; and needs analysis;
- Phase 2: Application of philosophy and development of prototype guidelines; and
- Phase 3: Development of tools for higher-tier site-specific guidelines.

However, only Phase 1 of the project was completed, hence the need to get back on track and assess the need for further phases in the project. In this respect the WRC has been in discussion with DWA Resource Quality Services (RQS) regarding the review and update of the SA WQ guidelines which started when Dr Kevin Murray was still the Research Manager (RM) at the WRC. Dr Jennifer Molwantwa then took over from Dr Murray in January 2014 and, together with Dr Nonhlanhla Kalebaila, has continued the discussion with Dr Sebastian Jooste and Dr Nadine Slabbert on taking the development of risk based water quality guidelines forward.

Objectives of the project

The objectives of the Short Term Research Project (STReP) are therefore to guide the formulation of the Terms of Reference for an update of the 1996 South African Water Quality Guidelines. The STReP must be informed by:

- The Phase 1 study (*Development of SA Risk-based Water Quality Guidelines: Phase 1, Needs Assessment and Philosophy*); and
- The approved risk based water quality guidelines currently under development for the irrigation sector project.

The ***specific objectives of the workshop*** will therefore be to:

- Agree on the definition of the risk-based approach to the development of the water quality guidelines;
- Agree on a **common set of principles to the risk based approach as it relates to all defined water user sectors**; and
- Agree on the framework of the risk **approach to be applied** when undertaking the update and development of the water quality guidelines in the different water user sectors.

Looking forward to seeing you at the workshop,

RSVP: Lee Boyd by Wednesday 18th February 2015

mailto:lboyd@golder.co.za or

Tel: 011 254 4915

Cell: 082 885 1799

Fax: 086 582 1561

ATTENDANCE REGISTER

DATE: 25 February 2015	TIME: 8h30 – 15h00	VENUE: Golder Associates Midrand
PROJECT NO:	PROJECT: 1402540	DESCRIPTION: Stakeholder Workshop

Title	Surname	Name	E-mail address	Organisation	Contact number	Signature
Prof	Annandale	John	John.Annandale@up.ac.za	University of Pretoria		Apologies
Mr	Backeberg	Gerhard	gerhardb@wrc.org.za	WRC		Apologies
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Prof	Bouwman	Henk	henk.bouwman@nwu.ac.za	University of the North West		
Mrs	Boyd	Lee	lboyd@golder.co.za	Golder Associates		
Prof	Casey	Norman	Norman.Casey@up.ac.za	University of Pretoria		
Mr	Coleman	Trevor	tcoleman@golder.co.za	Golder Associates (Water Resource specialist)		Apologies
Mr	de Fonteine	Marc	marcdef@randwater.co.za	Rand Water		Apologies
Prof	Dickens	Chris	c.dickens@cgiar.org	International Water Management Institute		Apologies.
Mr	du Plessis	Meiring	meiringd@gmail.com	Private (irrigation)		Apologies
Prof	du Preez	Chris	dPreezCC.SCI@ufs.ac.za	Dept of Soil, Crop and Climate Sciences Faculty , UFS		Apologies

ATTENDANCE REGISTER

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Dr	Heath	Ralph	raheath@golder.co.za	Golder Associates		Apologies
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Dr	Jooste	Sebastian	joostes@dwa.gov.za	RQS	0829276902	
Ms	Juggarth	Nivi	NJuggath@golder.co.za	Golder Associates (risk specialist)		
Dr	Kalebaila	Nonhlanhla	nonhlanhlak@wrc.org.za	WRC		Apologies
Mr	Kerneels	Esterhuyse	kerneelsE@Tshwane.gov.za	Tshwane Metro	0829243697	
Dr	Kleynhans	Neels	kleynhansN@dwa.gov.za	DWA RQS (aquatic specialist)		
Ms	Kruger	Marina	marina@midvaalwater.co.za	Midvaal Water	082 800 413	
Ms	Liee	Yvonne	yliee@randwater.co.za	Rand Water	0714372	

ATTENDANCE REGISTER

Title	Surname	Name	E-mail address	Organisation	Contact number	Signature
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Ms	Maurizi	Annamarie	Annamarie.Maurizi@ekurhuleni.gov.za	Ekhuruleni Metro		
Mr	Mey	Hans	hmey@sedibengwater.co.za	Sedibeng Water		
Dr	Meyer	James	jmeyerc@mweb.co.za	Independent	0835693167	
Ms	Mochotlhi	Deborah	MochotlhiD@dwa.gov.za	Department of Water and Sanitation		
Mrs	Mohapi	Ndileka	MohapiN@dwa.gov.za	DWS, RDM Office		
Dr	Molwantwa	Jennifer	jenniferm@wrc.org.za	WRC		
Mrs	Moodley	Priya	pmoodley@golder.co.za	Golder Associates		
Dr	Muller	Nikite	nikite@iwr.ru.ac.za	Unilever Centre for Environmental Water Quality Institute for Water Research, Rhodes University Grahamstown		
Dr	Ncube	Esther	encube@randwater.co.za	Rand Water		
Ms	Ndilileka	Mohapi	MohapiN@dwa.gov.za	DWS: RDM Office		

ATTENDANCE REGISTER

Title	Surname	Name	E-mail address	Organisation	Contact number	Signature
Dr	O'Brien	Gordon	obrieng@ukzn.ac.za	University of KZN, School if Life Sciences		
Prof	Palmer	Tally	tally.palmer@ru.ac.za	Rhodes University		Calling in
~~Mr~~ Dr	Peter	Wade	peterwade.za@gmail.com	pp UNW	0823061915	
Mr	Pietersen	Jan	Jan@midvaalwater.co.za	Midvaal Water	0829032761	
Mr	Rimmer	Russel	rrimmer@jwater.co.za	Joburg Water		
Prof	Roos	Jan	jcroos.water@gmail.com	Private		
Dr	Shaddock	Bridget	bshaddock@golder.co.za	GARL (Toxicity)	083 256 1566	
Mr	Singh	Anil	singha3@dwa.gov.za	Department of Water and Sanitation		
Dr	van Ginkel	Carin	carin.vanginkel@gmail.com	Private (aquatics)		
Mr	Vulindlu	Mjikisile	Mjikisile.Vulindlu@capetown.gov.za	City of Cape Town	021 4440158 0844715253	
Prof	Wepener	Victor	victor.wepener@nwu.ac.za	North West University		

ATTENDANCE REGISTER

DATE: 25/02/2015	TIME:8:00AM	VENUE: Golder Associates Africa
PROJECT NO: 1402450	PROJECT:WRC/SAWQGuidelineRevUpdate/PTA	DESCRIPTION: Meeting

NAME	REPRESENTING	TEL NO.	EMAIL	SIGNATURE
Mapula Mametja	Rand Water	0824782964	mmametja@randwater.co.za	
Marielle Swart	Rand Water	011 545 0513	MSwart@randwater.co.za	

WRC Short Term Research Project

Facilitation of workshops for the Development of risk based Water Quality Guidelines

SPECIALIST WORKSHOP: THE RISK BASED APPROACH AND A FRAMEWORK FOR ITS APPLICATION

PROJECT BACKGROUND

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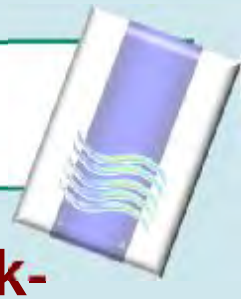

WHY is it necessary to introduce the concept of "risk-based" water quality guidelines?

- The 1996 guidelines were risk-based to some extent because risk (*i.e.* the probability of adverse effects) was considered at **least implicitly** in the development of the guidelines. One could argue that it could (or should) have **been considered more explicitly**.
- However, the **purpose of the current endeavour** is not only related to how risk is considered in the development of guidelines (*i.e.* risk approach to the science). - ***It is more about how they are to be used***

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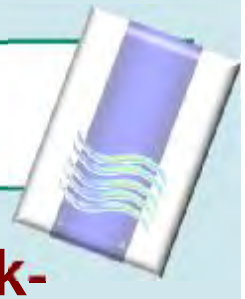
WHY is it necessary to introduce the concept of "risk-based" water quality guidelines?

- A more important issue is that the everyday use of the guidelines should be **more explicitly risk-based**.
- Guidelines should no longer be used simply **as "trigger" values** above which something needs to be done (to deal with the "problem") and below which water quality can be ignored.
- This requires a **paradigm shift** in thinking and in terms of how water quality is to be assessed and managed.



WHY is it necessary to introduce the concept of "risk-based" water quality guidelines?

- The 1996 water quality guidelines were **spatially "generic"** (*i.e.* they assumed some kind of "average" or typical scenario).
- They were also largely "**substance specific**" (*i.e.* they referred to single chemical or microbial components).
- A small degree of site-specificity was introduced with a few substances because their guidelines were given as a function of other chemical components (like hardness).
- They **cannot take account of inherent differences** in water use that exist merely by virtue of where the water use occurs.

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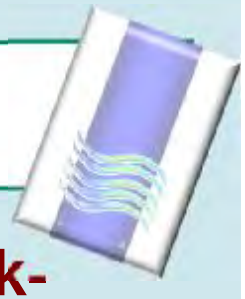

WHY is it necessary to introduce the concept of "risk-based" water quality guidelines?

- The **quantitative nature and extent of risk** needs to permeate water quality guideline development, guideline definition and description, and guideline use more explicitly.

So that the guidelines will then be more:

- Scientifically defensible;
- Transparent to all concerned; and
- Practical and usable to not only those managing our water resources but also those using the water.

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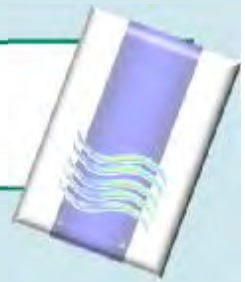

WHY is it necessary to introduce the concept of "risk-based" water quality guidelines?

- Ultimately, using a risk-based philosophy and common language, the nature and extent of the use (and protection) of South Africa's water resources can be appropriately balanced with our nation's other critically important priorities.

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RISK BASED WATER QUALITY GUIDELINES

In 2008:

- The DWS concluded that there was a need for the review of the 1996 version of the South African Water Quality Guideline series
- Among other recommendations, the new guidelines should support:
  - site-specificity, be risk-based, provide for tiered fitness for use assessment and consider a software-based decision support tool.

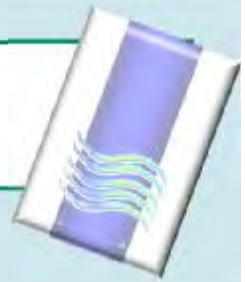
RISK BASED WATER QUALITY GUIDELINES

- **Overall project is aimed at**

- Updating, refining, aligning and expanding the South African National Water Quality Guidelines of 1996.
- The intention is that the revised guidelines should be specifically aligned with latest thinking in respect of risk based science and assessment and with harmonisation of water resource management instruments.

- **The final product envisaged**:
  - a multi-tiered assessment system, including the necessary software support which will facilitate its implementation.
  - The first tier - envisaged as a generic (national) conservative hazard-based system (similar in some ways to the 1996 guidelines).
  - Progressively higher tiers are intended to allow greater site specificity with the highest level using a comprehensive quantitative/qualitative risk assessment as the basis for the guidelines for a specific site (*e.g.* river reach or aquifer).

RISK BASED WATER QUALITY GUIDELINES



- **Development of the risk based guidelines - three phases:**
  - **Phase 1**: The development of the philosophical basis. In this phase the guiding principles were constructed and clarified. The thinking around the use of risk as opposed to hazard, the applicability of these concepts to water resource management was developed.
  - **Phase 2**: Develop a tiered water resource quality assessment system founded on a risk-based approach
  - **Phase 3:** Develop necessary instruments to facilitate implementation of the guidelines

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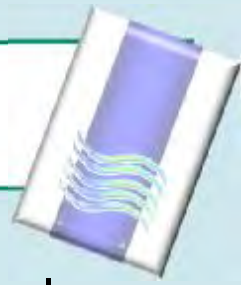
RISK BASED WATER QUALITY GUIDELINES



- **Product Specifications:** In the context of the envisaged final product, the following recommendations are made:
- The term “guidelines’ should refer to the numerical values as well as all narrative background and supporting information.
- The primary tool facilitating the determination and use of the water quality guidelines should be a software decision support system (DSS). This should be complemented with a set of hard copy manuals that at least present generic values and supporting information.
- The overall product should comprise a tiered system:
  - Tier 1 is equivalent to 1996 generic guidelines and is made available in the DSS and hard copy manuals;
  - High tiers should allow for site-specificity in specified contexts and is facilitated by the DSS

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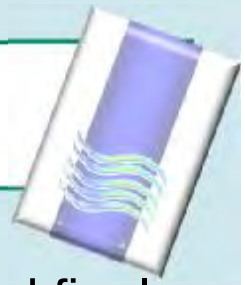
RISK BASED WATER QUALITY GUIDELINES

- **Product Specifications (2):** In the context of the envisaged final product, the following recommendations are made:
- The tier facility must be as easy to use as possible.
- The software user interface must be intuitively obvious, simple, unambiguous, guiding and informative.
- The facility must provide for quantitative fitness for use assessments and water quality objective setting that is aligned to the extent possible with the resource classification system.
- The facility must be as fully and as explicitly risk-based as possible and allow guidelines to be determined for a variety of site specific conditions or scenarios.
- The facility must provide comprehensive information supporting informed decision making and educational purposes.

RISK BASED WATER QUALITY GUIDELINES



- **Product Specifications (3):** In the context of the envisaged final product, the following recommendations are made:
- The DSS must provide a comprehensive “record of decision” facility.
- It is essential that the final product can be efficiently and effectively updated when new data or protocols become available.
- It is important that the overall facility is transparent in the sense that original data, protocols and assumptions upon which numerical guidelines are based are accessible to users.
- The guidelines are focussed on the water resource. Where serious philosophical inconsistencies arise among users this must be highlighted for the resource management decision process.

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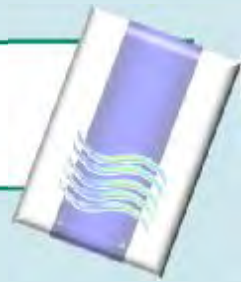
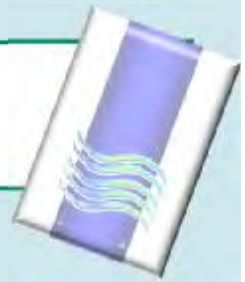


Water Users:

- **Domestic use**: In the context of water resources being used for “domestic use” minimum water treatment technology comprising cloth filtration and chlorine tablet disinfection can be assumed. Notwithstanding this requirement, there should not be any fundamental inconsistency between the envisaged water quality guidelines and the SANS 241 standard.

- **Recreational use**: The current definition of recreational use now includes uses such as personal or commercial activities and activities which contribute to the general health, well-being and skills development of individuals and society. This therefore includes social, cultural and religious uses of water resources. The existing guidelines will therefore need to be extended.



Water Users:

- **Aquatic ecosystem use**: The association between water resource class descriptors and levels of species protection should be carefully examined and an appropriate association formally accepted.
- **Animal watering**: Much local in-depth research has been performed relating to risk and site / scenario specificity. The nature of the final product should make full use of this local expertise.
- **Industrial processes**: These guidelines should not focus on industries *per se*. They should rather focus on well-defined problems occurring in industry, such as scaling, corrosion, fouling, foaming, abrasion, etc.
- **Aquaculture**: Consider having these guidelines determined as a component of the aquatic ecosystem guideline facility.
- **Irrigation:** The variables covered should be extended to include at least more biological and pesticide variables.

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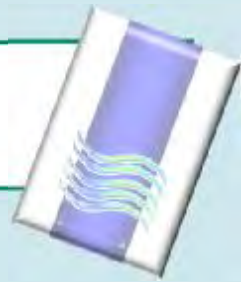
RISK BASED WATER QUALITY GUIDELINES



- **Recommendations:** Process towards final product
- Guiding principles should be used as criteria for development-related decision making. They should be used for *ad hoc* decisions and regularly revisited to assess the overall direction of ongoing progress.
- Since a wide range of stakeholder exists, communication with them should be regarded as important for not only keeping them informed but also to elicit comment.
- The protocols, guidelines and supporting documentation should be submitted to international peer review.
- Developers should constantly keep in mind capacity issues within DWS, not only in terms of numbers of people but also their absolute abilities. Software interfaces should enable very easy, clear and unambiguous use of the guidelines

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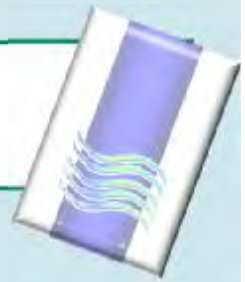
RISK BASED WATER QUALITY GUIDELINES



- **Recommendations:** Process towards final product
- The software decision support system (DSS) must be developed in a sufficiently modular way to effectively support tiered applications.
- Periodic assessments of the relevance of significant development decisions to other DWS initiatives must be made.
- The concept of “acceptable risk” and its implementation must be communicated and debated with stakeholders.
- Careful consideration should be given to the proposed criteria for including new variables in the final product to ensure that they are absolutely necessary and can be cost-effectively included.

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WRC Short Term Research Project

Facilitation of workshops for the Development of risk based Water Quality Guidelines

SPECIALIST WORKSHOP: THE RISK BASED APPROACH AND A FRAMEWORK FOR ITS APPLICATION

PURPOSE AND OBJECTIVES

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PURPOSE OF WORKSHOP

To achieve a common understanding of the risk-based guideline theory and application in the development of the update to the South African Water Quality Guidelines Series

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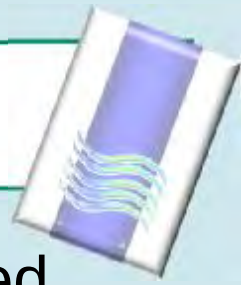
OBJECTIVES OF WORKSHOP



- Agree on a **common set of principles** to the risk based approach as it relates to all defined water user sectors;
- Agree on **the defined framework** of the risk-based approach to the development of the water quality guidelines (per user group per selected water quality variable);
- Agree on the **decision framework for risk assessment based on site specific conditions** as it relates to the water resource (could include selected parameters per user requirements, applicable water quality objectives, present water quality)

Golder Associates

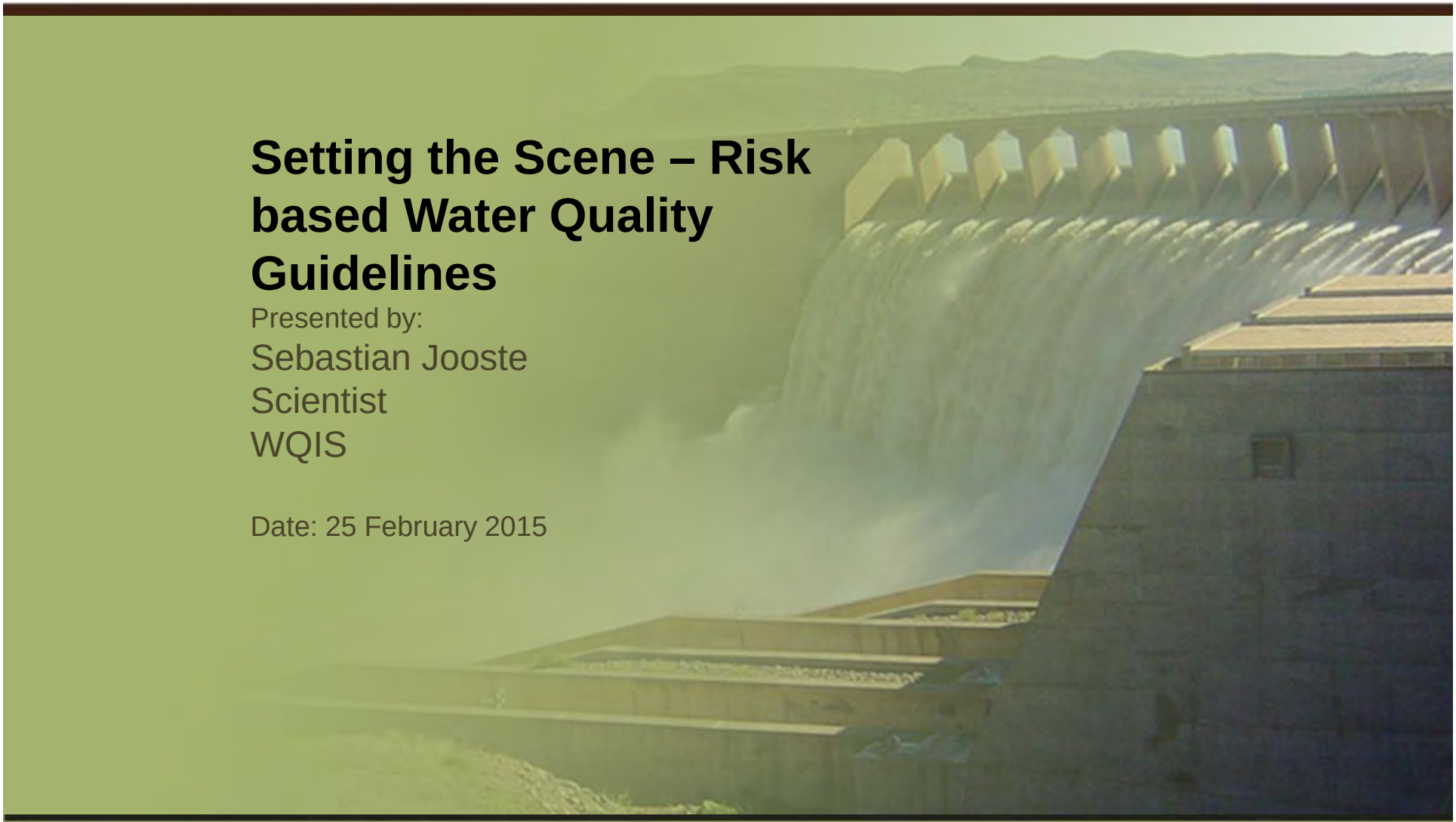
water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Setting the Scene – Risk based Water Quality Guidelines

Presented by:
Sebastian Jooste
Scientist
WQIS

Date: 25 February 2015



Presentation Overview

Decision context: why risk-based and why new?

Guidelines as a knowledge product: why so complex?

Presentation and specification: why a software product?

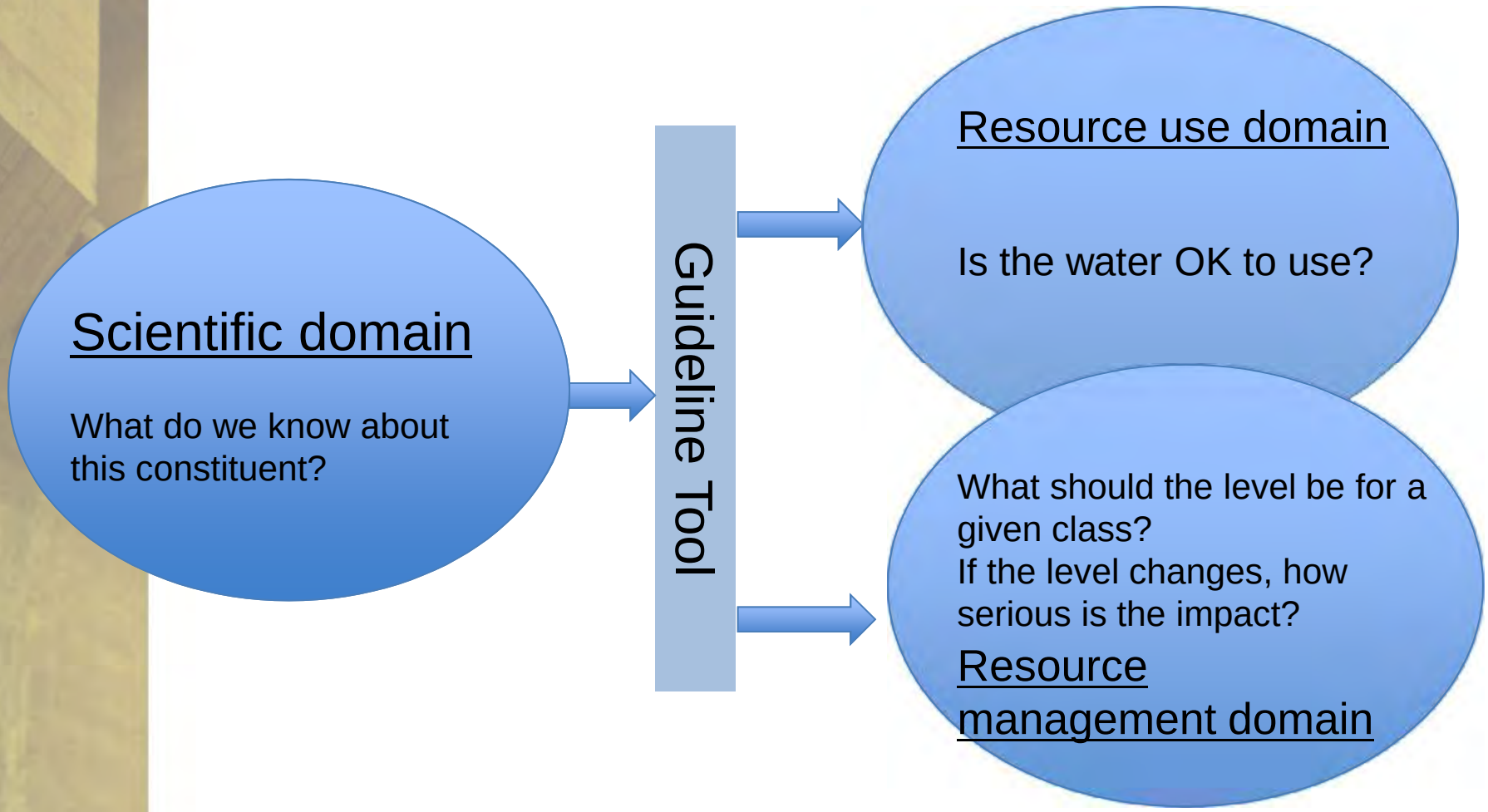
The decision context

- Given a set of water analyses, what is the fitness for use?
- Given a target fitness for use, what are the ranges in values of different parameters/ constituents that will give effect to the target?
  - An expression of the science supporting the decision.
  - Needs to reflect the state of the science.

Context (cont'd)

- Guidelines vs standards
  - Guidelines reflect the scientific environment, standards reflect the regulatory environment.
  - Guidelines are dynamic, standards tend to be static.

Context (cont'd)



Example

Constituent	Level
Al^{+3}	1 250 µg/l
E. coli	1 450 MPN/100ml
EC	225 $mS.m^{-1}$
Mn^{+2}	8 mg/l

Fitness for use?

Decision context (cont'd)

	SA Ecosystem 1996	USEPA	ANZECC 2000	Site level
Al	<5 (<10) µg/l 10 (20) µg/l 100 (150) µg/l	750 (40) µg/l	27 - 150µg/l	1 250µg/l
E. coli	Not specified	126/100ml	Not specified	1 450/100ml
EC	<15%change in normal cycle, frequency and amplitude retained	TDS 250 mg/l		~1 460mg/l TDS
Mn	<180µg/l 370 µg/l 1 300µg/l	50, 100 (30 µg/l)	1 200 – 3 600 µg/l	8 000 µg/l

Decision context (cont'd)

- Response is often continuous over constituent level.
  - Seldom possible to make binary decision in environmental assessment.
- How a constituent presents itself in the uptake process can have a critical impact on what one would expect to happen.
  - Presence ≠ availability
- The same constituent can enter the target through different routes
  - Recognize the use scenario

Why risk-based?

- Risk: the quantitative or semi-quantitative, site- and/or situation-specific expectation that that a given target organism will experience an unacceptable effect.
- Risk-based: recognizing the risk factors in giving effect to risk objectives.

Why risk-based? (cont'd)

- Expectation can be expressed mathematically on a continuous basis e.g. probability, possibility, etc.
- Long history and vast literature since formal application in 1901 (fortunately and unfortunately).
- Already used in many regulatory applications
- With a suitable end-point it facilitates comparison

Why new guidelines?

- Used in Canada, USA, Europe and Australia among others.
- South Africa alone requires classification of water resources.
  - Possible to use much of what has been done before
  - BUT be clear on validity of assumptions and application (e.g. ANZECC trigger values)

A knowledge product

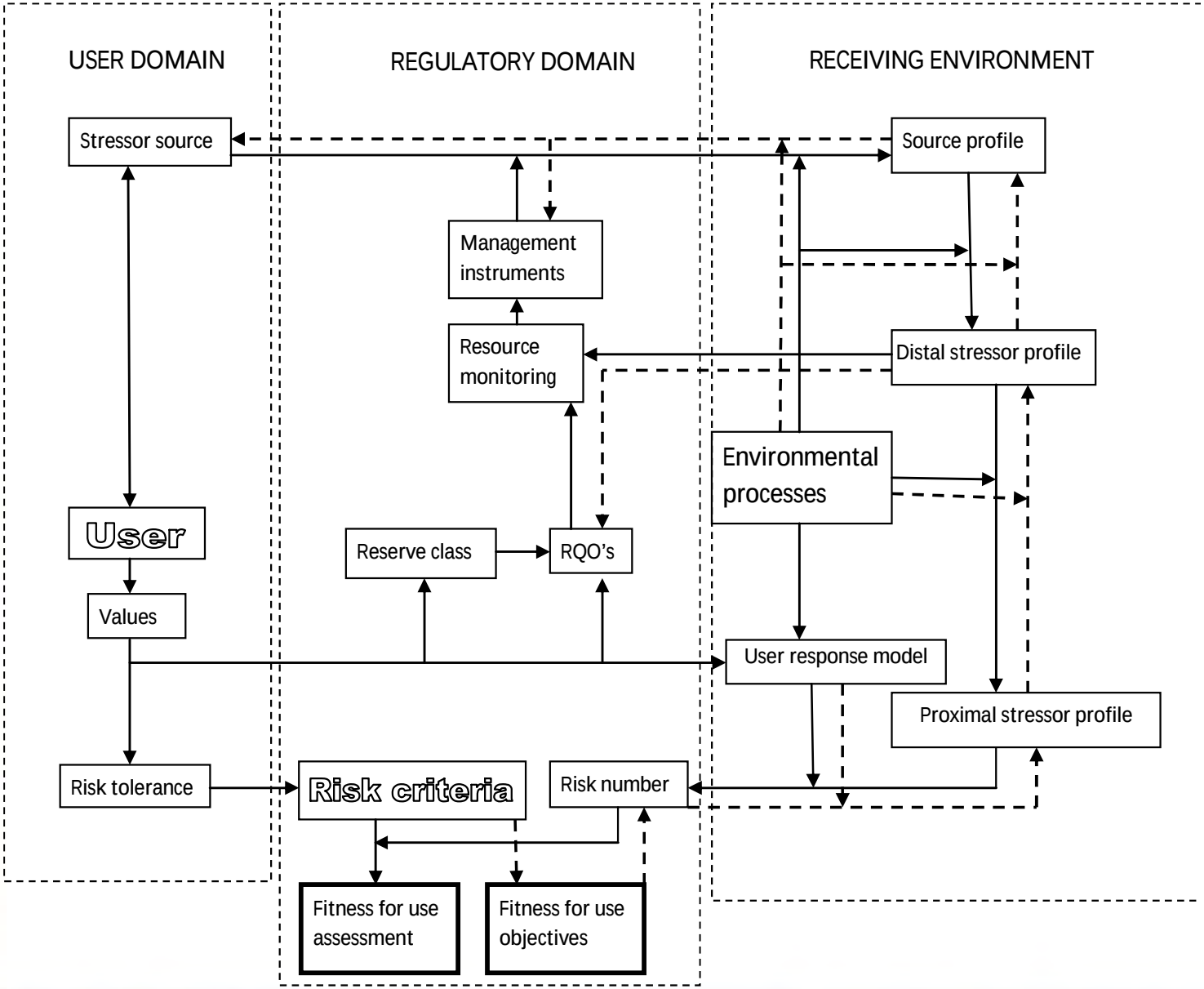
Things should be made as simple as possible, but no simpler

Albert Einstein

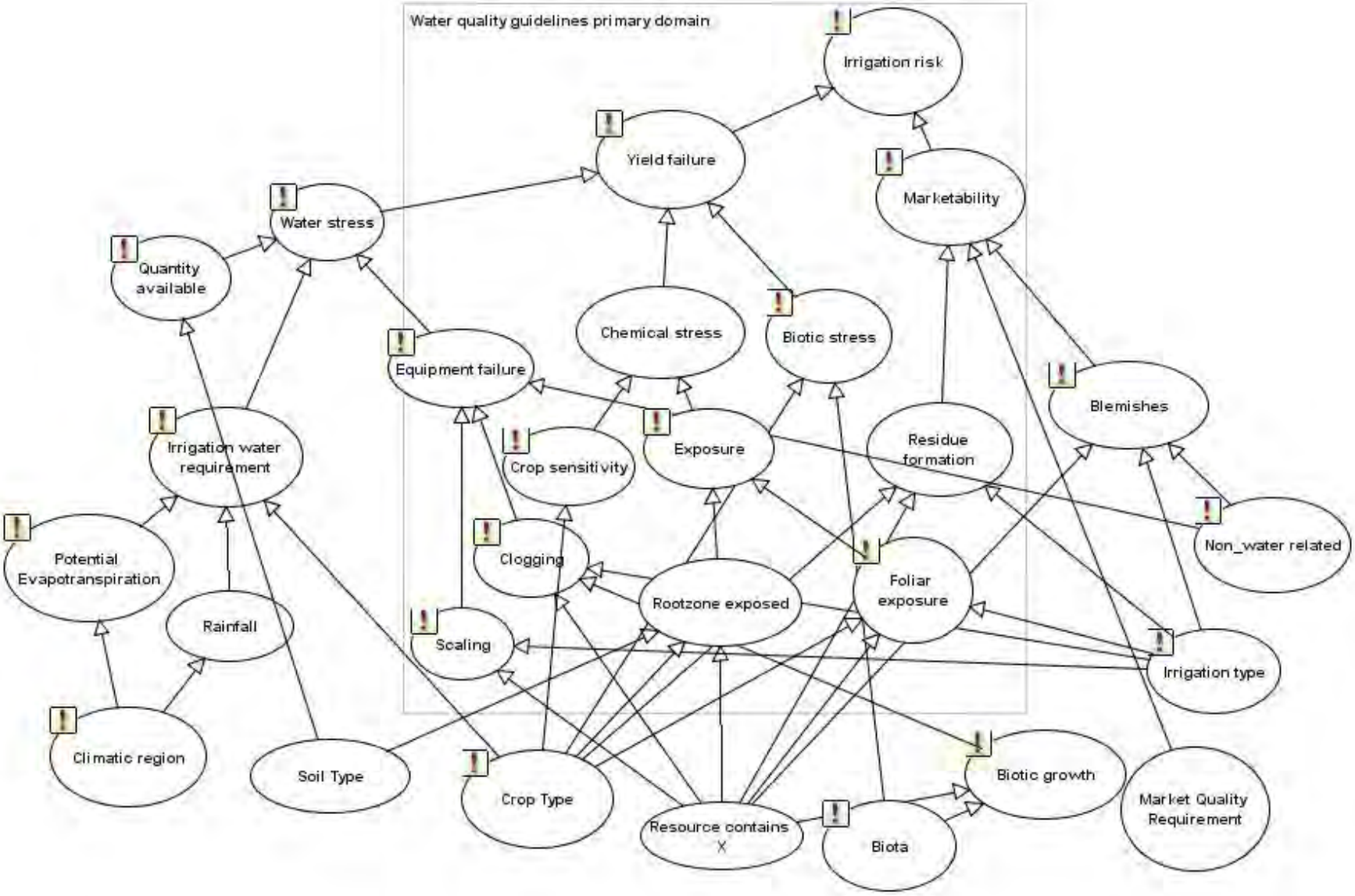
Perfection is attained, not when nothing is left to be added, but when nothing is left to be taken away.

Antoine de Saint-Exupery

Risk-based water quality guidelines



Risk-based water quality guidelines



A knowledge product

$X_{lab} \rightarrow E_{lab}$ $E_{lab} \rightarrow E_{field}$

Probability: Crisp mostly stochastic events

$$P(E_F) = P(X) \cdot P(E_F|X) + P(\neg X) \cdot P(E_F|\neg X)$$

$$P(E_F) = P(X) \cdot [P(E_L|X) - P(E_L|\neg X)] + \gamma P(E_L|\neg X)$$

$$P(X) = \frac{1 - P(E_F) + \gamma \cdot P(E_L|\neg X)}{\gamma \cdot [P(E_L|X) + P(E_L|\neg X)]}$$

$$\max_{i \in \{1,N\}}(E_i) \leq P(\bigcup_{i=1}^{N} E_i) \leq \min(1, \sum_{i=1}^{N} P(E_i))$$

A knowledge product

Fuzzy logic: Fuzzy events, deterministic processes

Rule: IF x ∈ A THEN y ∈ B

R=A°B

$$\mu_R(x,y) = max\left[\left(\mu_A(x) \wedge \mu_B(y)\right), \left(1 - \mu_A(x)\right)\right]$$

Given A" (level of exposure) find B" (level of effect):

$$A'' = B'' \circ R$$

Given ¬B' find ¬ A'

$$\mu_{A''}(x) = 1 - \bigvee_{y \in Y} \left(1 - \mu_{B''}(y)\mu_R(x,y)\right)$$

What is acceptable risk?

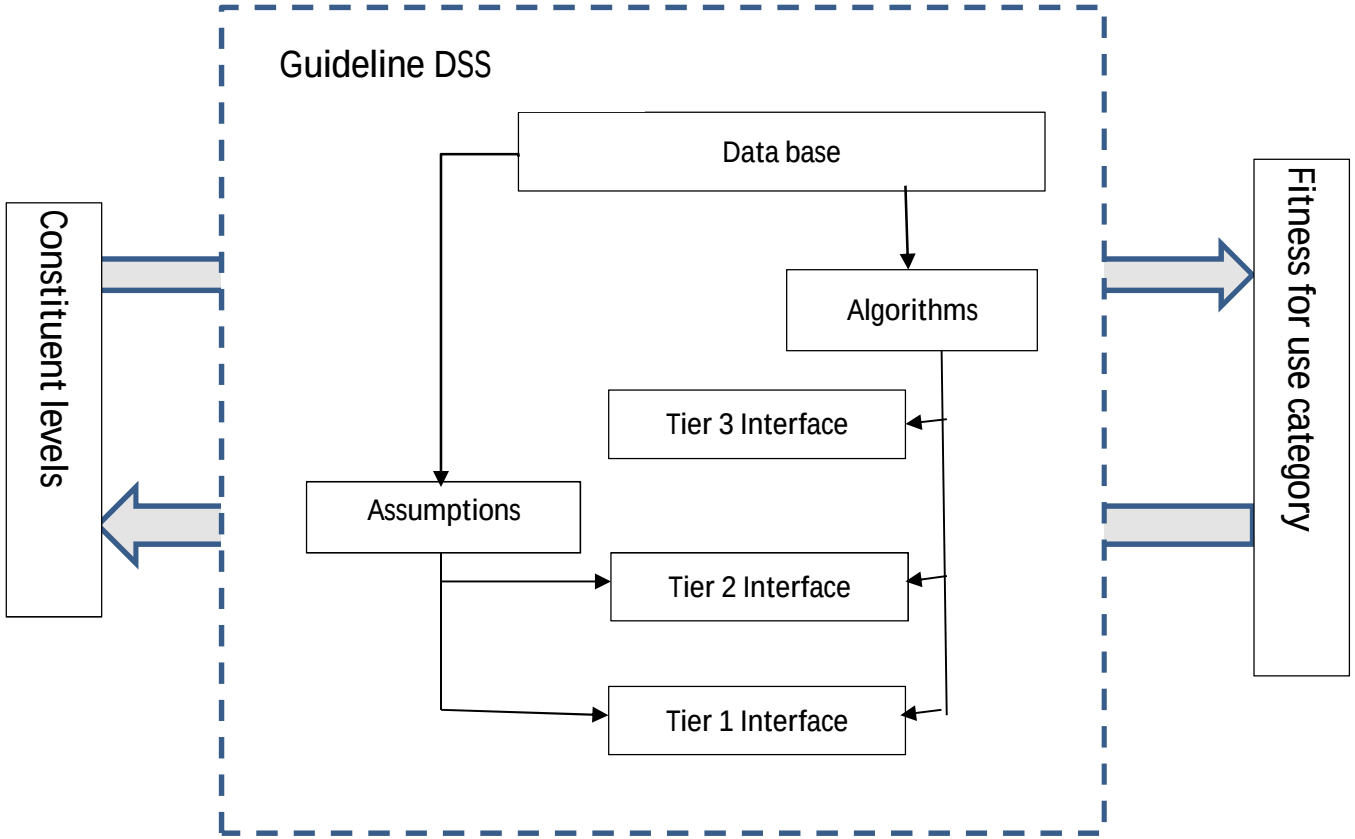
Acceptable risk (defined for each class) = Risk criterion

- FDA: risks < uncertainty in the incidence of the disease or condition in the general public. (E.g. botulism action level ~ 10^{-8}, more common conditions, 10^{-5} – 10^{-6}).
- NASA 4 x 10^{-3} for astronauts in shuttle missions.
- EPA, by statute, < 1 x 10^{-6} for pesticide residues in food, dependent on the numbers of people at risk, varying between about 10^{-4} and 10^{-6} (there are examples both larger and smaller according to a study published in *Risk Analysis* in the early 1990s)
- DOT 10^{-2} - 10^{-4} as acceptable (in highway and airport applications), depending on the cost expected to be incurred in reducing the risks.
- For drugs, it varies between 0.01 - 0.1 depending on the nature of the adverse effect observed and the benefit offered.
- In occupational setting, a 10^{-3} lifetime excess risk level is often used based on the 1980 Supreme Court decision on benzene.

A knowledge product

- "More research required" not an acceptable answer
  - Guidelines must present the user with what is known – not what is unknown.
- Use "precautionarity" circumspectly and explicitly when needed
  - Do not assume the decision maker's role
- Learn from other guidelines' data requirements and procedures, don't be enslaved to them.
  - Don't squander local knowledge resources.

Presentation: DSS



Presentation: Tiered Guidelines

- Reason: The extent of site-specificity in water quality assessment and objective setting varies among users.
- Three tier approach proposed:
  - Tier III: The most site specific guidance – probably a risk assessment protocol, requiring highly skilled input- and output interpretation;
  - Tier II: Moderately site-specific, requiring some skills, but largely uses pre-defined water use scenarios and limited site characterizing choices with common field observation and or measurement input required from the user. Possibly rule-based output interpretation. A simplification on Tier III.
  - Tier I: the most generic (and by implication the most conservative) approach to guidance. Minimum user input required and simple output provided.
- Presented as a decision- or reasoning support software tool with user manual.
- May serve as a means to operationalise research output.

Deriving risk-based guidelines: critical steps

1. Select suitable candidate end-points and by iteration (if necessary) select a suitable common end-point for all stressors and target combinations (e.g. crop yield). An end-point must, at least in principle, be quantifiable, but not unique to a stressor.
2. For each stressor-endpoint combination set up a fault tree that describes the salient environmental and target processes.
3. Evaluate the state of knowledge about each process, uncertainties, variability and quantitation of relationships as well as interactions with other stressors.
4. Formulate a suitable hazard expression for each stressor.
5. Consider the stressor exposure models. (These models do not necessarily have to be numeric/mathematical models at first but should be amenable to quantitative output.)

...critical steps (cont'd)

6. Consider how best to approach the numerical expression of risk, i.e. probabilistic vs possibilistic expression. Also consider how the main user output requirements (fitness for use-class vs class-related stressor profile) can be generated – this involves considering what risk numbers would reasonably correspond to expected outputs. Also consider how stressor time series inputs must be handled.

7. Consider various realistic exposure scenario's and how they could be quantified.

8. Formulate a risk assessment protocol for each stressor-target combination. This is the Tier 3 guideline. Of importance is the description of the input and output quality, important calculation aids such as algorithms, models etc., caveats and skills requirements.

...critical steps (cont'd)

9. From the risk assessment protocol, select key exposure and hazard variables with known typical values that can be used in the risk calculation. The exposure scenario's in 6 above might be used as basis to obtain inputs from the user to generate more generic but still workably site-specific risk calculation. This is the Tier 2 guideline.
10. Consider what combination of stressor, target and water use scenarios would generate the highest risk values. Use the to generate the Tier 1 output.
11. Consider what qualitative or quantitative outputs would be most useful at each tier to guide the user to a sensible decision (e.g. danger signs, water treatment or improvement options, further guidance internet links, reference material references, etc.)
12. Consider IP issues and controlled access to Tiers. Consider guideline updating issues and (perhaps) protocols.

WRC Short Term Research Project

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SPECIALIST WORKSHOP: THE RISK BASED APPROACH AND A FRAMEWORK FOR ITS APPLICATION

RISK BASED APPROACH: DISCUSSION

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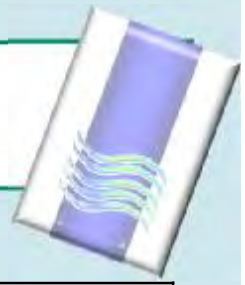
COMPARATIVE DEFINITION OF RISK AND RISK RELATED TERMS

Term	DWAF 2008	AS/NZS 4360:2004	ISO 3100:2009
RISK	Option 1: The probability of an adverse effect in an organism, system, or (sub)population caused under specified circumstances by exposure to an agent. Option 2: Sometimes defined in toxicology applications as the expected frequency of the occurrence of an undesirable effect arising from exposure.	The chance of something happening that will have an impact on objectives. Risk is measured in terms of a combination of the consequences of an event (occurrence of a particular set of circumstances) and their likelihood	The effect of uncertainty on the user's objectives.

RISK BASED WATER QUALITY GUIDELINES

Term	DWAF 2008	AS/NZS 4360:2004	ISO 3100:2009
RISK ASSESSMENT	A process intended to calculate or estimate the risk to a given target organism, system, or (sub)population, including the identification of attendant uncertainties, following exposure to a particular agent, taking into account the inherent characteristics of the agent of concern as well as the characteristics of the specific target system. The risk assessment process includes four steps: hazard identification, hazard characterisation, exposure assessment, and risk characterisation.	The overall process of risk identification (the process of determining what, where, when, why and how something could happen), risk analysis (systematic process to understand the nature of and to deduce the level of risk) and risk evaluation (process of comparing the level of risk (1.3.13) against risk criteria)	A process that is, in turn, made up of three processes: risk identification (a process that is used to find, recognize, and describe the risks that could affect the achievement of objectives), risk analysis (a process that is used to understand the nature, sources, and causes of the risks that you have identified and to estimate the level of risk), and risk evaluation (a process that is used to compare risk analysis results with risk criteria in order to determine whether or not a specified level of risk is acceptable or tolerable).

RISK BASED WATER QUALITY GUIDELINES



Term	DWAF 2008	AS/NZS 4360:2004	ISO 3100:2009
HAZARD	Inherent property of an agent or situation having the potential to cause adverse effects when an organism, system, or (sub)population is exposed to that agent.	A source of potential harm	Risk source: A source that has the intrinsic potential to give rise to risk
EXPOSURE	Concentration or amount of a particular agent that reaches a target organism, system, or (sub)population with a specific frequency and defined duration		
LIKELIHOOD/ CHANCE/ PROBABILITY	Not defined.	Likelihood: used as a general description of probability or frequency. Probability is a measure of 'the chance of occurrence expressed as a number between 0 and 1, attached to a random event'. Furthermore, probability 'can be related to a long run relative frequency of occurrence or to a degree of belief that an event will occur. For a high degree of belief, the probability is near 1.'	The chance that something might happen