

**UK Technical Advisory Group
on the Water Framework Directive**

**Updated Recommendations on
Environmental Standards**

River Basin Management (2015-21)

Final Report

November 2013

(Minor amendments January 2014)

Table of Contents

LIST OF TABLES AND FIGURES	3
CHAPTER 1: INTRODUCTION	5
<u>SCOPE OF THE REPORT</u>	6
<u>THE WATER FRAMEWORK DIRECTIVE</u>	7
<u>THE ROLE OF STANDARDS</u>	7
<u>River Basin Management Plans</u>	8
<u>Protected Areas</u>	8
<u>DERIVING STANDARDS</u>	8
<u>REVISING THE STANDARDS</u>	9
CHAPTER 2: STANDARDS FOR SPECIFIC POLLUTANTS	10
<u>SELECTING SPECIFIC POLLUTANTS</u>	11
<u>Selecting new candidate substances</u>	11
<u>Looking again at established Specific Pollutants</u>	12
<u>Uses and sources of the chemicals</u>	12
<u>Other existing standards</u>	13
<u>DERIVING THE STANDARDS FOR SPECIFIC POLLUTANTS</u>	14
<u>Scientific peer review</u>	15
<u>Accepting a Predicted No-Effect Concentration as the basis for a standard</u>	15
<u>ZINC STANDARDS</u>	16
<u>RECOMMENDATIONS</u>	18
<u>Use of standards for taking action</u>	23
<u>Use of standards for classification</u>	24
<u>THE IMPLICATIONS OF THE RECOMMENDED STANDARDS FOR SURFACE WATERS</u>	24
<u>Implications for England</u>	25
<u>Implications for Northern Ireland</u>	27
<u>Implications for Scotland</u>	27
<u>Implications for Wales</u>	30
<u>THE RESPONSE TO FAILURE OF THE RECOMMENDED STANDARDS</u>	31
<u>Issues arising from reporting compliance</u>	31
<u>The response to failure</u>	32
<u>National reporting</u>	33
CHAPTER 3: GROUNDWATER	34
<u>NITRATE THRESHOLD VALUES FOR ASSESSING RISKS TO WETLANDS</u>	35
<u>Use of the threshold values in status classification</u>	36
<u>Implications of the recommendations</u>	37

<u>THRESHOLD VALUES FOR ASSESSING RISKS TO USES OF GROUNDWATER</u>	38
<u>Application to groundwater being abstracted for human consumption</u>	39
<u>Implications</u>	40
<u>Application to assess impacts on the groundwater resource</u>	40
<u>Implications</u>	41
<u>THRESHOLD VALUES FOR RISKS TO ASSOCIATED SURFACE WATERS</u>	42
<u>Implications</u>	43
<u>RISK OF DETERIORATION</u>	43
<u>PREVENT OR LIMIT THE INPUT OF POLLUTANTS INTO GROUNDWATER</u>	44
<u>Recommended approach for hazardous substances</u>	44
<u>Recommended approach for non-hazardous pollutants</u>	47
CHAPTER 4: ALIEN SPECIES	50
<u>Alien species and classification</u>	50
<u>'Locally absent' species</u>	52
CHAPTER 5: RIVER FLOWS	53
<u>FINDINGS OF THE REVIEW</u>	53
<u>ECOLOGICAL RESPONSES TO CHANGES TO MID AND HIGH FLOWS</u>	54
<u>Mid flows</u>	55
<u>High flows</u>	55
<u>RECOMMENDATIONS FOR MID AND HIGH FLOW STANDARDS</u>	56
<u>IMPLICATIONS OF THE RECOMMENDATIONS</u>	58
<u>Risk assessment</u>	58
<u>Classification</u>	58
CHAPTER 6: WATER LEVELS IN LAKES	60
<u>USING THE STANDARDS</u>	63
<u>PEER REVIEW</u>	63
<u>IMPLICATIONS</u>	64
CHAPTER 7: INTERMITTENT DISCHARGES	66
<u>Fundamental Intermittent Standards</u>	66
<u>99-percentile Standards</u>	67
CHAPTER 8: STANDARDS FOR ACIDIFICATION IN RIVERS	71
<u>Comparison of current and recommended standards for acidification</u>	72
<u>Implications</u>	73
REFERENCES	74
<u>GENERAL</u>	74
<u>SPECIFIC POLLUTANTS</u>	74
<u>GROUNDWATER</u>	76

<u>ALIEN SPECIES</u>	77
<u>RIVER FLOW</u>	77
<u>WATER LEVELS IN LAKES</u>	78
<u>INTERMITTENT DISCHARGES</u>	79
<u>STANDARDS FOR ACIDIFICATION</u>	79

LIST OF TABLES AND FIGURES

Table 1: Main uses of the chemicals and their potential sources	12
Table 2: Ambient Background Concentrations for dissolved zinc.....	16
Table 3.1: Recommended standards for benzyl butyl phthalate ($\mu\text{g/l}$)	18
Table 3.2: Recommended standards for carbendazim ($\mu\text{g/l}$)	18
Table 3.3: Recommended standards for chlorothalonil ($\mu\text{g/l}$).....	18
Table 3.4: Recommended standards for 3,4-dichloroaniline ($\mu\text{g/l}$).....	19
Table 3.5: Recommended standards for glyphosate ($\mu\text{g/l}$).....	19
Table 3.6: Recommended standards for manganese	19
Table 3.7: Recommended standards for methiocarb ($\mu\text{g/l}$)	19
Table 3.8: Recommended standards for pendimethalin ($\mu\text{g/l}$).....	19
Table 3.9: Recommended standards for tetrachloroethane (TCE) ($\mu\text{g/l}$).....	19
Table 3.10: Recommended standards for triclosan ($\mu\text{g/l}$).....	20
Table 3.11: Recommended standards for copper	20
Table 3.12: Recommended standards for diazinon ($\mu\text{g/l}$).....	20
Table 3.13: Recommended standards for 2,4-dichlorophenol ($\mu\text{g/l}$).....	20
Table 3.14: Recommended standards for permethrin ($\mu\text{g/l}$).....	20
Table 3.15: Recommended standards for toluene ($\mu\text{g/l}$)	21
Table 3.16: Recommended standards for zinc	21
Table 4: Look-up table for 95% confidence of failing a 95-percentile standard	23
Table 5: Specific Pollutants – implications for England.....	25
Table 6: Implications for England when applying bioavailable metal standards	26
Table 7: Specific Pollutants – implications for Scotland	28
Table 8: Implications for Scotland when applying bioavailable metal standards	28
Table 9: Specific Pollutants – implications for Wales	30
Table 10: Implications for Wales when applying bioavailable metal standards	30
Table 11: Threshold values for nitrate in groundwater	35
Table 12: Recommended threshold values for nitrate in groundwater	39
Table 13: Recommended standards for hazardous substances	46
Table 14: Revisions to the UKTAG listings of alien species.....	51
Table 15: High impact species in Great Britain	51
Table 16: Recommended revisions to the “moderate” standards for river flows.....	57
Table 17: Recommended revisions to the “poor” standards for river flows.....	57
Table 18: Standards for the effect of water level changes on lake surface area	61

Table 19: Fundamental intermittent standards for Dissolved Oxygen	66
Table 20: Fundamental intermittent standards for Un-ionised Ammonia.....	67
Table 21: Types of river to which standards apply	68
Table 22: 99 percentile standards for BOD.....	68
Table 23: 99 percentile standards for Ammonia	69
Table 24: Comparison of current and recommended standards for pH and ANC	72
Table 25a: Movements in class in clear waters as a result of new standards	73
Table 25b: Movements in class in humic waters as a result of new standards.....	73
Figure 1. Schematic representation of a lake where level has been lowered on day = d.	62

CHAPTER 1: INTRODUCTION

The UKTAG is a working group of experts drawn from UK environment agencies and conservation agencies¹. It also includes representatives from the Republic of Ireland.

The UKTAG develops guidance and makes recommendations to the UK's government administrations on technical aspects of implementation of the Water Framework Directive to help with river basin planning. It operates through a series of technical task teams established for specific subjects including chemicals, marine waters, water resources, groundwater and fresh waters.

The UKTAG's role includes provision of technical advice on appropriate classification tools and classification rules for chemical, biological and physical quality elements and the environmental standards² for achieving different WFD status and how they may be used for river basin planning.

The group also offers advice to the agencies that provide its members.

In developing recommendations for environmental standards the UKTAG takes into consideration available scientific and technical or it may commission research into specific areas where the science is not fully understood.

In presenting its advice and recommendations to UK's government administrations, the UKTAG seeks to put proposals for new or revised standards in to context by describing the likely changes in WFD status classification at a UK level or at an individual country level where possible.

The UK government administrations consider these implications before deciding whether to adopt the UKTAG's recommendations for environmental standards. The approach to the adoption and implementation of recommendations can vary for each country within the UK, depending on present and proposed legislation, and on policy in each country. This is for Ministers to decide.

In using the term "standard", the UKTAG means numerical limits on things like the concentrations of chemicals, river flow or water levels, or measurements for biological communities. In some cases a failure of a standard leads directly to firm action on protection. In others, a failure leads only to further investigation and monitoring.

¹ Natural Resources Wales (NRW), Natural England (NE), Environment Agency (EA), Northern Ireland Environment Agency (NIEA), Joint Nature Conservation Committee (JNCC), Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH), Republic of Ireland's Department of Environment, Community and Local Government (DECLG).

² These encompass the words of the Directive - values, concentrations and Environmental Quality Standards. It covers standards used for classification, and standards used to decide action. It also covers guideline values, thresholds and conditions that might be used to take a next step in further work on classification and in investigations needed to decide action.

Recommendations for standards were first published in 2007 and 2008 [1-5]. These were adopted for the first cycle of the Directive's river basin management plans. The plans were published in 2009. The standards help focus efforts to improve and protect the water environment.

This document is the UKTAG's recommendations for a third set of standards and conditions and follows a scientific stakeholder review during the period April 2012 to June 2012. As understanding improves, any standard may be revised. The UKTAG's role is to look at and consider the evidence. This can lead to proposals that are tighter or more relaxed than current standards. Where possible, we have amended and clarified the report to take account of stakeholder feedback. Detailed feedback on comments raised in the consultation can be found at <http://www.wfduk.org/stakeholders/phase-3-environmental-standards-stakeholder-review-201213>

This report is the final Phase 3 report; zinc standards have been added since the interim report. The new and revised phosphorus and biological standards are outlined in two further reports available on the UKTAG website at <http://www.wfduk.org/resources/new-and-revised-phosphorus-and-biological-standards>

The recommendations are seen as sufficiently developed to help with the second cycle of plans. The report also maps out plans for future work.

SCOPE OF THE REPORT

This report covers:

- standards for certain chemicals known as Specific Pollutants
- developments in the assessment of risks to groundwater
- non-native species
- standards for flows in rivers
- standards for levels in lakes
- standards for acidity in rivers
- standards for intermittent discharges

The standards recommended:

- are matched correctly to processes of monitoring and mathematical modelling;
- allow a proper assessment of compliance;
- lead to sound and transparent methods for taking decisions to protect and improve the water environment.

This report does not describe all the details of these three activities. This is done by the individual agencies and countries, within the requirements of the Directive.

THE WATER FRAMEWORK DIRECTIVE

The Directive¹ sets out objectives for rivers, lakes, groundwater, estuaries and coastal waters. Objectives are set for water bodies and expressed in terms of status. The objectives include,

- preventing deterioration in status;
- restoring water bodies to good status by 2015.

In addition, requirements of European legislation outside the Water Framework Directive may lead to the definition of waters as various types of “protected area” which have their own objectives. Where a water body has more than one objective, the most stringent requirement applies.

The process of setting objectives for water bodies, their timescale for achievement and consideration of any relevant exemptions (for example, if achieving them would be disproportionately costly or technically infeasible) is part of the River Basin Planning process.

THE ROLE OF STANDARDS

Standards are matched to the objectives of the Directive. The environment agencies use standards to set limits on the amount of water that can be abstracted, or how much pollutant can enter the environment, to either improve environmental quality or to prevent it from deteriorating.

Action to improve or protect the condition of the water environment may take at least two forms:

- By setting local and bespoke controls, in order to meet a standard in a particular water body.
- By applying uniform controls across all operators of a certain type or size. This constitutes a step that benefits all water bodies in a region or nation, a step that can be reduced or extended once its impact is demonstrated.

Surface water bodies are assigned to one of five classes, high, good, moderate, poor or bad status. To assign a class, the UK agencies assess the condition of communities of plant and animals. The achievement of environmental standards is also taken into account. For example, if a water quality standard identified for good status is not met, the status will be moderate or worse.

The Directive requires that the overall status of the water body is determined by the lowest status from all the standards that are assessed. This is known as the ‘one out, all out’ rule. To have high status, for example, a water body cannot fail any of the standards associated with high status².

¹ 2000/60/EC

² This covers all the indicators used to classify, whether for biological quality, river flow and water levels, chemical quality, or whatever, are covered by the general description “quality elements”.

River Basin Management Plans

In preparing river basin management plans the environment agencies estimate, by monitoring, the shortfall in environmental quality needed to meet the standards established for the Directive's objectives. They seek to determine what needs to be done to achieve the standards in partnership with others and identify the most cost-effective combinations of actions to meet the objectives. The plans are also subject to "regulatory impact assessment" and "strategic environmental assessment", where appropriate. These cover estimates of the full costs and benefits and who will pay and receive these.

Protected Areas

For protected areas established for Natura 2000 sites¹, the conservation agencies set conservation objectives underpinned by standards based on a Common Standards Monitoring Guidance which is agreed across the conservation agencies. The UKTAG has examined the evidence used to develop Common Standards for a number of parameters. The aim is to align, as far as possible, standards for the Water Framework Directive and Natura 2000 Protected Areas. This work is ongoing and proposals are not included in this report. The indications are that some of the standards recommended for protecting the status of water bodies could also apply in the context of Natura 2000.

DERIVING STANDARDS

The UKTAG seeks standards that apply to all water bodies of the same type. It wants standards that can lead to and make use of sound monitoring programmes and so produce unbiased estimates of compliance and national performance. These help take decisions to improve and protect waters, decisions that are well-targeted and which can be shown not to be wasteful.

In developing some of its standards, the UKTAG may be able to use biological data collected from hundreds or thousands of sites. The UKTAG can compare these with information for the same sites on the environmental conditions to which the plants and animals are sensitive. This process can identify standards that correspond directly with the biological definition of good status. Such standards are well matched to the objectives expanded in the preceding paragraph – produce sensible estimates of compliance and lead to good decisions.

In other cases, in estuaries and coastal waters for example, and generally for pollutants not subject to big programmes of monitoring, there are insufficient data to derive standards in this way. In such cases, the UKTAG uses the current scientific understanding of the causes of ecological change. The UKTAG compares this understanding with the Directive's biological descriptions of the classes. In doing this, the UKTAG relies on advice from independent experts from a range of scientific disciplines. The UKTAG has used this approach to identify limits for river flow and water levels, and for standards for particular chemicals.

¹ That is, sites designated under the Birds or Habitats Directives for species or habitats of importance at European level.

REVISING THE STANDARDS

Existing standards may need to be revised for two main reasons:

- Biological standards have changed: the UK works with Member States¹, and with the European Commission, to compare methods of biological classification. This is known as inter-calibration. The aim is to ensure that the boundaries of good status are consistent across Europe and within the Directive's requirements². The results of inter-calibration may lead to new or revised biological standards. To achieve these may require that new or revised environmental standards are developed for water quality, water flows or levels, or morphological characteristics of water bodies.
- Improved scientific understanding: environmental standards are also revised where improved understanding through research and monitoring, or the benefit of experience in their practical application, shows that existing standards are not as well matched to ecological quality as they could be.

¹And Norway.

² So that what constitutes "good" status in the UK is consistent with "good" status in another European country.

CHAPTER 2: STANDARDS FOR SPECIFIC POLLUTANTS

The Water Framework Directive requires that Member States identify Specific Pollutants¹ and set standards for them. Specific Pollutants are toxic substances that are discharged in significant quantities into the water environment. Previous work by the UKTAG has led to standards for 19 Specific Pollutants [1]. These are:

ammonia, arsenic, chlorine, chromium(III), chromium(VI), copper, cyanide, cypermethrin, diazinon, 2,4-dichlorophenol, 2,4-dichlorophenoxyacetic acid (2,4-D), dimethoate, iron, linuron, mecoprop, permethrin, phenol, toluene and zinc

The standards for these were used in the first cycle of river basin management plans. For 11 of the substances, the standards were the same as those set previously under the Dangerous Substances Directive. These substances are underlined in the above list. The UKTAG has looked again at these in the light of the latest scientific information.

The UKTAG now recommends that 10 further pollutants are identified as Specific Pollutants. This chapter sets out the UKTAG's recommendations on standards for these [2]. The standards are set out later in Table 3.1 to 3.16. This chapter describes:

- (a) the way proposed new Specific Pollutants are selected;
- (b) the process used to derive the standards;
- (c) the recommended standards;
- (d) how these differ from the existing standards;
- (e) estimates of the extent of compliance with the standards.

This chapter also suggests how the recommended standards should be used to:

- assess the ecological status of bodies of surface water;
- identify where action should be taken and what action is needed.

The UKTAG uses a process that reviews the scientific basis of a standard [3]. The process also looks at the use of the standard to take decisions, and ensures the standard could be used to assess correctly the impact on those who will need to invest in action to secure compliance. The standard must be expressed in a way that renders it suitable for use in an economic assessment of the action needed to comply².

¹ Pollutants covered by Annex VIII, points 1 to 9, of the Water Framework Directive. The identification of Priority and Priority Hazardous Substances and the setting of their standards is done at the European level. There is no requirement in the Water Framework Directive for standards for Specific Pollutants to be set so as to protect human health. Separate EU legislation, such as the Drinking Water Directive and the Food Hygiene Regulations, cover the requirements of human health.

² For example, to allow correct calculations in any Regulatory Impact Assessment that may be required.

SELECTING SPECIFIC POLLUTANTS

Selecting new candidate substances

The UKTAG started by considering more than 300 chemicals¹. The list included substances covered by existing legislation, substances subject to obligations for monitoring, and substances that have emerged as possible concerns.

The substances were ranked using a process consistent with European guidance [4]². For each substance, this covers:

- the hazardous properties: the toxicity, persistence, and potential to accumulate in organisms;
- potential exposure of the environment to the substance. This is based on the extent and pattern of use, and on data from monitoring.

Each substance is scored against these criteria and the results are combined into a single number. A value of 1 indicates high risk; a value of 5 suggests very low risk. Substances ranked 1 or 2 are considered as candidates for Specific Pollutants.

Sixty-nine substances were scored as 1 or 2. Their ranking was subject to peer review. As a result of this review a substance either:

- is a priority for the development of standards (and a candidate Specific Pollutant); or
- is not a priority because other issues influence the potential use of the substance³, or because controls of the substance are already in place; or
- requires investigation or monitoring to improve confidence in the ranking.

Fifteen substances emerged as potential new Specific Pollutants. The list was reduced to ten because three are under consideration at the European level as Priority Substances⁴, and, for another two, aluminium and silver^{4,5}, the review concluded that there was insufficient information to derive standards. The UKTAG recommends that the remaining 10 are identified as Specific Pollutants:

benzyl butyl phthalate, carbendazim, chlorothalonil, 3,4-dichloroaniline, glyphosate, manganese, methiocarb, pendimethalin, tetrachloroethane and triclosan

¹ The list of substances for identifying candidate Specific Pollutants is kept under review by the UKTAG.

² The process of ranking applies to organic chemicals, but the UKTAG looked also at inorganic substances, (metals) and substances identified as potential candidates during the previous review of Specific Pollutants [1].

³ For example, the substance is no longer approved for use.

⁴ And so need not be considered as Specific Pollutants at this time.

⁵ For silver, for example, a standard could be derived and data from monitoring indicates low risk. But there is a need to consider the issue of nanosilver as more data become available. It was therefore decided not to take forward a proposal at this time.

Looking again at established Specific Pollutants

As noted above, the UKTAG has also reviewed standards for 11 Specific Pollutants for which it had previously recommended the continued use of old standards [1]¹. Because of new scientific information, the UKTAG is now in a position to recommend revised standards for the following six of these:

copper, diazinon, 2,4-dichlorophenol, permethrin, toluene, zinc

The standards for these six substances are set out later in Tables 3.11-3.16.

For, arsenic, ammonia and chlorine, the UKTAG recommends keeping the existing standards.

Uses and sources of the chemicals

A summary of the main uses and likely sources of these chemicals is given in Table 1.

Table 1: Main uses of the chemicals and their potential sources		
Substance	Major uses	Likely sources in surface waters
benzyl butyl phthalate	PVC plasticizer occurring in a wide range of industrial and domestic products	wastewater treatment works, industrial effluents
carbendazim*	fungicide used in horticulture and agriculture	diffuse agricultural
chlorothalonil*	fungicide used in agriculture, horticulture and amenity turf	diffuse agricultural
copper	widespread occurrence in domestic and industrial applications	domestic sources (wastewater treatment works), industrial effluents, minewaters, sediments
diazinon*	organophosphate insecticide, with agricultural, horticultural and veterinary uses (sheep dip)	diffuse and point source agricultural
3,4-dichloroaniline	industrial intermediate	industrial effluents, wastewater treatment works
2,4-dichlorophenol	industrial intermediate	industrial effluents, wastewater treatment works
glyphosate*	herbicide, including aquatic weed control	diffuse, including amenity, industrial and agricultural uses

¹ These substances were set up as Specific Pollutants through Directions in England, Wales and Scotland and Regulation SR 2011 Number 10 in Northern Ireland.

manganese	industrial applications (e.g. metal alloys, pigments, electrical)	industrial effluents, minewaters, domestic sources (wastewater treatment works), sediments
methiocarb*	carbamate insecticide and molluscicide	diffuse agricultural
pendimethalin*	agricultural herbicide	diffuse agricultural
permethrin*	pyrethroid insecticide, including some household uses	diffuse agricultural and domestic sources
tetrachloroethane	industrial solvent and intermediate	industrial effluents, wastewater treatment works
toluene	industrial solvent and intermediate	industrial effluents, wastewater treatment works
triclosan	biocide (antibacterial); widely used in domestic products and personal care products	domestic sources (wastewater treatment works)
zinc	widespread occurrence in domestic and industrial applications	domestic sources (wastewater treatment works), industrial effluents, diffuse inputs (e.g. road runoff), minewaters, sediments
* A pesticide currently approved for use in the UK		

Other existing standards

A number of substances were previously identified in the UK under the Dangerous Substances Directive and standards set for them at national level. These are known as "List II" substances. Twelve of these were not included in the previous lists of Priority Substances identified at European level nor in the lists of Specific Pollutants recommended by UKTAG. The Dangerous Substances Directive will be repealed in 2013. The UKTAG has reviewed the risks posed by these List II substances [5]. The 12 substances are¹:

bentazone, biphenyl, 4-chloro-3-methylphenol, chloronitrotoluenes, 2-chlorophenol, dichlorvos, fenitrothion, malathion, 1,1,1-trichloroethane, 1,1,2-trichloroethane, triphenyltin, xylene

Nearly all of these are no longer used in the UK or have extensive controls on their marketing and use. None has been identified in significant concentrations by programmes of monitoring. Consequently, the UKTAG is not recommending these pollutants as Specific Pollutants. Existing measures and policies will deliver progressive reductions without further action at this time.

One of the substances, dichlorvos, has recently been suggested by the European Commission for identification as a Priority Substance; future controls for this substance may be put in place at the European level.

Standards previously established under the Dangerous Substances Directive can still be used as operational values for those situations where the substances occur.

¹ Substances no longer authorised for use were not included in the main review, but were considered in an annex [6]. These were azinphos-methyl, demeton, omethoate, triazophos, PCSDs, sulcofuron and flucofuron.

DERIVING THE STANDARDS FOR SPECIFIC POLLUTANTS

The method is based mainly on laboratory work on toxicity, supported by field data where available¹. The process is outlined below²:

Step 1: Identify what may be at risk. This covers, for example, aquatic animals and plants, sediment-dwelling organisms, or predators that feed on aquatic organisms.

Step 2: Collate information on the effects on aquatic biota³. Assess the quality of the data and decide which are critical. This work includes determining:

- the quality of the toxicity data – whether the observed effects are relevant and big enough to be of concern, and whether the studies that produced them are reliable;
- the particular chemical form of the substance that is toxic;
- whether naturally occurring concentrations are likely, and whether biota acclimatise to these.

Step 3: Use these data to derive Predicted No-Effects Concentrations (PNEC)⁴. This is done by extrapolating from a concentration that shows no effect on biota in laboratory experiments. This projection can be done in two ways:

1. Start from the most sensitive species

The process for the Water Framework Directive starts with the lowest credible toxic concentration for any of the biota tested. This concentration is tightened by a safety factor⁵ that lies between 10 and 1000. Low confidence in the set of data, for example because only a small range of species is covered, leads to the use of a high safety factor⁶.

2. Use mathematical models

Species Sensitivity Distribution Models describe the number of species likely to be affected by a particular concentration. Such models can be used for chemicals where data are plentiful. The model can improve confidence in the value chosen to derive the PNEC and so allow the safety factor to be reduced to between 1 and 5.

Laboratory data are also supplemented by field data where these are available, and these are used to inform the PNEC.

¹ For most substances, extensive sets of field data on chemistry and biology are not available.

² Annex B of the supporting report [2] sets out in more detail the process for developing standards.

³ The UKTAG uses the outputs of European risk assessments where these are available.

⁴ The PNEC is the concentration below which no harmful effects would be expected.

⁵ These factors, called “assessment factors”, are applied as specified in the EU guidance [5]. A smaller assessment factor might be justified, for example when the toxicity dataset on which the PNEC is based includes taxa that the UKTAG expects to be particularly sensitive to that substance.

⁶ A factor of 10 means that the standard will be one tenth of the value derived from the laboratory work.

Step 4: Set up a peer review of the PNECs to seek confirmation that they are valid scientifically, and that the data used to derive them are sound and complete. The PNECs that come through this process can then be recommended as the basis for new standards. Those that do not are the subject of proposals for further work.

Separate PNECs are derived for freshwaters and marine waters. These reflect differences in chemical behaviour in these media, and the different assemblages of organisms that might be exposed. Within these, two PNECs are often provided for each substance. The first leads to a short-term standard. The PNEC for this is usually based on data from studies of acute toxicity from experiments that last for hours or a few days. The standard aims to protect against brief periods of exposure.

The second PNEC leads to a long-term standard. This is derived from chronic toxicity tests, typically conducted over weeks, months or even years. The tests measure the effects on reproduction, growth and development; the PNEC is designed to protect against prolonged or continuous exposure.

Scientific peer review

A panel of independent scientists from the UK has advised on the adequacy of the data, the extent to which these data should influence the final PNEC, and how the UKTAG should interpret the data. The results have been discussed at several workshops attended by members of the UKTAG, contractors undertaking some of the scientific assessments, and peer reviewers.

Generally, the recommendations of the UKTAG represent the consensus of the reviewers. Any differences are discussed in the technical reports.

Step 5: The final step looks at the practicalities of implementing a standard.

Accepting a Predicted No-Effect Concentration as the basis for a standard

The UKTAG does not recommend a standard if the safety factor¹ is greater than 50 for freshwater, or 100 for salt water [2]. If for these reasons neither freshwater nor salt water standards can be recommended, the substance is not recommended for identification as a Specific Pollutant.

When data are sparse, a large safety factor is applied to allow for the uncertainty that results from this. However, a large safety factor can lead to standard that is too strict in terms of the cost and benefits of meeting the standard compared with the cost of getting better data. Failure of such a standard should trigger the generation of data to help reduce uncertainty and so lead to a smaller safety factor. The UKTAG will identify studies that could lead to smaller safety factors.

¹ Used in Step 3, above.

In a previous report [1], the UKTAG was unable to make recommendations for some substances and so commissioned new data on toxicity. Some of the recommendations in this report reflect these new data. Other data (for example, from field monitoring) have also increased confidence in some of the recommended standards.

Recommendations for a salt water standard are not made where the use of a substance is likely to result only in discharges to freshwater, and the impact disappears before rivers reach the sea. This is the case, for example, for many agricultural pesticides.

ZINC STANDARDS

Zinc is a naturally occurring substance and is ubiquitous in aquatic environments where it tends to occur at higher concentrations than most metals. Therefore to best assess compliance with the environmental quality standard (EQS) we need to take account of ambient background concentrations (ABCs); the EQS applies only to the additional contribution over and above the ambient background level (i.e. the value at which toxic effects occur, ignoring contributions from background concentrations).

Ambient background concentrations in freshwater

ABCs have been derived by assessing a dataset of around 150000 data points and using a low percentile¹ to ensure significant anthropogenic influences are excluded. Where there are sufficient data, ABCs have been defined for a catchment or group of catchments. Where there are insufficient data, data are subject to uncertainty because many measured concentrations are reported as ‘less than’ concentrations or where there are minimal differences between catchments, a default value based on pooled data is used. The ABCs are outlined in Table 2 and are used in conjunction with the freshwater EQS of 10.9 ug/l bioavailable zinc detailed in Table 3.16.

Table 2: Ambient Background Concentrations for dissolved zinc (to be used in conjunction with Table 3.16)	
Catchment/Group of catchments (1)	ABC (ug/l)
Freshwaters in England & Wales	
Tyne	4.8
Tees	4.1
Ouse, Humber	2.9

¹ Throughout, we have used the Kaplan-Meier method of interpolation because it is well-suited to estimating low %iles from censored datasets such as we have with much of the zinc monitoring data.

Nene	4.0
Great Ouse	3.1
River Stour	3.0
Blackwater/Chelmer	3.6
Lee	3.3
Thames	2.0
Test	2.0
Avon/Hants	3.1
Exe	1.4
Dart	1.7
Clywd/Conwy	2.0
Dee	2.9
Eden	1.2
Anglesey	3.0
Tamar	2.9
Fal	5.8
Camel	7.1
Tone/Parrett	3.3
Frome, Bristol Avon	2.3
Wye	2.0
Usk	2.2
Taff	2.8
Neath	2.8
Loughar	3.9
Tywi	2.0
Teifi	2.5
Rheidol/Ystwyth	4.1
Dovey	3.2
Glaslyn	2.6
All freshwaters in Scotland & NI	1.0
All other freshwaters not listed	1.4
(1) Freshwater ABCs in England and Wales are delineated by Hydrometric Area, details of which can be found on the CEH website .	

Ambient background concentrations in saltwater

Saltwater ABCs have been derived by assessing around 43000 samples and as with the freshwater method, a low percentile has been used to exclude significant anthropogenic influences. There are limited variations in ABCs around most of the UK coast, and hence a national ABC value of 1.1 ug/l dissolved zinc is recommended for all coastal and estuarine waters.

The saltwater EQS in the original consultation was 3.4 ug/l. Data provided by consultees allowed a review of this value, and as a result the EQS has been revised to 6.8 ug/l dissolved zinc. This should be used in conjunction with the ABC.

RECOMMENDATIONS

The UKTAG recommends new standards for 16 substances: benzyl butyl phthalate, carbendazim, chlorothalonil, copper, diazinon, 3,4-dichloroaniline, 2,4-dichlorophenol, glyphosate, manganese, methiocarb, pendimethalin, permethrin, tetrachloroethane (TCE), toluene, triclosan, zinc [2,6]¹.

Tables 3.1 to 3.16 set out the UKTAG's recommended standards for the new Specific Pollutants and the revisions to standards for existing Specific Pollutants. Unless specified otherwise, the standards apply to unfiltered samples².

The long-term EQS value for pendimethalin has been revised following the stakeholder review. The revised value is 0.3ug/l rather than 0.1ug/l. In addition the formula used to correct for DOC in the copper saltwater EQS has been modified following stakeholder review. These changes are included in the tables below.

Table 3.1: Recommended standards for benzyl butyl phthalate (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	7.5	20
	Short-term	95-percentile	51	100
Salt	Long-term	Mean	0.75	20
	Short-term	95-percentile	10	100

The recommended salt water standard is derived using a safety factor of 100. Where the standard is failed, it is recommended that supporting evidence of ecological damage should be obtained before committing to expensive action.

Table 3.2: Recommended standards for carbendazim (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.15	0.1
	Short-term	95-percentile	0.7	1.0

Table 3.3: Recommended standards for chlorothalonil (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.035	0.1
	Short-term	95-percentile	1.2	1.0

¹ The supporting report [2] sets out information for each proposed standard. The detailed documents are available via the UKTAG [6]. The standards apply to the water column as opposed, say, to sediments.

² This is in line with the approach adopted at EU level for setting standards for priority substances.

Table 3.4: Recommended standards for 3,4-dichloroaniline (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.2	–
	Short-term	95-percentile	5.4	–
Salt	Long-term	Annual mean	0.2	–
	Short-term	95-percentile	5.4	–

Table 3.5: Recommended standards for glyphosate (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	196	–
	Short-term	95-percentile	398	–
Salt	Long-term	Mean	196	–
	Short-term	95-percentile	398	–

Table 3.6: Recommended standards for manganese				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	123 µg/l bioavailable	30 µg/l dissolved

"Bioavailable" means the fraction of the dissolved concentration of manganese likely to result in toxic effects as determined in accordance with the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for manganese [7]

Table 3.7: Recommended standards for methiocarb (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.01	0.01
	Short-term	95-percentile	0.77	0.16

Table 3.8: Recommended standards for pendimethalin (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.3	1.5
	Short-term	95-percentile	0.58	6.0

Table 3.9: Recommended standards for tetrachloroethane (TCE) (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	140	–
	Short-term	95-percentile	1848	–

Table 3.10: Recommended standards for triclosan (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.1	–
	Short-term	95-percentile	0.28	–
Salt	Long-term	Mean	0.1	–
	Short-term	95-percentile	0.28	–

Table 3.11: Recommended standards for copper				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	1µg/l bioavailable	1–28 µg/l dissolved
Salt	Long-term	Mean	3.76 µg/l dissolved, where DOC ≤ 1 mg/l	5 µg/l dissolved
			$3.76 + (2.677 \times ((\text{DOC}/2) - 0.5))$ µg/l dissolved, where DOC > 1 mg/l	

"Bioavailable" means the fraction of the dissolved concentration of copper likely to result in toxic effects as determined using the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for copper [8].

"DOC" means the annual mean concentration of dissolved organic carbon in mg/l.

The recommended salt water standard applies to the fraction of a water sample that passes through a 0.45-µm filter or that is obtained by any equivalent pre-treatment.

The existing freshwater standard depends on the hardness of the water.

Table 3.12: Recommended standards for diazinon (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Salt	Short-term	95-percentile	0.26	0.1

No changes are proposed to the UKTAG's existing recommendations on freshwater standards for diazinon or to its recommended long-term salt water standard.

Table 3.13: Recommended standards for 2,4-dichlorophenol (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	4.2	20
	Short-term	95-percentile	140	–
Salt	Long-term	Mean	0.42	20
	Short-term	95-percentile	6	–

Table 3.14: Recommended standards for permethrin (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	0.001	-

	Short-term	95-percentile	0.01	0.01
Salt	Long-term	Mean	0.0002	-
	Short-term	95-percentile	0.001	0.01

Table 3.15: Recommended standards for toluene (µg/l)				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	74	50
Salt	Long-term	Mean	74	40

No changes are proposed to the UKTAG's existing recommendations on short-term standards for toluene in freshwaters and salt waters

Table 3.16: Recommended standards for zinc				
Water	Exposure	Annual statistic	New standard	Existing standard
Fresh	Long-term	Mean	10.9 bioavailable plus Ambient Background Concentration (ug/l) dissolved	8-125 ug/l (total)
Salt	Long-term	Mean	6.8 dissolved plus Ambient Background Concentration (ug/l)	40 ug/l (dissolved)

"Bioavailable" means the fraction of the dissolved concentration likely to result in toxic effects as determined using the Metal Bioavailability Assessment Tool (also referred to as a PNEC Estimator) for zinc [8].

Ambient Background Concentration (ABC) is an estimate of background levels of zinc based on a low percentile of monitoring data. ABCs for freshwaters are given in Table 2. For saltwater, an ABC of 1.1 ug/l is recommended.

The existing freshwater standard depends on the hardness of the water.

The standards are defined as summary statistics so that they can be used correctly in classification, and in a transparent manner to calculate the action needed for compliance. For a long-term PNEC, the standard is an annual mean.

For most substances, the annual mean is well correlated with the probability that higher and lower concentrations occur within a year. Also, for many types of risk, measures taken to comply with an annual mean act in parallel on the risks associated with the full spread of concentrations that make up the annual mean.

Given a particular level of monitoring at a site, the annual mean is estimated more precisely than, say, the annual 95-percentile or a maximum. This means that the use of the annual mean, where appropriate, helps detect with confidence, smaller degrees of failure.

For a short-term standard, the PNEC is usually presented as a “Maximum Allowable Concentration (MAC)”. If the MAC is used as an absolute “maximum”, serious and arbitrary errors will result. These lead to a biased classification of water bodies, and wrong decisions on action to secure compliance. Any recommended short-term standard is therefore defined by the UKTAG as an annual 95-percentile¹.

Experience has shown that most decisions to protect water quality can be based successfully on samples collected 12 times per year. This means that we accept the risk of exceeding the MAC and not knowing (because we don’t sample all the time). A sampling rate of 12–20 samples per year is the mathematical equivalent of assuming that the MAC is an annual 90 or 95-percentile.

For standards set as the annual mean or an annual percentile, there is full scope to calculate correctly the extent and costs of actions needed to secure compliance. For example, the improvements to discharges can be calculated to ensure the standard is met in the receiving water. This is not possible with a standard that is expressed as an absolute limit.

Where short-term standards are not recommended, the associated risk has been considered to be managed through the achievement of the long-term standards. The protection provided to meet the long-term standard is usually more stringent than the protection needed to meet the standards based on short-term toxicity.

Where the stringency embodied in the short-term standard is only slightly less than that in the long-term standard, compliance with the long-term standard may not give enough protection. For such substances, it may be necessary to use a short-term standard to protect more specifically against high concentrations that may occur in a year. Such circumstances also arise for substances whose concentrations are trivial most of the year, but high on rare occasions².

Generally, any protection that achieves an annual mean or an annual 95-percentile must be backed up with measures to control the risks from accidents and dramatic events. For some chemicals and their mode of use, the annual mean and annual 95-percentile may need to be augmented more prominently by extra measures to control the risks from accidents or illegal use.

¹Unless a case is made for a seasonal mean or a different percentile.

² For example, in the case of a pesticide that is only used at a particular time of the year.

For substances such as pesticides, it may be useful to do additional monitoring during parts of the year when applications are most likely to occur. In such instances, it is important to avoid bias when determining compliance with a standard that is expressed as an annual mean or an annual percentile. For example, if we normally take 12 samples per year, but include an additional ten samples in a given month, all the data from that month would be used to provide an estimate of the monthly mean. This, in turn, would be used to calculate that month's contribution to the annual mean¹.

Use of standards for taking action

The UKTAG recommends that there should be at least 95% confidence that the standard is failed² before serious and expensive action to improve a site is sought.

For determining the compliance with the annual percentile, one method is to use a look-up table. Table 4 gives the number of failed samples required to give 95% confidence that a 95-percentile is failed³. Other methods, for example, assessing compliance with an annual mean, are based on an assumption of the statistical distribution of the spread of values of concentration. These approaches follow the International Standard ISO 5667-20 [12].

Table 4: Look-up table for 95% confidence of failing a 95-percentile standard	
Number of samples	Required number of exceeding samples
4–7	>1
8–16	>2
17–28	>3
29–40	>4
41–53	>5
54–67	>6

Within a regime like Table 4, it remains important to note cases where a single sample result exceeds the concentration expressed as the annual 95-percentile short-term standard. This should be followed up as an indication of potential risk.

¹ Albeit with improved precision for the value for that month and in the estimate of the annual mean.

² Shortfalls in confidence can be made good by extra monitoring of compliance, or by seeking corroboration from other types of extra information.

³ As used for 95% confidence of failure of 95-percentile standards under the Urban Waste Water Treatment Directive. Tables for other percentiles and other degrees of percentage confidence can easily be constructed.

Use of standards for classification

The annual mean long-term standard is usually the most appropriate and critical for classification. The UKTAG recommends that the annual 95-percentile standards are also used, within rules like those discussed above with Table 4.

THE IMPLICATIONS OF THE RECOMMENDED STANDARDS FOR SURFACE WATERS

This section describes the likely implications of the standards in terms of compliance. Assessments have been made separately for each part of the UK and have relied mainly on existing monitoring data.

Much of current monitoring has been targeted at sites that are at risk on the basis of experience, or of knowledge of activities in the catchment.

Results¹ are given for face-value² estimates of failure and for failures recorded with high statistical confidence³. A good estimate of the proportion of failures at face value would be relevant to the development of national measures to improve compliance such as controls on the use of the chemical or land. Those with high statistical confidence imply high priority for local action.

For some substances there are few or no monitoring data available because the substances are not covered under existing legislation (and there is no requirement for monitoring) and because the substance has not previously been considered a threat to water quality.

These substances include the herbicide, glyphosate. This is sometimes used in the water environment to control aquatic plants. To do this, it has to be discharged in concentrations that are toxic to the target plants. This means there is a risk of exceedences of the type recorded under Table 4 for the recommended short-term standard. The target plants are often invasive species and their control can protect or improve the ecological quality of the water environment. Glyphosate is expected to break down quickly and so pose little risk to the wider aquatic ecosystem. Such occasional and short duration events would not be expected to affect decisions on classification.

Similarly the use of the recommended standards assumes ongoing application of the current controls and regimes that provide extra protection, where needed, against the risk of extreme events, accidents, and the illegal actions that could lead to incidents of pollution.

¹ Using programmes of monitoring set up to meet the requirements of national or European laws.

² Face value gives at least at 50 per cent confidence of failure. Or, in stating compliance, at least 50% confidence of compliance. The estimates ignore statistical errors in monitoring data.

³ 95–100% confident

Intermittent discharges of Specific Pollutants could result in concentrations in the environment that cause harm. Such concentrations may not be detected by the type of routine monitoring used to assess compliance with mean and 95 percentile standards in the receiving water, especially where compliance with the percentile standard is based on counting failed samples and using the 'look up table' reproduced in Table 4. In such a case, a water could be deemed compliant with the percentile even if one or two elevated (harmful) concentrations are picked up by monitoring. As noted above, the agencies would follow up such events.

Where such risks exist in known discharges, the UKTAG recommends that they are managed by the controls set in permits, perhaps designing the operation of the discharge to meet a 99 percentile standard in the receiving water as described in Chapter 7, or more extreme percentiles, and setting absolute limits on discharge quality. Where an intermittent discharge is expected to be frequent enough for the planned monitoring strategy to pick up occasional harmful concentrations, UKTAG also recommends using the parametric methods described in the relevant ISO Standard [12] to assess compliance with the percentile standards for waters.

Implications for England

Table 5 gives estimates¹ of the numbers of monitored sites in England that would not meet the new long-term standards.

Table 5: Specific Pollutants – implications for England			
Substance	Freshwater sites 'not good'		Number of sites assessed
	Face value	At 95% confidence	
Carbendazim	0	0	6
Chlorothalonil	0	0	6
3,4-Dichloroaniline	0	0	8
2,4-Dichlorophenol	0	0	45
Glyphosate	0	0	15
Methiocarb	0	0	1
Pendimethalin	0	0	6
Triclosan	0	0	4
Substance	Salt water sites 'not good'		Number of sites assessed
	Face value	At 95% confidence	
Copper (dissolved)(1)	37 (12%)	17 (5%)	311
2,4-Dichlorophenol	0	0	24
Glyphosate	0	0	3
Zinc (dissolved) (2)	45 (15.7%)	No data	286

¹ Based on sites with sufficient samples assessed using analytical methods that are sufficiently sensitive.

- (1) The saltwater standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high.
- (2) Allowing for a default background of 1.1 ug/l dissolved zinc.

The implications for copper, manganese and zinc in the freshwater environment have been reviewed by taking account of the bioavailability at sites for which matched data¹ are available [2]. The results are in Table 6.

Table 6: Implications for England when applying bioavailable metal standards			
Substance	Freshwater sites 'not good' (face-value assessment)		Number of sites assessed
	Based on compliance with the existing standard	Based on compliance with the recommended bioavailable standard	
Copper	85 (12%)	35 (5%)	698
Manganese (1)	No data	2 (1%)	156
Zinc (2)	22 (7.5%)	23 (7.8%)	293

(1) As no established existing standards are available for manganese, compliance has not been assessed.

(2) Indicative only: the existing EQS is expressed as total zinc but dissolved concentrations were used for this illustration. The values may therefore underestimate the levels of failure using the existing standard. The data for the recommended standard makes allowance for ambient background concentration.

Data for metals are more readily available than for other substances. In addition, there are over 3000 sites that have data on dissolved copper, but the assessment in Table 6 has been limited to those sites that have the data required to assess the bioavailability of the metal.

It is expected that number of failures of copper will fall as a result of introducing the approach based on bioavailability. However, there may be situations where sites may fail which currently comply, for example, in south-east England. This is because the approach takes account of a wider range of physico-chemical parameters¹.

For salt waters, there is likely to be an increase in the sites assessed as “not good” by the recommended standards for copper. With the current standards, only 0.6% of those monitored for copper fail at 95% confidence. The compliance indicated in Table 5 however may increase when corrections for dissolved organic carbon are made for copper.

The compliance for 2,4-dichlorophenol does not look set to change. All sites comply.

Data from monitoring are sparse for most of the substances listed in Table 5. Additional data are available in some cases. Scans² of surface and groundwaters from England and Wales indicate widespread occurrence of triclosan, but only occasional occurrences of 3,4-dichloroaniline, pendimethalin, benzyl butyl phthalate, chlorothalonil and tetrachloroethane.

¹Data on the metal concentration, pH, the dissolved organic carbon concentration and the calcium concentration.

² By GC-MS ... Gas Chromatography–Mass Spectrometry

These data cannot be used to assess compliance because of their semi-quantitative nature and the limited number of results. However, modelling based on measured levels of triclosan in sewage effluent suggest risk of failure in waterbodies and additional monitoring has been commissioned. As of January 2013, four out of forty sites had reported concentrations marginally above the triclosan EQS, based on one or two samples in preliminary monitoring results. For the other substances noted above the limited results for tetrachloroethane, chlorothalonil and 3,4-dichloroaniline indicate compliance with the recommended standards. For benzyl butyl phthalate and pendimethalin, although occasional results exceed the sort of concentrations recommended as standards, the data do not give a reliable reflection of what this means in terms of compliance.

Implications for Northern Ireland

The following indicates the implications of the recommended standards based on limited available surveillance data. No data are available for chlorothalonil, 3,4-dichloroaniline, manganese, methiocarb, pendimethalin, permethrin.

- Benzyl butyl phthalate: a limited amount of data is available covering seven months in 2009. There were four positive detections of benzyl butyl phthalate.
- Carbendazim: Data for 2008–2009 are available for 44 sites, although not covering 12 months at most sites. There were three positive detections of carbendazim.
- 2,4-Dichlorophenol: data for 2008–2009 are available for 20 sites for 12 months. There were four positive detections of 2,4-dichlorophenol.
- Glyphosate: Data for 2008–2009 for 28 sites produced 85 positive detections.
- Tetrachloroethane: data for 2007–2008 are available for 70 sites with less than 12 samples per site. There were no positive detections.
- Triclosan: There were 45 positive detections at 14 of 16 monitored sites for 2008–2009.

There were no face-value failures of the recommended freshwater standards for the above substances, although data were limited in some cases.

There is a large amount of monthly and quarterly data on dissolved copper data. These indicate where the recommended freshwater standard is exceeded, but this assumes the dissolved concentrations are completely bioavailable. An assessment taking account of bioavailability is not possible at this time.

Implications for Scotland

Table 7 gives an estimate¹ of the number of monitored sites that might not meet the new long-term standards.

¹ Sites with sufficient samples and analytical methods that are sufficiently sensitive.

Table 7: Specific Pollutants – implications for Scotland			
Substance	Freshwater sites 'not good'		Number of sites assessed
	Face value	95% confidence	
Benzyl butyl phthalate	0	0	58
Chlorothalonil	0	0	8
2,4-Dichlorophenol	0	0	20
Pendimethalin	0	0	8
Permethrin	1	0	21
Substance	Saltwater sites 'not good'		Number of sites assessed
	Face value	95% confidence	
Benzyl butyl phthalate	0	0	1
Copper (dissolved) (1)	3 (2%)	0	151
Permethrin	0	0	8
Zinc (2)	0	0	59
<p>(1) The saltwater standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high.</p> <p>(2) The revised EQS is expressed as dissolved zinc but total concentrations were included for this illustration. Two sites had insufficient data to apply the recommended standard. It is possible that there are breaches in one or both of these sites. The data make allowance for a default background of 1.1 ug/l dissolved zinc.</p>			

The implications for copper, manganese and zinc in the freshwater environment have been reviewed by taking account of bioavailability at sites for which matched data are available [2]. The results are in Table 8.

Table 8: Implications for Scotland when applying bioavailable metal standards			
Substance	Freshwater sites 'not good'(face-value assessment)		Number of sites assessed
	Based on compliance with the existing standard	Based on compliance with the recommended bioavailable standard	
Copper	2 (1.8%)	0	113
Manganese (1)	No data	1 (1.3%)	78
Zinc (2)	3 (2.6%)	0	140
<p>(1) As no established existing standards are available for manganese, compliance here has not been assessed.</p> <p>(2) Indicative only: the existing EQS is expressed as total zinc but dissolved concentrations were used for this illustration. The values may therefore underestimate the levels of failure using the existing standard. The data for the recommended standard make allowance for ambient background concentration.</p>			

Monitoring data are sparse for some of the substances in Table 7 mainly because there has been no requirement for monitoring in the past or because there are only a few localised pressures. The implications are:

- Benzyl butyl phthalate: the monitoring covers major rivers across Scotland. There are no known sources of the chemical and the results from monitoring are thought to provide a reasonable estimate of the overall position across Scotland. The data indicate no failures of the recommended standard.
- 2,4-dichlorophenol: monitoring is targeted at the major urban rivers. Again there are no known sources and the results should provide a good estimate of compliance throughout Scotland. There are no failures of the recommended standard.
- Chlorothalonil, pendimethalin and methiocarb: monitoring for certain pesticides has been started recently in a limited number of agricultural catchments that have been identified as potentially at risk from pesticides. The data so far indicate no failures of the recommended standards.
- The monitoring for carbendazim, permethrin, tetrachloroethane and toluene is limited and directed at point sources. Environmental monitoring is no longer done for some of the substances because the small numbers of sources are well controlled.
- 3,4-dichloroaniline, glyphosate: no monitoring is currently undertaken for these.
- Triclosan: although there are no environmental monitoring data for triclosan, an assessment of data from a small number of sites for waste water treatment was used to predict concentrations in the receiving waters. The results mirror similar work in England and Wales. The substance is widely present, but the levels are not expected to lead to widespread failures of the standard.

Data for metals are more readily available across Scotland. The data are augmented by a large number of sites that assess the impact of pressures such as mining.

Concentrations of dissolved metal tend to be measured only where the total concentrations indicate potential concern over compliance. The number of sites assessed is limited to those that have supporting data on the parameters used to estimate the bioavailable concentrations.

The implications for Scotland indicate a reduction in the small number of failures in freshwaters for those metals with recommended bioavailable standards.

Implications for Wales

Table 9 gives an estimate¹ of the number of monitored sites in Wales that might not meet the new long-term standards. The implications for copper and manganese in freshwaters have been reviewed by taking account of bioavailability at sites for which matched data are available [2]. The results are in Table 10.

Table 9: Specific Pollutants – implications for Wales			
Substance	Freshwater sites 'not good'		Number of sites assessed
	Face value	95% confidence	
Carbendazim	0	0	2
2,4-Dichlorophenol	0	0	3
Glyphosate	0	0	3
Methiocarb	0	0	1
Substance	Salt water sites 'not good'		Number of sites assessed
	Face value	95% confidence	
Copper (dissolved)(1)	0	0	51
Zinc (dissolved) (2)	3 (5.3%)	No data	56

(1) The salt water standard for copper includes a correction for dissolved organic carbon (DOC). The compliance assessment has not been able to take account of this because of limited data for DOC. The reported number of failed sites may be too high.

(2) Allowing for default background concentration of 1.1 ug/l dissolved zinc.

Table 10: Implications for Wales when applying bioavailable metal standards			
Substance	Freshwater sites 'not good' (face-value assessment)		Number of sites assessed
	Based on compliance with the existing standard	Based on compliance with the recommended bioavailable standard	
Copper	85 (35%)	2 (1%)	243
Manganese (1)	No data	3 (6%)	51
Zinc (2)	36 (41%)	36 (41%)	88

(1) As no established standards are available for manganese, compliance here has not been assessed.

(2) Indicative only: the existing EQS is expressed as total zinc but dissolved concentrations were used for this illustration. The values may therefore underestimate the levels of failure using the existing standard. The data for the recommended standard make allowance for ambient background concentration.

¹Based on sites that have sufficient samples, and analytical methods that are sufficiently sensitive.

Monitoring data are sparse for most of the substances listed in Table 9. As noted above for England and Wales (in the section on England), scans indicate widespread occurrence of triclosan, and only occasional occurrences of 3,4-dichloroaniline, pendimethalin, benzyl butyl phthalate, chlorothalonil and tetrachloroethane.

There are over 850 sites with data on dissolved copper, but the assessment in Table 10 is limited to those that have the matched data required to assess bioavailability.

With the current standards, all sites assessed for copper comply.

THE RESPONSE TO FAILURE OF THE RECOMMENDED STANDARDS

The first response is to assess whether we are sufficiently confident that the standard is truly breached, taking account uncertainties in monitoring and modelling. The second is to work out what is causing the breach. The third step is to decide what can be done to improve the quality of the water.

Issues arising from reporting compliance

The Water Framework Directive provides for a “risk-based” approach to monitoring. Some locations are judged not to be at risk because of the absence of significant discharges; the results of past monitoring; a lack of evidence of impacts; or the results of mathematical models that predict the exposure to chemicals from various sources. These sites do not need the type of chemical monitoring required for the routine assessment of compliance with standards¹. In effect the standard is assumed to be met.

For sites at risk, the assessment of compliance uses data from monitoring. In some cases it might involve calculations using models. The data or models will always be associated with errors and uncertainty. Such errors must be quantified. The resulting uncertainty is used to calculate the confidence that a standard has been met or failed (as, for example, reported in Tables 5, 7 and 9).

The Water Framework Directive expects us to know and report these levels of confidence. As noted above, when deciding what action to take, the environment agencies look at the confidence that the standard has been failed. If there is at least 95% confidence, the agencies seek remedial action. If confidence is lower than this, the agencies seek to do more monitoring and so check if the failure is confirmed with sufficient confidence for remedial action².

¹ UKTAG Guidance on monitoring groundwater and transitional and coastal waters. www.wfduk.org/reference/assessing-status-water-environment.

² This caution applies to expensive or controversial action. Any agreed and available low-cost measures would always be applied, even at sites where confidence of failure was low.

In all this, national actions like controls on chemicals or on the use of land may be easier to justify with high confidence because of the effect of pooling hundreds of monitored sites in assessing, say, the percentage of failed sites. This irons out the uncertainties associated with single sites.

The UKTAG recommends that, in general, action to achieve compliance for Specific Pollutants does not require additional and local ecological corroboration of damage. This stance is based on the nature of the substances and risks, and the process by which the standards are set.

The response to failure

There are two ways in which compliance is used to take decisions. First, the result at a particular location is used to design action for that location, such as reviewing the permit for a discharge of the substance. Second, summaries of compliance with a standard across a region or country may lead to measures, such as recommending national restrictions on the use of a chemical. Sites at risk may benefit from both types of action.

Where a standard is failed, the agencies seek to determine the cause in a systematic way. Where this reveals a problem with, for example, a single discharge, the agencies seek to tighten permit conditions subject to the Directive's considerations of cost effectiveness and disproportionate cost. Where there are several discharges, the most cost-effective approach is sought.

Where there is a mix of point sources, diffuse sources and unknown sources, further steps are taken to apportion the causes of the failure. This may involve monitoring and modelling, a consideration of cost-effectiveness and proportionate cost, and looking at the technical feasibility of securing compliance.

The environment agencies will also continue to seek to influence developments and growth in a way that manages the risks of deterioration and ensures that sustainable uses of the environment can continue and develop. They will assess the effectiveness of their efforts through compliance with the standards, and by calculating the changes in annual means and annual 95-percentiles.

The environment agencies may use biological data to inform their advice and decisions. For example, certain pesticides can give rise to particular changes in biological diversity. If such changes are confirmed, the agencies have a good idea on which substances are responsible.

National reporting

The rules for the Water Framework Directive state that a water body cannot be in good status if a standard for a Specific Pollutant is failed. Where such failures are at “face-value”, there is a risk (up to 50 per cent) that the failure is not true, but reflects uncertainties in monitoring. There is a similar risk that failed sites are wrongly reported to have passed. Nonetheless, for a single substance and standard, the proportions of failed waters can lead to a precise measure of the national position in terms of “percentage of failed sites”¹.

Where good status is declared as an integrated result across lots of standards (under the Directive’s “one-out all-out” rule), the estimate of the national proportion of failed sites is heavily biased in a pessimistic direction. This bias rises with increase in the number of standards. This fact must be taken into account in the framing of national targets, and in assessing whether such targets are met. For Specific Pollutants, this is best done through separate targets for each substance². Statements such as “40 per cent of waters fail for Specific Pollutants” should be avoided.

¹ Assuming the monitoring is not targeted at failed sites.

² Though it is also possible to remove the bias by statistical techniques.

CHAPTER 3: GROUNDWATER

The chapter describes the results of the UKTAG's review of its recommendations on classifying the status of bodies of groundwater [1] and on protecting groundwater from pollution [2]. The review produced recommendations on:

- threshold values for nitrate in groundwater for use in assessing threats to wetlands that depend on groundwater;
- revised threshold values for nitrate in groundwater for use in assessing risks to current and planned abstractions of water for human consumption;
- revised threshold values for nitrate, and revised generic methods, for use in assessing the risk of significant impairment of the ability of groundwater to support potential human uses;
- a revised method for deriving threshold values for groundwater for use in assessing risks to surface waters affected by groundwater;
- standards for assessing compliance with the objective to prevent or limit the inputs of pollutants into groundwater.

A breach of a threshold value indicates a risk to the chemical status of a body of groundwater and leads to further investigation aimed at confirming whether or not significant adverse impacts are present. These investigations typically involve consideration of other monitoring and the results of mathematical modelling.

The work that underpins this chapter has been subject to peer review¹. The reviewers agreed that, to the best of their knowledge, the guidance and the consultation documents:

- incorporate the best of the current state of scientific knowledge in terms of management and understanding of the relationships between groundwater, surface water and wetlands for the hydrogeological systems encountered across the UK;
- represent a sound basis for determining the chemical status of groundwater bodies and are an improvement on the methods used for the first cycle of river basin plans;
- recommend an approach to the prevent or limit objective that is transparent and consistent with the objectives of preventing or limiting the entry of hazardous and non-hazardous pollutants to groundwater.

The UKTAG also commissioned two experts² to review the technical report [3] that led to the recommendations on threshold values for nitrate in groundwater for use in assessing threats to wetlands. Both supported the method and techniques used to develop the recommended values.

¹Carried out by Rob Sage (Veolia Water) and John Chilton (International Association of Hydrogeologists).

²Professor A J Davy from University of East Anglia and Professor M Acreman from the Centre for Ecology and Hydrology.

NITRATE THRESHOLD VALUES FOR ASSESSING RISKS TO WETLANDS

The following recommendations apply with respect to “groundwater dependent terrestrial ecosystems” – wetlands that depend directly on groundwater. The ecological quality of these wetlands can be significantly affected by changes to the volume and quality of inflows from groundwater.

One of the criteria for the classification of a groundwater body as good or poor is whether pressures on the groundwater, such as pollution, are causing significant damage to a wetland. Each Member State is required to establish threshold values for use in assessing threats to wetlands.

Previously, the UKTAG was unable to make recommendations on suitable threshold values for this purpose because of insufficient data and an inadequate scientific understanding. To remedy this, the UKTAG’s member agencies have collected and assessed data from a wide range of wetlands. This involved looking at the condition of wetlands and the concentration of nitrate and phosphate in groundwater. The recommendations in this section are based on this work and on information from the scientific literature [3].

The UKTAG found no clear link between the concentration of phosphate in groundwater and the condition of wetlands. Consequently, it is unable recommend threshold values for phosphate at this time.

For nitrate, the UKTAG found that the relationship between nitrate concentration and the condition of the wetland varies between wetland type, and in some cases, with altitude (which acts as a proxy for the intensity of land-use). The recommended thresholds for nitrate are set out in Table 11.

Table 11: Threshold values for nitrate in groundwater			
	Annual mean nitrate concentration (mg/l NO ₃)		
Wetland type [3]	Altitude Above Ordnance Datum		
	up to 175 metres	more than 175 metres	any
Quaking bog	18	4	
Wet dune			13
Fen (mesotrophic) and Fen Meadow	22	9	
Fen (oligotrophic and wetlands at tufa forming springs)	20	4	
Wet grassland	26	9	
Wet heath	13	9	
Peatbog and woodland on peatbog			9

Wetland directly irrigated by spring or seepage			9
Swamp (mesotrophic) and reedbed			22
Swamp (oligotrophic)			18
Wet woodland	22	9	

Use of the threshold values in status classification

The UKTAG recommends that further investigation is triggered to determine whether or not a body of groundwater body should be classed as poor rather than good status when all the following conditions apply:

- (a) a wetland identified as directly dependent on groundwater is significantly damaged;
- (b) the characteristics of the damage are such that there is reason to believe at least a significant contributory cause may be nitrate reaching the wetland via groundwater;
- (c) the threshold value applicable to the wetland type is breached.

In practice, it is expected that the data with which to assess whether the threshold value is breached will be collected and evaluated only where conditions (a) and (b) above apply. The assessment of whether the threshold value is breached should be based on an analysis of monitoring data expected to be representative of the quality of the groundwater on which the wetland depends or, where such data are unavailable, modelled estimates of the quality of that groundwater.

The UKTAG recommends that the further investigations are site-specific and seek to establish the degree of the ecological damage and the flow and chemical pathways from the groundwater to the wetland. The work may require an ecological assessment of the wetland and a more detailed hydrogeological investigation. The level of investigation will depend on the existing ecological data and on the confidence that the available monitoring data for the groundwater are representative of the groundwater on which the wetland depends.

If the investigation confirms that the damage to a wetland is significant and that it is being caused by inputs of nitrate from the groundwater, the groundwater body should be classed as poor status. Otherwise, it should be classed as good status with respect to the effect of its nitrate content on wetlands.

The Directive requires that the confidence of classification is specified. The UKTAG recommends that high confidence of class is assigned if:

- for poor status, sufficient hydrogeological and ecological monitoring data are available to: (i) confirm that the wetland is significantly damaged; and (ii) validate a suitable conceptual model showing how nitrate in the groundwater is contributing significantly to that damage;
- for good status, (i) no groundwater dependent wetlands are identified as significantly damaged; (ii) one or more wetlands is identified as significantly damaged but no relevant threshold value is breached; or (iii) further investigation has concluded that, based on the

clear the weight of the evidence, the damage to the wetlands is not significant or that nitrate from groundwater is not making a significant contribution to the damage.

In other cases, the classification decision should be assigned low confidence.

Implications of the recommendations

There may be many places over a body of groundwater at which the groundwater is sufficiently close to the surface of the land to create wet ground. However, for damage to a wetland to be “significant”, the wetland has to be of economic, environmental or social importance [4]. All the wetlands identified in the first cycle of river basin management planning are sites designated for their international or national importance to nature conservation (that is, Natura 2000 sites designated under the Habitats Directive, and Sites of Special Scientific Interest). The threshold values will help target action needed to achieve the objectives for these sites.

Important wetlands are typically found in upland areas and in parts of the lowlands that have not been drained for land uses, such as agriculture. Many wetland areas that once existed in lowland agricultural areas were drained to allow the land to be converted into productive farmland.

The nitrate threshold value is not expected to be being breached at many important wetland sites. If we were to re-run the 2009 classification using the new thresholds, we would expect that 5% of the groundwater bodies in England, 1% in Wales and less than 1% in Scotland would progress to the stage of further investigations.

This reflects the location of wetland sites in relation to intensive land uses. The groundwater on which a wetland depends is typically confined to the area close to the wetland. Relatively high concentrations of nitrate can occur across a large part of a body of groundwater without posing a risk to a wetland.

The identification of wetlands that depend on groundwater is part of the process of river basin management. This process requires that the characteristics of, and risks to, each body of groundwater, are assessed; and that an inventory of wetlands is established for all bodies of groundwater identified as being at risk. The assessments and the inventory are reviewed and updated every 6 years.

For the purposes of developing the threshold values, the UKTAG evaluated 180 wetland sites. In Scotland, impacts related to groundwater nitrate concentrations were suspected at around 20% of 50 sites evaluated. However, these impacts were not considered to constitute significant damage.

In England and Wales, around 25% of the 93 wetland sites that were used in the evaluation were in unfavourable condition and exceeded the relevant nitrate threshold value. These represent around 5% of the groundwater bodies in England and Wales. Several further investigations are under way to examine the relationship between nitrate pressure and wetland damage.

Where a wetland is found to be significantly damaged, action to reduce groundwater nitrate concentration is only required where it would not be disproportionately expensive. The action might typically consist of adopting best practices, including those designed to reduce losses of nutrients from farmland. The threshold values help in determining the magnitude of the reduction in concentration needed to improve the condition of the wetland. Where action is necessary, it can be designed to target the specific sources of pollution of the groundwater on which the wetland depends. A breach of the threshold value has no relevance to decisions on the designation of Nitrate Vulnerable Zones under the Nitrate Directive.

The threshold values are expected to play an important role in protecting wetlands from damage. The threshold values are recommended for use in assessing the risk posed by proposed developments, or upward trends in nitrate concentrations, near to wetlands, likely to increase nitrate concentrations in the groundwater on which the wetlands depend. These assessments provide information on the risk of deterioration [8] to help inform decisions on the acceptability of developments and the steps needed to safeguard the wetlands.

THRESHOLD VALUES FOR ASSESSING RISKS TO USES OF GROUNDWATER

The UKTAG's previous recommendations included threshold values for assessing risks to:

- current and planned abstractions of groundwater for human consumption;
- significant impairment of the ability of groundwater to support potential human uses.

These two risks are assessed by applying the same threshold value in two different ways. The threshold value for the second purpose is designed to help assess the risk to groundwater as a potential resource for human consumption. This is the principal human use of groundwater. Protecting the potential for this use will also help protect groundwater for other human uses.

The existing threshold values were derived separately by each of the UK environment agencies following UKTAG guidance [5]. This recommended that the threshold values be derived as an annual mean that is statistically equivalent to the maximum concentration of nitrate allowed in drinking water¹ (the statistically-based option). The guidance also provided that agencies could instead set the annual mean at 75% of the maximum concentration allowed in drinking water. Differences in the threshold value between the different parts of the UK arose because of differences in the data on groundwater nitrate concentrations available to each environment agency.

¹Council Directive 98/83/EC on the quality of water intended for human consumption.

The UKTAG has reviewed the statistically-based option for setting threshold values. As part of this review, it compared monitoring results from different types of aquifers rather than from different countries. The results showed no significant difference between the types of aquifer. The overall value for nitrate was close to the value produced by using the option of setting the annual mean at 75% of the maximum concentration allowed in drinking water standard. The UKTAG recommends that all threshold values for assessing risks to the quality of water being abstracted for human consumption and for assessing the risk of significant impairment of the ability of the groundwater to support potential human uses should be set using this latter option rather than the previously recommended statistically-based option.

The changes to the numeric values for the thresholds values for nitrate described in Table 12 below follow from this recommendation:

Table 12: Recommended threshold values for nitrate in groundwater		
Risk indicated by failure of the threshold in groundwater	Existing threshold	Recommended revision
	Annual mean concentration of nitrate (mg/l)	
Risk to the quality abstracted for human consumption, or intended to be abstracted. Risk of significant impairment of the ability of groundwater to support human uses	31 (Scotland) 42 (England & Wales) 37.5 (Northern Ireland)	37.5

Application to groundwater being abstracted for human consumption

Virtually all bodies of groundwater in the UK have been identified as drinking water protected areas because they are used to provide water for human consumption. The key objective for these areas is to prevent deterioration in the quality of groundwater so as not to compromise an abstraction for human consumption. Classification of the status of a body of groundwater as good requires that this objective is being achieved.

UKTAG's previous recommendations [1] apply to the revised threshold values for assessing risks to water abstracted for human consumption. These are that, where a relevant threshold value is breached, further investigation is triggered to determine whether or not a body of groundwater body should be classed as at poor status rather than good status. Monitoring results for sites representative of the quality of groundwater being abstracted or planned to be abstracted for human uses should be used to determine whether or not the threshold value is breached.

Implications

The number of groundwater bodies classed as at poor status across the UK because a drinking water protected area objective has been compromised is not expected to change. This is because achievement of the objective for these areas depends on whether or not deterioration in the quality of groundwater has compromised a drinking water abstraction. The threshold value is designed to help identify potential risks and target investigations. However, compliance with the threshold is not a consideration in determining whether the protected area objective is met and hence whether the water body can be classed as good status.

In Scotland there may be a reduction in the number of abstractions in relation to which a further investigation is triggered on the basis of a breach of the threshold value. In England and Wales there may be an increase. However, the implications are expected to be minimal. Investigations are also driven by other indications of deterioration in water quality, such as trends detected by providers of public water supplies.

Application to assess impacts on the groundwater resource

Spatially extensive pollution of groundwater can both compromise existing uses of groundwater and impair the ability of groundwater to support abstractions for human consumption and other uses in the future. Classification of a body of groundwater as good status requires that its ability to support human uses has not been significantly impaired.

UKTAG's previous recommendations apply to the revised threshold value for nitrate. These are that, where a threshold value is breached at one or more monitoring points, further investigation is triggered to determine whether or not a body of groundwater body should be classed as at poor status rather than good status. Monitoring data from sites representative of groundwater quality over an appropriate spatial extent of the body of groundwater should be used to determine whether the threshold is breached.

The UKTAG has also reviewed its previous recommendation on the further investigations required where any threshold value for assessing risks to a groundwater body's ability to support human uses is breached. The existing recommendation is that a body of groundwater should not be classed as good status if the average of all the monitoring results from all the monitoring points representative of the risk to the quality of the groundwater exceeds the threshold value. This criterion is designed to assess whether the cumulative effect on groundwater quality of a large number of small inputs of pollutants is resulting in a breach of a threshold value over a wide area¹.

On the basis of its review, the UKTAG recommends that its existing recommendation on the further investigations is amended and supplemented as follows. These new recommendations are intended to be applied to all investigations triggered by a breach of a relevant threshold value:

¹ For example, in the form of diffuse pollution associated with general use of the land.

- the body of groundwater should not be classed as good status if both (a) the average of all the monitoring results from all the monitoring points representative of the risk to the quality of the groundwater exceeds the threshold value [i.e. the existing UKTAG recommended criterion]; and (b), additionally, the concentration of the pollutant to which the threshold value applies exceeds the maximum concentration allowed for it in drinking water in at least one sample from an appropriately representative monitoring point;
- the body of groundwater should not be classed as good status if (i) the threshold values is exceeded across any plume of pollutants extending for over 2 square kilometres or more; and (ii) the maximum concentration allowed in drinking water for any of the pollutants in the plume is exceeded in at least part of the plume.

The revision to the existing criterion recommended in point (a) above is designed to help confirm that the pollution is sufficiently severe to compromise the potential of the body of groundwater to support human uses. The second criterion is designed to take account of spatially extensive impacts arising from individual sources of pollution, such as large contaminated land sites. The investigation is expected to involve the use of modelling and monitoring information to predict and validate the severity and extent of the plume.

Implications

Change in the nitrate threshold value: Most nitrate problems arise from the cumulative impact of lots of diffuse sources, in particular from agriculture. Nitrate from agriculture is managed under the Nitrates Directive. Two approaches apply. In Northern Ireland actions to reduce nitrate pollution are taken across the whole territory. In the rest of the UK, discrete areas, called Nitrate Vulnerable Zones are identified. Action programmes to reduce nitrate pollution are applied within these zones.

The UKTAG's recommended revision to the nitrate threshold value will have no impact on the designation of Nitrate Vulnerable Zones (NVZ) in Wales, England or Scotland.

As a result of the change in the threshold value, the number of groundwater bodies assessed as poor status in Scotland because of widespread pollution by nitrates is expected to decrease. UKTAG estimates that less than 5% of groundwater bodies are expected to change status. In England and Wales, the number of groundwater bodies assessed as poor status because of widespread pollution by nitrates is expected to increase. UKTAG estimates that less than 5% of groundwater bodies are expected to change status. For Northern Ireland, the threshold value has not changed and consequently changes to water body classifications are not expected.

Changes to further investigation criteria: The UKTAG has undertaken an initial analysis of the effect of the new criteria recommended for the further investigations. The first of its two recommendations was that, for classification as poor status, at least one sample from a relevant monitoring point must breach the maximum concentration allowed in drinking water. The analysis concluded that this criterion is highly likely to be met where the average of all monitoring results breaches the threshold value. Consequently, the UKTAG expects this criterion to have no impact, or at most a negligible impact, on the classification of water bodies.

The criteria for the extent of plumes of pollutants are expected to lead to additional water bodies being classed as poor status. Further analysis is needed to determine how many. A significant proportion of the water bodies in which there are extensive plumes will already be classed as poor status for other reasons. Extensive pollutant plumes result from large point sources, including contaminated land. Reducing the extent of a plume involves stopping or limiting further inputs from these sources. Such action is already the focus of other legislation, including legislation on the remediation of contaminated land. The reflection of the impact of large pollutant plumes in status classifications may help inform decisions on priorities for action under other legislation. However, it is not expected to result in a change to the measures required.

THRESHOLD VALUES FOR RISKS TO ASSOCIATED SURFACE WATERS

A significant proportion of flow in some rivers can come from groundwater. The ecological quality of such rivers can be harmed by changes to the volume and quality of the groundwater inflows.

One of the criteria for the classification of a groundwater body as good or poor is whether pressures on groundwater, such as pollution, are leading to significant damage to the ecological quality of a river, lake, estuary or coastal water. Each Member State is required to establish threshold values for groundwater for use in assessing this threat. The threshold values are designed to identify risks and so target further investigations. The latter are used to decide whether or not the groundwater body meets the criteria for classification as good or poor. A body is classed as poor status where:

- An environmental standard for good for a pollutant in an associated surface water body is breached; and
- The concentrations of the pollutant in the surface water resulting solely from anthropogenic inputs via groundwater represents at least 50% of the value of the environmental standard.

The UKTAG has reviewed its recommended method for calculating the threshold values. The review concluded that the existing method can produce thresholds that fail to identify significant risks. To improve the identification of risks requiring further investigation, the UKTAG recommends that the method for deriving thresholds is revised as follows:

Existing threshold	Recommended threshold
surface water standard ÷ dilution factor	0.5 x (surface water standard ÷ dilution factor)
Notes: The "dilution factor" is taken to be the fraction of the average annual river flow derived from groundwater inflows. It can be estimated from established hydrological indices such as the baseflow index, or from the ratio of catchment groundwater recharge to effective precipitation.	

Groundwater inflows can occur as obvious point sources (for example, from resurgences of mine water) and these can contribute to breaches of environmental standards in the surface water. In such cases, the UKTAG continues to recommend that assessments are based on a comparison of surface water quality upstream and downstream of the groundwater inflows. Threshold values in groundwater are not required for such assessments.

Implications

The recommended revision is expected to result in an increase in the number of groundwater bodies identified as requiring further investigation. It will not affect the outcome of these investigations, as the criteria for classification as good or poor status remain the same. However, the likely overall effect is that more water bodies at significant risk will be investigated and so more bodies will be identified as poor status.

In particular, the number of investigations relating to phosphate concentrations in groundwater from diffuse sources and small point sources is likely to increase. There may also be an increase in the number of further investigations relating to ammonia and some metals.

In Scotland, the effect is expected to be minimal. This is because no relevant threats to surface waters were identified in the first round of river basin planning. In Northern Ireland, the revised method for deriving threshold values has already been introduced into the classification process. The recommendation will have the greatest effect in England and Wales, probably for phosphorus and certain metals. An assessment of the impact on the number of further investigations will be made once the changes in surface water standards recommended elsewhere in this consultation have been reflected in updated assessments for surface waters.

RISK OF DETERIORATION

One of the principal objectives of the Directive is to prevent deterioration. The revised criteria described above for good status will also be taken into account in assessing the risk of deterioration. For example, if an upward trend in concentration is predicted to cause failure of any one of the criteria for good status within 12 years, UKTAG recommends that the water body is identified as at risk of deterioration and appropriate and prioritised action taken with the aim of reversing the trend. UKTAG's existing recommendations on identifying risks of deterioration provide further details [8].

PREVENT OR LIMIT THE INPUT OF POLLUTANTS INTO GROUNDWATER

If uncontrolled, individual inputs of pollutants into groundwater can cause local problems. The accumulated effect of these can lead to a deterioration of the status of bodies of groundwater. The Directive includes the objectives of preventing the input of hazardous substances¹ into groundwater and limiting inputs of other pollutants so as to avoid deterioration and significant and sustained upward trends in the concentrations of pollutants. These objectives are elaborated in Directive 2006/118/EC on the protection of groundwater against pollution and deterioration. The standards described in this section are recommended for use in designing measures to achieve these objectives and assessing whether the measures have been effective.

Recommended approach for hazardous substances

Standards for hazardous substances in groundwater are used to help assess whether or not measures to prevent inputs from identified sources have been successful. They are based on the “limits of quantification” achieved routinely by competent laboratories. UKTAG recommends that the standards are normally applied in the immediate vicinity of the input by:

- calculation of the concentration that will be present in the unsaturated zone immediately before entry; or
- calculation of the concentration that will be present in the saturated zone immediately after entry into groundwater; or
- calculation or measurement of the concentration of the substance in groundwater as near to the point of entry as is practically possible.

Details of how assessments are made in practice are available in guidance from the relevant environment agency.

The approach was first introduced to implement an earlier Directive, 80/68/EEC, on the protection of groundwater against pollution caused by certain dangerous substances. This also has an objective of preventing the introduction into groundwater of listed hazardous substances.

The UKTAG recommends that the approach to setting and applying standards for hazardous substances established under Directive 80/68/EEC is also used to implement the Water Framework Directive's objective of preventing inputs of hazardous substances.

The standards recommended by the UKTAG for hazardous substances in groundwater are listed in Table 13. Most have already been subject to public consultation² in England and Wales [6]. Whilst they are also used across the UK, up until now, no definitive UK list has been published.

The standards are recommended for use in assessing:

¹ These are substances or groups of substances that are toxic, persistent and liable to bio-accumulate or which give rise to an equivalent level of concern.

² For the purpose of these consultations, the standards were referred to as “minimum reporting values”.

- the risk of inputs posed by proposed new developments, such as new landfill sites;
- whether or not existing activities and contaminated land with the potential to cause inputs are doing so.

In the latter case, a breach of a standard in a sample of groundwater may result in a requirement for extra controls on the source of the pollutant input unless an exemption is applicable. The criteria for exemption are set out in Article 6 of Directive 2006/118/EC¹. These include consideration of whether preventing inputs would require disproportionately costly measures to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil. Details of how assessments are made in practice are available in guidance from the relevant environment agency.

Where there is a significant risk of inputs of a hazardous substance not listed in Table 13, UKTAG recommends that the agency derives and applies a standard based on the routine “limit of quantification” for the substance achieved by a competent laboratory.

Standards have not been identified for all listed hazardous substances. The assessment of whether or not pollutants should be listed as hazardous is undertaken by the Joint Agency Advisory Group on the Groundwater Directive (JAGDAG). The criteria JAGDAG apply for the purpose of this assessment are published on the UKTAG website [9] together with information on the results of completed assessments. The hazardous substances applied in each part of the UK are based on the JAGDAG assessments. For example, the current list of substances for Scotland is available on SEPA's website [10].

Implications

All activities on or in the ground with the potential to cause inputs of hazardous substances into groundwater will continue to be subject to fundamentally the same restrictions as currently apply under the control regime established to implement Directive 80/68/EEC.

The Water Framework Directive's requirements also apply to contaminated land sources of pollution. The standards are expected to be used to help in identifying on-going inputs of hazardous substances from these sources and the measures needed to prevent them. Actions currently taken with respect to contaminated land are not always sufficient to prevent inputs of hazardous substances. Additional remediation may be needed in some cases to remove the source of the inputs or to otherwise prevent the pollutants from percolating into groundwater.

However, land remediation can be very expensive. This is why Directive 2006/118/EC provides for an exemption where preventing further inputs would require “disproportionately costly measures” to remove quantities of pollutants from, or otherwise control their percolation in, contaminated ground or subsoil. Details of how the prevent requirements apply to contaminated land are available in guidance from the relevant environment agency.

¹ Groundwater Daughter Directive to the Water Framework Directive - 2006/118/EC

Table 13: Recommended standards for hazardous substances

Column 1	Column 2	Column 3
Substance	Default standards ^a (µg/l)	Alternative water standards ^b (µg/l)
1,1,1-trichloroethane	0.1	
1,1,2-trichloroethane	0.1	
1,2,4-trichlorobenzene	0.01	
1,2-dichloroethane	1	
2,4-dichlorophenol (2,4-DP)	0.1	
2-chlorophenol	0.1	
4-chloro-3-methylphenol	0.1	
Aldrin	0.003	
Atrazine	0.03	
Azinphos ethyl	0.02	0.05
Azinphos methyl	0.001	0.03
Benzene	1	
Cadmium	0.1	
Carbon tetrachloride (tetrachloromethane)	0.1	1
Chlorfenvinphos	0.001	0.01
Chloroform	0.1	
Chloronitrotoluene ^c	1	
DDT ^d	0.002	
Demeton	0.05	
Diazinon	0.001	0.05
Dieldrin	0.003	
Dimethoate	0.01	0.05
Endosulfan ^e	0.005	
Endrin	0.003	
Fenitrothion	0.001	0.01
Fenthion	0.01	0.01
Hexachlorobenzene (HCB)	0.001	
Hexachlorobutadiene (HCBD)	0.005	
Hexachlorocyclohexane (lindane / γ-HCH)	0.001	
Isodrin	0.003	
Malathion	0.001	0.03
Mercury compounds	0.01	0.1
Mevinphos	0.005	0.07
Parathion	0.01	0.06
Parathion-methyl	0.015	0.01
Polychlorinated biphenyls (PCBs) ^f	0.001	
Pentachlorophenol (PCP)	0.1	1
Cis-Permethrin	0.001	0.02
Trans-Permethrin	0.001	0.01
Simazine	0.03	
Tetrachloroethylene	0.1	
Toluene	4	
Trifluralin	0.01	
Tributyltin oxide (TBTO) ^g	0.001	
Trichloroethylene	0.1	

Table 13: Recommended standards for hazardous substances

Triphenyltin oxide (TPTO) ^g	0.001	
Xylene ^h	3	

Notes:

- a. The standards in column 2 are based upon Minimum Reporting Values (MRV) published by the Environment Agency [7]
- b. The standards in Column 3 are based upon Minimum Reporting Values (MRV) published by the Environment Agency [11]. They are only to be used when monitoring compliance, where the sample matrix has been agreed with the relevant agency to be technically unsuitable for meeting the normal limits of quantification. In these cases, they apply instead of the standards in Column 2.
- c. The standard applies to each of the following individual chloronitrotoluene compounds: 2,4-chloronitrotoluene; 2,5-chloronitrotoluene; 2,6-chloronitrotoluene; 4,2-chloronitrotoluene; 4,3-chloronitrotoluene.
- d. The standard applies to the following DDT compounds or breakdown products: o,p-DDT; p,p-DDT; o,p-DDE; p,p-DDE; o,p-TDE; p,p-TDE.
- e. The standard applies to α -Endosulfan.
- f. The standard applies to each individual polychlorinated biphenyl (PCB) congener.
- g. These specific compounds are listed as hazardous by Joint Agency Groundwater Directive Advisory Group (JAGDAG). They are examples of 'tributyltin compounds' and 'triphenyltin compounds'.
- h. The standard applies to o-xylene and m+p-xylene.

Recommended approach for non-hazardous pollutants

Standards for non-hazardous pollutants in groundwater are used to help assess the extent to which inputs to groundwater need to be limited to ensure that they do not cause deterioration or a significant and sustained upward trend in the concentrations of pollutants in groundwater.

Deterioration is said to occur where increases in concentration cause significant adverse impacts on surface waters, wetlands, or on existing uses and potential future uses of groundwater. Trends are "significant" if they would result in such adverse impacts unless preventative actions were taken.

This section therefore covers standards to limit point sources inputs of non-hazardous pollutants so as to avoid deterioration. The standards will vary depending on the receptor at risk (i.e. the quality of abstracted water, an associated surface water, etc.):

- Existing UKTAG technical guidance [2] explains the approach taken to protect different receptors. Where the receptor is a surface water or an abstraction for human consumption, groundwater standards are dictated by, respectively, the corresponding standard for surface water or for drinking water. The threshold values for wetlands described in an earlier section of this chapter are recommended for use in protecting wetlands from inputs of nitrate.
- Where, the body of groundwater is a drinking water protected area and, at the location concerned, no other receptor requires a more stringent standard for its protection, UKTAG recommends applying standards derived from those required to protect water used for human consumption. Inputs of pollutants can limit the potential for economically productive uses of groundwater in the area concerned. They also add to the cumulative impact on the groundwater body. Where a body of groundwater's ability to support potential human uses becomes significantly impaired over a wide area, the body is

classed as poor status. Controlling inputs from each source helps prevent such deterioration in status

In relation to protecting the groundwater within a Drinking Water Protected Area as a resource for future uses, the standards would normally apply at a distance of 50 metres from the source of the inputs in the direction of groundwater flow. This distance may be extended up to a maximum of 250 metres where there other constraints on the future development of the local groundwater resource.

Limits on discharges and other point source inputs are calculated taking into account both the standard and the capacity for dilution and attenuation between the source and the point at which the standard applies. More information on the process can be found in the UKTAG's technical guidance on setting regulatory standards in groundwater [2].

The UKTAG recommends that the appropriate standard for a pollutant is selected as follows:

- (a) a national drinking water standard for the pollutant established under domestic legislation, including legislation implementing the Drinking Water Directive;
- (b) if no standard is available via (a), a standard specified in World Health Organisation (WHO) Guidelines for Drinking Water Quality;
- (c) if no standard is available via (a) or (b), a standard established following peer review by a national authority in another country;
- (d) if no suitable standard is available via any of the above, an operational value adopted by the agencies based on the best available scientific information on the pollutant concerned.

If the relevant standard for a non-hazardous pollutant is breached in any sample, extra controls on the input may be required unless one or more of the following applies:

- a sequence of measured concentrations in the groundwater shows an improving trend as a result of action taken at the site;
- the breach is shown to be short term. Evidence here includes a check that the estimate of the annual 95-percentile does not exceed the standard with statistical confidence¹;
- concentrations are the result of the natural characteristics of the groundwater rather than anthropogenic inputs;
- it is demonstrated that concentrations are elevated by other sources of pollution. In such a case the standards applied may be elevated to avoid penalising one site because of pollution from a neighbour²; or
- an exemption is applicable in accordance with the criteria set out in the Groundwater Directive³.

¹The degree of additional sampling depends on the required level of confidence which in turn depends on site specific variability, and on the costs of the action being proposed. For example, where it is clear that groundwater quality does not vary, this may require one or two additional samples.

²The degree of adjustment will depend on the extent of natural attenuation expected in the groundwater at the site.

³Article 6 of the Groundwater Daughter Directive to the Water Framework Directive - 2006/118/EC.

Implications

The approach recommended is largely the same as that put in place to implement the Directive 80/68/EEC on the protection of groundwater from pollution by Dangerous Substances. It has been used for many years throughout the UK as part of agreeing compliance values and conditions on permits and licences for landfills, discharges to ground, and other activities that need to be controlled in order to protect groundwater.

All activities on or in the ground with the potential to cause pollution of groundwater will be subject to the same restrictions as currently apply under the control regime established to implement Directive 80/68/EEC and under the legislation for remediating contaminated land.

CHAPTER 4: ALIEN SPECIES

This Chapter describes the UKTAG's revisions to its recommendations on alien species. An alien species is defined by the International Union for Conservation of Nature and Natural Resources as a species introduced “outside its normal past or present distribution”. “Invasive” alien species are those which “threaten ecosystems, habitats or species with environmental or socio-economic harm” [1].

Alien species and classification

UKTAG's existing guidance places alien species in Great Britain on one of three lists – high impact, low impact, or unknown impact - in relation to the risks they pose to the water environment. (A separate list containing only high-impact species has been compiled for Northern Ireland and the Republic of Ireland.)¹

The effect on the ecological quality of waters in which a high impact alien species is established is expected to be more than very minor. This means the waters cannot be classed as in high ecological status. They are instead classified as good, moderate, poor or bad status, depending on the extent and severity of the impact of the species on the structure and functioning of the ecosystem [2].

The UKTAG recommends that decisions on the appropriate listing for an alien species are based on the results of risk assessments¹ coordinated by the Great Britain Non-native Species Secretariat (GBNNS) [3].

To facilitate this, the UKTAG is recommending adding a list of moderate impact alien species to its existing lists. This is because the GBNNS risk assessments differentiate moderate impacts from high and low impacts. The listings are intended to help prioritise efforts to monitor and assess risks; prevent or contain introductions; and attempt eradication.

The GBNNS has completed a number of risk assessments since the UKTAG published its original recommendations. Table 14 describes the changes to the UKTAG lists that would follow from taking account of these results.

The UKTAG is also developing an 'alert' list. This will cover alien species that are not yet present in Great Britain but have the potential to be introduced. Ireland has already developed an 'amber list' for this purpose. The aim is to provide greater readiness for future invasions.

Table 15 is the revised high impact list², taking account of the revisions described in Table 14. An assessment on common carp by GBNNS is underway. Its listing will be reviewed when this is complete.

¹ Risk assessments are reviewed if substantive new evidence comes to light.

²The full list (including that for Northern Ireland and the Republic of Ireland) can be obtained from the UKTAG website: http://www.wfd.uk.org/sites/default/files/Media/UKTAG%20classification%20of%20alien%20species%20working%20paper%20v7_0.PDF

Table 14: Revisions to the UKTAG listings of alien species		
Species	From	To
Pacific oyster (<i>Crassostrea gigas</i>)	High	Moderate
<i>Crangonyx pseudogracilis</i> (a freshwater amphipod)	High	Low
Japanese weed (<i>Sargassum muticum</i>)	High	Low
¹ Pikeperch (<i>Sander lucioperca</i>)	Unknown	Moderate
Jenkins' spire shell (<i>Potamopyrgus antipodarum</i>)	Unknown	Moderate
<i>Caprella mutica</i> (a marine amphipod)	Unknown	Moderate
Noble crayfish (<i>Astacus astacus</i>)	Unknown	Low
Narrow-clawed (Turkish) crayfish (<i>Astacus leptodactylus</i>)	Unknown	Low
<i>Dikerogammarus haemobaphes</i> (a freshwater amphipod)	-	High
Virile crayfish (<i>Orconectes virilis</i>)	-	High
Giant knotweed (<i>Fallopia sachalensis</i>)	-	High
American lobster (<i>Homarus americanus</i>)	-	Moderate
Water hyacinth (<i>Eichhornia crassipes</i>)	-	Low

Table 15: Revised high impact species in Great Britain	
Freshwater plants	species with updated risk assessments by GBNNS
Australian swamp stonecrop (<i>Crassula helmsii</i>)	yes
Floating pennywort (<i>Hydrocotyle ranunculoides</i>)	yes
Water fern (<i>Azolla filiculoides</i>)	yes
Parrot's feather (<i>Myriophyllum aquaticum</i>)	yes
Curly water-thyme (<i>Lagarosiphon major</i>)	yes
Water primrose (<i>Ludwigia grandiflora</i>)	yes
Canadian pondweed (<i>Elodea canadensis</i>)	pending
Nuttall's pondweed (<i>Elodea nuttallii</i>)	pending
Freshwater animals	
North American signal crayfish (<i>Pacifastacus leniusculus</i>)	yes
Freshwater amphipod (<i>Dikerogammarus villosus</i>)	yes
Mysid crustacean (<i>Hemimysis anomola</i>)	no
Zebra mussel (<i>Dreissena polymorpha</i>)	yes
Topmouth gudgeon (<i>Pseudorasbora parva</i>)	yes
Goldfish (<i>Carassius auratus</i>)	no
Red swamp crayfish (<i>Procambarus clarkia</i>)	yes
Virile crayfish (<i>Orconectes virilis</i>)	yes
Freshwater amphipod (<i>Dikerogammarus haemobaphes</i>)	yes
Coastal and transitional water species	
Common cord-grass, Townsend's grass or ricegrass (<i>Spartina anglica</i>)	no
Chinese mitten crab (<i>Eriocheir sinensis</i>)	yes
Slipper limpet (<i>Crepidula fornicata</i>)	no

¹On the basis of expert judgement.

Leathery sea squirt (<i>Styela clava</i>)	no
American oyster drill (<i>Urosalpinx cinerea</i>)	no
Colonial tunicate (non-native <i>Didemnum</i> spp.)	yes
Marine tubeworm (<i>Ficopomatus enigmaticus</i>)	no
Bankside alien plants	
Japanese knotweed (<i>Fallopia japonica</i>)	yes
Giant knotweed (<i>Fallopia sachalensis</i>)	yes
Japanese knotweed and Giant knotweed hybrid (<i>Fallopia x bohemica</i>)	no
Himalayan balsam (<i>Impatiens glandulifera</i>)	no
Giant hogweed (<i>Heracleum mantegazzianum</i>)	no
Rhododendron (<i>Rhododendron ponticum</i>)	no

'Locally absent' species

Some species that are native in parts of the country can take on the characteristics of alien invasive species when they are moved to another part of the country. These are called 'locally absent'¹. One example is ruffe – a freshwater fish, native to Britain but not to Scotland. In the early 1980s it was recorded in Loch Lomond; it is thought to have been introduced by anglers. The population rose exponentially and caused serious damage to native species, including rare species important for conservation.

The UKTAG is currently exploring whether there is sufficient information to reliably identify areas of the UK in which different species of freshwater fish would be "locally absent" in the natural environment. It is also considering whether there is enough information to assess the likely impact of introductions of species into such areas. At this stage, it is not possible to make recommendations, though a list of possibilities is available [4].

¹These do not include species whose distribution may move as a result of climate change, as this is considered to be a natural aspect of population dispersal.

CHAPTER 5: RIVER FLOWS

This chapter outlines changes to the UKTAG's recommendations on standards for river flows [1, 2]. The standards affected are those dealing with modifications to medium and high flows.

UKTAG's current recommendations were designed to help:

- assess the risk of deterioration in ecological status that is posed by recommended changes to river flows (for example, through new abstractions);
- estimate the status of rivers already subject to flow alterations in cases where no suitable biological methods are available to assess directly the impact on ecological quality [3];
- inform investigations into the potential causes of biological damage. This is done by comparing the degree of alteration to river flows with the results of assessments of ecological quality.

The UKTAG reconsidered its previous recommendations in response to the experience of using its standards, and because of requests for a review by water users such as hydropower companies. Under certain circumstances, the member agencies of the UKTAG were finding that some of the standards appeared to over-estimate the severity of adverse impacts [4, 5].

The review looked at scientific developments since the UKTAG made its first recommendations in 2007. It was informed by a number of projects.

The standards are expressed as the percentage of the natural flow that may be abstracted without a significant risk of damage to the ecology of rivers. Different percentages apply depending on the flow, with higher percentages used for higher flows.

FINDINGS OF THE REVIEW

The UKTAG concluded that there is no new quantitative information that can be used to refine the standards generally for low flows [6]. Consequently, the UKTAG proposes no changes to its current recommendations on standards for low flows, however this topic is being kept under review and further work is expected particularly in relation to any alignment possible with standards for Natura 2000 sites.

Low flows are defined as flows that are smaller than the flow exceeded for 95% of the time¹. This is labelled, Q95. If we imagine the natural river, with no abstractions and discharges, the flow that would be exceeded for 95% of the time is called the Qn95.

¹In other words, for 347 days per year on average.

As river flow increases from very low levels, there is an increase in the extent and suitability of in stream habitats for species. This increase in the value of the habitat¹ for some species may not begin to level off until flows are higher than the Qn95 [7]. There is also evidence that invertebrates living on the bottom of rivers² are impacted where flows are reduced below Qn95. The Dried-Up research project [8] found evidence of significant impacts when summer Qn95 flows are reduced by between 10 and 30%³. This finding broadly agrees with the existing low flow standards for good status.

In contrast, the UKTAG did conclude that there is a need to revise its recommendations on flow standards for medium and high flows. Much of the evidence for this change comes from sites where low flows are maintained, but medium and higher flows are abstracted.

For a site to be assigned bad ecological status, severe adverse ecological impacts should be present⁴. These severe impacts are not being found at sites predicted to be at bad status using the standards for medium and high flows in cases where low flows are largely unaffected.

The methods of biological classification previously recommended by the UKTAG and applicable across the UK are not specifically designed to detect the ecological effects of alterations to flow; Even so, if severe impacts are present, it is expected that these methods would provide some indication of impact. In a project which sought to verify limits and conditions set on the managed flows downstream of impoundments [5], no evidence was found of a relationship between the flow sensitive LIFE score⁵ and the degree of flow impact at high flows (Q5⁶). The project found some evidence of reduced variability in LIFE scores downstream of impoundments, but no clear indication of the major or severe impacts that would be associated with poor and bad ecological status.

ECOLOGICAL RESPONSES TO CHANGES TO MID AND HIGH FLOWS

Published studies show that effects on aquatic organisms can result from changes to mid and higher flows [5, 7, 8]. However, the available evidence does not suggest that these effects can be sufficiently severe on their own to lead to bad ecological status.

¹For example where impact is expressed in terms of features such as the habitat space measured by “wetted width” .

²As measured by the flow-sensitive LIFE score.

³ The study showed a deviation of around 0.5 standard deviations from reference condition LIFE score.

⁴Typically, this will mean that large portions of the biological communities normally present under undisturbed conditions are absent.

⁵ A special form of biological index designed to be sensitive to changes in river flow.

⁶ Flows exceeded 5% of the time.

Mid flows

The ecological impacts caused by reductions in mid range flows are expected to be a loss in habitat space and a prolonging of periods of low flows. These effects will tend to lead to a shift in aquatic plant and animal communities from those favouring flowing water to those preferring stiller water. Reductions in mid range flows increase the typical duration of episodes of low flow at which river conditions become less favourable to a varied aquatic ecology. Unfavourable conditions in extended low flow events can include higher temperatures, decreased dissolved oxygen and reduced habitat space.

The UKTAG advises that these effects can be sufficient to cause the ecological status to be poor¹. The recovery time following exceptional periods of low flow can extend over a number of years, particularly for the recovery of species diversity [9].

With a reduction of 60% of mid flows it can be shown that extreme episodes of low flow such as those which, under natural conditions have a 1 in 20 year return period, can increase their frequency to a return period of once a year. It is likely that, with such a frequency, ecological recovery becomes compromised, and a change in the character of the biological communities will result.

The duration of periods of low flow increases gradually as mid flows (flows above Q_{n90^2}) are reduced. Reductions greater than 60% appear to lead to a substantially increased rate of extension to the durations of periods of low flow.

The sensitivity of a river to extended periods of low flows is likely to depend on the characteristics of that river. There is some evidence that rivers with large contributions from groundwater to their flows are more sensitive than flashier types with limited groundwater contributions to their flows. Recent work has noted a difference in the response of macro-invertebrates between upland and lowland rivers, with bigger effects caused by extended low flows in lowland rivers [8]. However, at this time, the UKTAG considers the scientific understanding to be insufficient to differentiate the relative sensitivity of different types of river to extended low flows. Consequently, the UKTAG's recommendations for revised standards apply to all river types.

High flows

The ecological processes affected by reductions in high flows typically revolve around loss of stream energy and, in turn, reduced mobility of the bed load and increased deposition of sediment. Added to this, reductions in high flows can affect habitats by their impact on the connectivity between the river and its floodplain.

¹ At poor status, there will typically be major alterations to the composition and abundance of aquatic plants and animals such that the biological communities present differ substantially from those normally found under undisturbed conditions.

² The natural flow exceeded for 10% of the time.

Reductions in the frequency of high flow events, and changes in their timing, will also have an impact on migratory fish, with disrupted cues for migration, and impacts on spawning habitats. The UKTAG is not confident that the ecological effects of changes to high flows can be sufficiently severe on their own to result in a worse status than poor. In practice, changes to high flows are normally accompanied by large changes to mid range flows.

RECOMMENDATIONS FOR ALL FLOW STANDARDS

Experience of using the existing flow standards has shown that, particularly in high baseflow rivers, the existing standards for maximum permissible abstraction may result in lower residual flows at higher flows than at lower flows. The standards have been revised to ensure that this is not the case. A caveat is recommended which applies to all river flow standards which states that residual flows at higher flows resulting from the maximum permissible abstraction should not be lower than the residual flow at lower flows.

RECOMMENDATIONS FOR MID AND HIGH FLOW STANDARDS

The UKTAG's recommendations are summarised in the Tables 16 and 17. The results are that:

- On days when flow would naturally be greater than the Qn90, maximum abstraction rates are determined by the linear rate of increase in flow proportion from the Q90 standard to 70% abstraction at Q60
- On days when flow would naturally be greater than Qn60, the maximum abstraction rates will be 70% of Qn.

Table 16: Recommended revisions to the “moderate” standards for river flows

	Permitted maximum abstraction per day as a proportion of natural flow			
	At daily flows (Q _n) from Q _{n60} up to Q _{n5}		At daily flows (Q _n) greater than Q _{n90} and less than Q _{n60}	
River Type	Existing standards	Recommended revision	Existing standards	Recommended revision
A1	60% of Q _n	70% of Q _n	50 - 55 % of Q _n	The proportion of Q _n determined by the linear increase from 50% at Q _{n90} to 70% at Q _{n60}
A2 (downstream), B1, B2, C1, D1	55% of Q _n	70% of Q _n	45 - 50 % of Q _n	The proportion of Q _n determined by the linear increase from 45% at Q _{n90} to 70% at Q _{n60}
A2 (headwaters), C2, D2	50% of Q _n	70% of Q _n	40 - 45 % of Q _n	The proportion of Q _n determined by the linear increase from 40% at Q _{n90} to 70% at Q _{n60}

No changes are recommended to the existing standards for daily flows from Q_{n95} and up to Q_{n90} and for daily flows less than Q_{n95}.

Table 17: Recommended revisions to the “poor” standards for river flows

	Permitted maximum abstraction per day as a proportion of natural flow	
	At daily flows (Q _n) from Q _{n90} up to Q _{n5}	
River Type	Existing standards	Recommended revision
A1	75 - 85% of Q _n	Q _n less 25% of Q ₉₀
A2 (downstream), B1, B2, C1, D1	70 - 80% of Q _n	Q _n less 30% of Q ₉₀
A2 (headwaters), C2, D2	65 - 75% of Q _n	Q _n less 35% of Q ₉₀

No changes are recommended to the existing standards for daily flows from Q_{n95} up to Q_{n90} and for daily flows less than Q_{n95}

IMPLICATIONS OF THE RECOMMENDATIONS

Existing Abstractions

The recommended standards do not affect the high and good status categories and, as such, those water bodies that currently fail good status with the existing river flow standards will continue to fail under the revised standards.

Risk assessment

Proposed developments that may lead to deterioration of the status may be allowed to go ahead if they meet the strict criteria for exemption from the Directive's objective of preventing deterioration (Article 4.7). The essence of this exemption is that deterioration of the status as a result of new activities that are of overriding public interest may be allowed. The overriding public interest test involves a thorough consideration of the positive and negative consequences of such proposals. With the new standards, the process of weighing up positive and negative consequences will be less complicated.

In Scotland, standards for river flow help assess the risk of deterioration posed from proposed new abstractions or increases in existing abstractions. The changes to the standards are expected to affect risk assessments for developments that propose to abstract a large proportion of mid and high flows but which leave low flows largely unaffected.

Proposals that, using the existing standards, would be assessed as likely to cause deterioration to bad status, may be assessed as risking deterioration to moderate or, at worse, poor, on the basis of the revised standards.

The revisions are also expected to result in fewer proposals being assessed as likely to cause deterioration to poor. This is because the revised standard for the moderate-poor boundary for mid flows is less stringent than it was in the UKTAG's previous recommendations.

From a regulatory perspective, the revisions mean that some proposals will either:

- not be considered to pose a risk that would previously have been assessed as likely to cause deterioration; or
- be assessed as likely to cause a deterioration that is less severe than previously thought.

Classification

The UKTAG has previously recommended that river flow standards can be used in the classification of ecological status in cases where suitable biological methods are not available for the direct assessment of ecological impacts.

The UKTAG is developing indicators of the ecological impacts of flow alterations. The aim is to enable all parts of the UK, as a minimum, to identify major effects on ecological quality that result from changes to the river flow regime. This will help to reduce the reliance on the sole use

of river flow standards to classify sites as poor or bad ecological status. A consultation on these indicators is planned for later in 2012.

The UKTAG has also set priorities for the development of methods of ecological assessment that could differentiate sites affected by hydromorphological alterations into high, good and moderate status, as well as poor and bad status. The first of these is expected to be available in a few years' time.

Currently only SEPA relies on river flow standards to inform classifications of ecological status. This is because the biological methods available to SEPA are insufficiently sensitive to the effects of alterations to river flows. The main effects of the revisions to the flow standards, and of the introduction of ecological indicators, will be on the classification of rivers affected by abstractions for the generation of hydropower, or on rivers abstracted for water storage schemes for public water supply. The effect is likely to be that a better class is assigned to around 30% of all river water bodies in Scotland currently classed as poor, and to 20% of those classed as bad.

In England, the Environment Agency use flow standards to classify if a water body is at High ecological status and if flows are supporting, or not supporting, Good ecological status. The UKTAG good standards are translated into the Environmental Flow Indicator that forms the basis of water abstraction regulation. In rivers where flows are not supporting Good ecological status, the deviation from the Environmental Flow Indicator is assigned to a 'non-compliance' band. These are used to prioritise investigations and improvement measures. The 'non-compliance' bands will not be affected by the changes to the less than good standards.

The UKTAG maintains its existing recommendation that requiring costly action is not appropriate for waters classified as moderate status on the basis of river flows unless there is corroborating evidence of ecological damage.

CHAPTER 6: WATER LEVELS IN LAKES

The UKTAG's recommendations on standards for water levels in lakes were designed to help:

- assess the risk of deterioration in the ecological status of lakes posed by future abstractions;
- estimate the ecological status of lakes already subject to changes in levels in cases where no biological methods are available to assess the impact on ecology [1].

The original standards were based on expert views on the degree of change in the natural variation in levels expected to pose a significant risk of ecological damage [2]. They were converted into corresponding changes in a lake's natural outflow. This was done using a simple hydraulic equation to estimate the reduction in a lake's natural inflows that would give rise to the level change. The inflow criteria were then converted to outflow standards to try to account for lake water storage effects¹.

The UKTAG undertook a review in response to experience of using the standards. The standards were predicting large changes in impact from very small changes in water level. For example, in some lakes, the difference between good and bad status could result from a 10centimetre change in water level [3].

The review concluded that the standards were overestimating the risk posed by small changes in water levels and that they were failing to differentiate between slight, moderate, major and severe impacts (that is – between good, moderate, poor and bad status). One reason for this was the assumptions made in translating the changes in natural levels into standards defined in terms of lake outflows.

The ecological quality of lakes can be significantly affected by changes to the quality and extent of shallow water through which sunlight can penetrate to the lake bed. This is because this habitat, known as the littoral zone [4], has a particularly productive ecologically, supporting rooted plants and bottom-living algae. The depth to which light penetrates depends on the clarity of the water but generally falls into the range from 1 to 10 metres. The depth of light penetration in peaty lakes is typically much less than in clear water lakes.

Lowering the water levels in lakes can change the area of the littoral zone and impact upon other lake habitats such as through the settling of resuspended sediment on aphotic habitats below the littoral zone. It can also change the quality of the habitat by increasing the extent of very shallow areas exposed to the erosive effects of wave action.

¹ Low flows in lake outflows are typically elevated compared with low flows in lake inflows. This is because of the lake storage effect. This results in changes to outflows lagging behind changes in inflows.

The shape of the lake (its bathymetry) has a significant bearing on the impact of a change in level. In deep, steep-sided lakes, the area of the littoral zone and other lake habitats is not significantly affected by relatively large changes in water level. The main effect in these lakes is likely to be on the interaction between the lake and surrounding terrestrial habitats and feeder streams. In shallow, gently shelved lakes, small reductions in level can have a significant effect on the area and quality of different lake habitats.

The existing standards were designed with these same impacts in mind. The use of type-specific standards was an attempt to account for variation in the area of lake habitat affected by a given abstraction. Tighter standards apply to shallow, shelving basin types of lake than to deep, steep-sided lakes.

The UKTAG recommends replacing the existing standards with standards specified directly in terms of changes in the area of lake habitat. This avoids the problems that stemmed from attempts to reflect the impacts in terms of changes to lake outflows. The recommended standards are as follows:

Table 18: Standards for the effect of water level changes on lake surface area			
Daily maximum percentage reductions in lake surface area in 99 percent of days in any year			
High	Good	Moderate	Poor
1	5	10	20
<p><u>Lake surface area</u> means, for any day, (a) the area under the reference conditions of the lake's surface that would overly water from the shore out to 5 metres deeper than the depth to which light penetration to the lake bed would be sufficient, under those conditions, to enable the growth of rooted plants or bottom-living algae; or (b), if the deepest part of the lake is shallower than this, the whole area of the lake's surface, under reference conditions. The lake habitat extends 5m below the zone of light penetration to account for impacts on the aphotic habitat.</p>			
<p><u>Reference conditions</u> means the absence of any abstractions or discharges¹ that could affect the surface area of the lake. For the purposes of setting a maximum allowable abstraction, it is recommended that reference conditions should be representative of the current standard UK Meteorological Office climate reference period (currently 1981 to 2010). In terms of determining the depth of light penetration, reference conditions should be determined in habitats where water clarity is not affected by water quality impacts such as eutrophication.</p>			
<p>In the absence of field data to the contrary, the depth to which light penetration to the lake bed is sufficient to enable the growth of rooted plants or bottom-living algae may be taken to be 2 metres for lakes with the geological sub-type of "peat" and 7 metres for all other lake types. A lake is considered to have the sub-type of "peat" where (i) its mean water colour is more than 90 hazen units; or (ii), where information on colour is unavailable, more than 75 % of the soils of its catchment area are comprised of peat.</p>			

¹For lakes designated as heavily modified for water storage, "reference conditions" may be taken to mean the regime as (a) altered by the use for which the lake has been designated; and (b) with all mitigation measures that can be put in place without a significant adverse impact on the use or the wider environment.

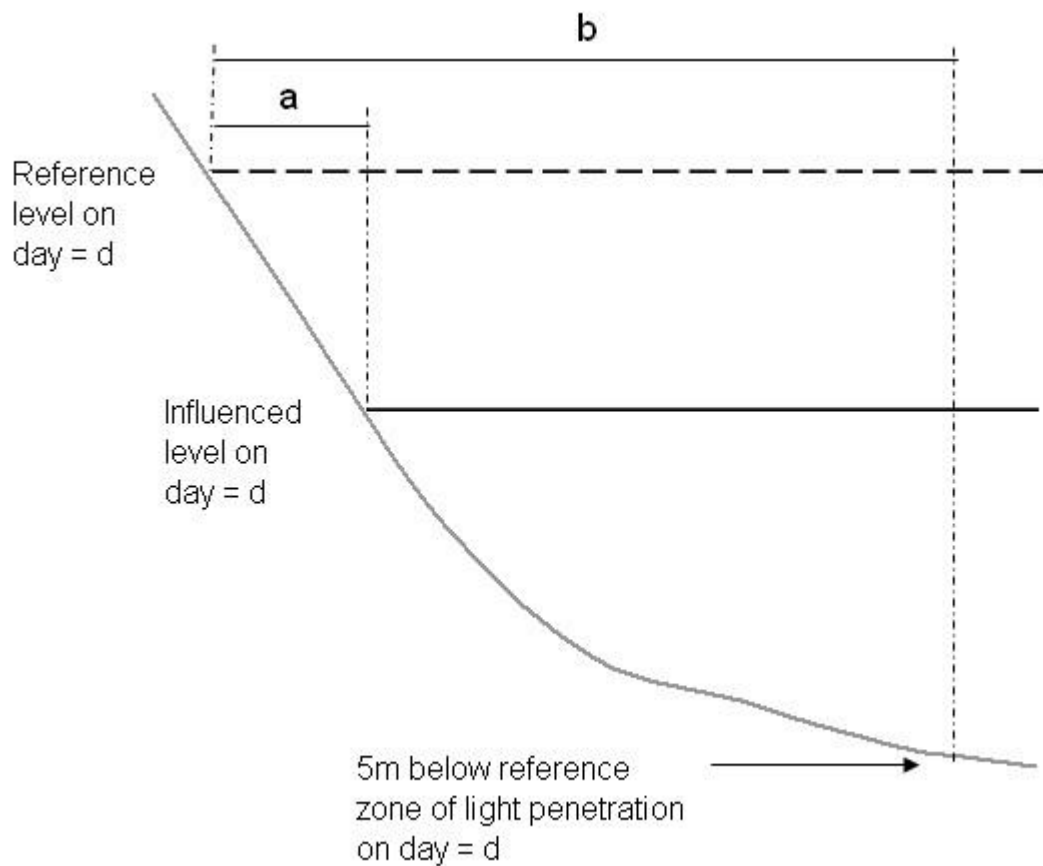


Figure 1. Schematic representation of a lake where level has been lowered on day = d.

The percentage reduction in area on day d is given by the equation:

$$100 \times \frac{a}{b}$$

Where:

"a" is the difference between "b" and the area of the lake on day "d" as affected by abstraction pressures.

"b" is the area that the lake would have on day "d" under reference conditions.

"area of the lake" means the area of the lake's water surface beneath which the depth of water is no more than 5 metres deeper than the maximum depth to which light would penetrate under reference conditions.

The recommended standards stipulate the reduction that may not be exceeded for more than 1% of days in any one year.

USING THE STANDARDS

To use the standards it will be necessary to estimate the area of the lake habitat in the absence of impacts from the use of water resources (for example, abstractions of water). This will be achieved by modelling the lake levels using measured or modelled values for the natural inflows to the lake¹.

Compliance will be assessed by the modelling of natural and influenced lake levels, and by using bathymetry to assess corresponding changes in the area of the lake habitat. The abstractions will comply if the thresholds in Table 18 are not exceeded for more than 1% of days in any period of 12 months.

In order to set a maximum allowable abstraction for licence conditions, it is necessary to estimate the numbers of days that abstractions would not exceed the percentage changes in Table 18. This involves determining the quantity of water that can be abstracted without breaching the standards across the range of typical climatic conditions. The UKTAG recommends using the current 30 year period defined by the UK Meteorological Office as the basis for determining typical climatic conditions, although other data periods may be used when appropriate. The 30 year reference period is updated by Meteorological Office every 10 years.

PEER REVIEW

As part of the development of these standards, a peer review was undertaken by:

- Professor Kenneth Irvine, Chair of Aquatic Ecosystems UNESCO-IHE, Netherlands
- Dr. John Rowan, Reader in Physical Geography, School of the Environment - Geography, University of Dundee

The move to more lake specific standards (based upon bathymetry and lake level regimes) was welcomed by the reviewers as a step in the right direction. The reviewers went on to suggest that standards for lake levels should ideally take account of factors such as differences in the sensitivity of species (including within-year sensitivity); the rate of level changes; finer-scale differences in the sensitivities of habitats within lakes; and connectivity between the lake and its shore. However, the reviewers did not identify a means of reflecting these factors in standards. The reviewers recommended that ongoing research into these factors is brought into a future review of lake standards by the UKTAG.

The reviewers felt that accounting for the additional sensitivity of peaty lakes was important and could be achieved as recommended by the UKTAG. They recommended that the sizes of zones should be measured on a site by site basis using, for example, a Secchi disc to determine the light penetrating zone, or surveys of habitat. This recommendation is reflected in the

¹A research project commissioned by SEPA has shown it is possible to use inflows transposed from data from a nearby gauging station [5].

recommended standards, but since the data may not always be available, a standard set of zone definitions has been developed.

The reviewers were clear that the standards should take no account of any notional 'gains' in habitat. Such gains might occur for the submerged areas that fall into a habitat zone as a result of an impact. The standards recommended here only take account of losses to habitat.

Both reviewers indicated that effects of climate change should be accommodated. By explicitly linking reference conditions to a 30-year period that will be updated each decade, the UKTAG recommends that any impacts of a changing climate will be included.

IMPLICATIONS

For most shallow lakes, the recommended standard for good equates to a water level change of between 20 cm and 50 cm. This corresponds closely with the criteria for good on which the existing standards were based [2]. These criteria translated into reductions in levels of up to about 40 centimetres. For deep, steep-sided lakes, the recommended standard for good can translate into reductions in levels up to around 1.5 metres.

The application of the recommended standards requires information on bathymetry and on the variation in the levels. Both may be derived from modelling or monitoring. Where the information is not already available, the UKTAG recommends applying the existing outflow standards as part of a screening step to decide if it is necessary to obtain extra information. . The outflow standards are tighter than the standard for good status in Table 18 and if the existing standards are met there will be high confidence that these water bodies meet at least good status. If they are not breached, neither will the recommended surface area standards.

Most lakes subject to major alterations to their water levels serve as reservoirs for public water supply or for hydropower generation, or have done so in the past. Most have been designated as heavily modified water bodies under the Water Framework Directive. The recommended standards may be used to help assess the risk of deterioration of the water bodies' ecological potential posed by proposed new abstractions or modifications to the existing operating regimes. When making such assessments, UKTAG recommends that the reference surface area used is that expected for the lake at good ecological potential, as defined with reference to the existing use. Some non-heavily modified lakes have been raised in the past (i.e. by raising the height of the sill). This produces a larger surface area. Where the raising is not considered to compromise the achievement of high or good ecological status, the reference surface area used in applying the recommended standards should be based on the area of the raised lake.

The revised standards are expected to better reflect significant risks to the ecological quality of lakes. The existing standards overestimate the risks.

One of the expected consequences of replacing the existing standards is that fewer proposed new abstractions will be assessed as likely to cause deterioration. More water could be abstracted before the standards are breached.

Proposed developments that may lead to deterioration of the status may be allowed to go ahead if they meet the strict criteria for exemption from the Directive's objective of preventing deterioration (Article 4.7). The essence of this exemption is that deterioration of the status as a result of new activities that are of overriding public interest may be allowed. The overriding public interest test involves a thorough consideration of the positive and negative consequences of such proposals. With the new standards, the process of weighing up positive and negative consequences will be less complicated.

The standards may be used to help classify where no suitable biological methods are available with which to assess directly the impact of changes in lake levels. Currently, Scotland relies on the existing lake level standards to inform classification. If the new standards were to be applied, there would be a small reduction in the number of lakes classed as worse than good and, of those that are worse than, considerably fewer would be classed as poor and bad.

CHAPTER 7: INTERMITTENT DISCHARGES

In its first report the UKTAG set out standards for rivers for Biochemical Oxygen Demand (BOD), dissolved oxygen and ammonia [1]. Such standards are used, for example, to assess the need for further action on discharges from sewage treatment works.

In support of these standards the UKTAG also recommended [1] the continued use of standards that help design works to improve intermittent discharges to rivers that can occur in wet weather [2]. These include unsatisfactory discharges from combined sewer overflows, and discharges from storm tanks.

Fundamental Intermittent Standards

A review by the Water Research Centre [3] has confirmed that the standards known as Fundamental Intermittent Standards need not be changed. They can continue to be used in support of plans to achieve good status. The standards are listed in Tables 19 and 20.

The Fundamental Intermittent Standards provide values for dissolved oxygen and for a type of ammonia known as un-ionised ammonia. Concentrations of this form of ammonia are linked directly to causes actual damage to fish. Un-ionised ammonia is a tiny part of the total concentration of ammonia and is particularly toxic.

The Fundamental Intermittent Standards refer to events of particular frequency and duration and are generally used with mathematical models that deal with the effect and probability of storms.

Table 19: Fundamental intermittent standards for Dissolved Oxygen			
Ecosystem suitable for a sustainable salmonid fishery			
Return period	Dissolved oxygen concentration (mg/l)		
	1 hour	6 hours	24 hours
1 month	5.0	5.5	6.0
3 months	4.5	5.0	5.5
1 year	4.0	4.5	5.0
Ecosystem suitable for a sustainable cyprinid fishery			
Return period	Dissolved oxygen concentration (mg/l)		
	1 hour	6 hours	24 hours
1 month	4.0	5.0	5.5
3 months	3.5	4.5	5.0
1 year	3.0	4.0	4.5

The above limits apply when the concurrent concentration of un-ionised ammonia concentration is below 0.02 mg/l. The following correction factors apply at higher concurrent un-ionised ammonia concentrations:

Where the un-ionised ammonia lies between 0.02-0.15 mg NH₃-N/l: the correction factor is an addition of $(0.97 \times \log(\text{mg NH}_3\text{-N/l}) + 3.8)$ mg O₂/litre. For concentrations that exceed 0.15 mg NH₃-N/l, the correction factor is +2 mg O₂/litre.

A correction factor of 3 mg O₂/l is added for salmonid spawning grounds.

Table 20: Fundamental intermittent standards for Un-ionised Ammonia			
Ecosystem suitable for a sustainable salmonid fishery			
Return period	Un-ionised Ammonia concentration (mg NH₃-N/l)		
	1 hour	6 hours	24 hours
1 month	0.065	0.025	0.018
3 months	0.095	0.035	0.025
1 year	0.105	0.040	0.030
Ecosystem suitable for a sustainable cyprinid fishery			
Return period	Un-ionised Ammonia concentration (mg NH₃-N /l)		
	1 hour	6 hours	24 hours
1 month	0.150	0.075	0.030
3 months	0.225	0.125	0.050
1 year	0.250	0.150	0.065
The above limits apply when the concentration of dissolved oxygen is above 5 mg/l. At lower concurrent concentrations of dissolved oxygen the following correction factor applies: For Dissolved Oxygen less than 5 mg/l DO, multiply the standard by 0.0126 and the concentration of Dissolved Oxygen in mg O ₂ /litre, C, raised to the power of 2.72, that is, $0.0126 C^{2.72}$.			
The standards also assume that the concurrent pH is greater than 7 and temperature is greater than 5 degrees C. For lower pH and temperatures the following correction factors apply: Where the pH is less than 7, multiply the standard by 0.0003 and by the value of the pH, p, raised to the power of 4.17, that is: $0.0003 p^{4.17}$. Where the temperature is less than 5 degrees Centigrade, multiply this correction factor by a further 0.5.			

99-percentile Standards

The calculation of levels of dissolved oxygen and un-ionised ammonia downstream of discharge requires good data on the physical and chemical processes in the river. The results for un-ionised ammonia are sensitive to errors in pH – a change of 1% in pH causes a 10% change in the concentration of unionised ammonia.

This issue has meant that another family of standards is used instead of or as well as the Fundamental Intermittent Standards. These are the 99-percentile Standards for BOD, Total Ammonia and Un-ionised Ammonia.

The calculations for the 99-percentile Standards for BOD and Total Ammonia are less vulnerable to data and assumptions and the outcomes are strongly correlated with damage linked to dissolved oxygen and un-ionised ammonia.

The existing 99-percentile standards were derived from the 90-percentile standards used before the Water Framework Directive to define classes of rivers known as River Ecosystem (RE) Classes. The 90-percentiles for River Ecosystem (RE) were adjusted slightly for the new Directive and its typologies¹. Table 21 shows the typologies:

Table 21: Types of river to which standards apply					
Altitude	Alkalinity (as mg/l CaCO ₃)				
	Less than 10	10 to 50	50 to 100	100 to 200	Over 200
Under 80 metres	Type 1	Type 2	Type 3	Type 5	Type 7
Over 80 metres			Type 4	Type 6	

Table 22 and 23 sets out the new values for the Water Framework Directive, and provides the old values for comparison.

Table 22: 99 percentile standards for BOD				
Status	Types of river	Old objective	Biochemical Oxygen Demand	
			90-percentile	99 percentile
		RE1	2.5	5.0
High	1, 2, 4 and 6	RE2	3.0	7.0
High	3, 5 and 7		4.0	9.0
Good	1, 2, 4 and 6		5.0	11.0
Good	3, 5 and 7	RE3	6.0	14.0
Moderate	1, 2, 4 and 6		6.5	14.0
Moderate	3, 5 and 7		7.5	16.0
Poor	1, 2, 4 and 6	RE4	8.0	19.0
			9.0	19.0
Poor	3, 5 and 7		15.0	30.0
		RE5		

¹The types are described and set out in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2009; The Scotland River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) Directions 2009; and The Solway Tweed River Basin District (Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values) (Scotland) Directions 2009.

Table 23: 99 percentile standards for Ammonia					
Type of standard	Types of river	Old objective	Total Ammonia (mg/l)		Un-ionised ammonia (mg/l)
			90-percentile	99-percentile	
High	1, 2, 4 and 6		0.2	0.5	0.04
		RE1	0.25	0.6	0.04
High	3, 5 and 7		0.3	0.7	0.04
Good	1, 2, 4 and 6				
Good	3, 5 and 7	RE2	0.6	1.5	0.04
Moderate	1,2,4 and 6		0.75	1.8	0.04
Moderate	1,3,5 and 7		1.1	2.6	0.04
Poor	1,2,4 and 6				
		RE3	1.3	3.0	0.04
Poor	1,3,5 and 7	RE4	2.5	6.0	-
		RE5	9.0	25.0	-

Implications

The implications for the 99 percentiles are tied to the changes in the objectives from the now defunct classes under River Ecosystem to the status classes under the Water Framework Directive.

91% of 40,000 kilometres of rivers in England and Wales met their objectives under River Ecosystem for BOD, dissolved oxygen and ammonia. For the objectives under the Water Framework Directive, the corresponding figure is around 90% of 50,000 kilometres. This indicates that 1000 to 2000 more kilometres may be in need of action in the form of tighter controls on sewage effluents and/or to any intermittent discharges to the same rivers.

The figures of 91 and 90% have been corrected for the pessimistic bias under the classification used with the one-out all-out rule the Water Framework Directive. This rule changes the 90% to 85%. If we to take action only when there is 95% confidence of failure of the standard, the effect of the change to the Water Framework Directive remains limited to 1000 to 2000 kilometres of river. In some of these rivers improvements to sewage effluents alone is likely to achieve Water Framework Directive objectives.

There are also likely to be implications for the Fundamental intermittent standards (FIS) associated with waterbodies that do not meet good status as a result of the Water Framework Directive fisheries classification scheme. It is estimated, in England and Wales, there are between 0.6 to 2.2 % of waterbodies that are likely to need to use the salmonid FIS rather than the cyprinid FIS to meet WFD good status requirements despite previous designation under the Freshwater Fish Directive as cyprinid fisheries. These are waterbodies designated as cyprinid fishery under the Fish Directive but which have a high expected prevalence of trout under WFD.

The implications will be far less significant in Scotland and Northern Ireland where the salmonid FIS have usually been previously applied anyway.

CHAPTER 8: STANDARDS FOR ACIDIFICATION IN RIVERS

Anthropogenic acidification is caused by emissions to the atmosphere of sulphur dioxide and oxides of nitrogen. These are released as a result of the combustion of fossil fuels. The gases undergo oxidation to form sulphuric acid and nitric acid, respectively. The acids are then deposited, either in rain or snow, or when particles or gases stick to the ground, plants or other surfaces.

Base cations¹ in soils, such as calcium, potassium and manganese, act as a natural buffer against acidity. The acidification of rivers and lakes occurs in areas which have limited buffering capacity, such as land with thin soils that overlay granite rock. Forests can enhance the deposition of acid pollutants from the atmosphere because of the greater air turbulence caused by their rough canopies. The way forests are planned, designed and managed influences the risk of them contributing to acidification.

Action taken under a series of treaties dating from the 1980s and 1990s has led to significant reductions in emissions of acid pollutants from power stations and industry. Despite this, acidification remains an issue, particularly in upland western parts of Scotland and Wales, where rainfall is high, soils are generally base poor, and significant conifer plantations exist.

The UKTAG has developed recommendations on standards for acidification in rivers [1]. The standards are for pH and a parameter called the Acid Neutralising Capacity (ANC)². The first of these acts as a surrogate for “labile aluminium”, which is believed to provide the toxicity which shapes biological communities at low pH. The ANC is a direct measure of longer-term anthropogenic acidification.

Dissolved Organic Carbon (DOC) plays an important role in determining the damage to waters prone to acidification. A value of 10mg/l of DOC is used as a threshold to distinguish “clear” and “humic” waters³ in the biological method that is used to describe the impact of acid pressures in rivers [2]. The UKTAG recommends that this value is used as a threshold to develop separate standards for each type of water.

The UKTAG's existing recommendations on standards for pH are set as the annual 5 or 10-percentile for acidification, and the annual 95-percentile for alkalinity. The studies that underpin this review have demonstrated strong correlations between the annual mean and the biological data. Consequently, it is recommended that the new standards are defined as annual mean values.

¹Base cations are the most prevalent, exchangeable and weak acid cations in the soil.

²As calculated by the Cantrell method.

³Humic material provides the brown staining of water in peat catchments and is derived from the oxidation of peat.

The pH boundary for good and moderate is placed at the start of increases in concentrations of labile aluminium – a point at which significant damage starts to be observed in biological communities. For ANC, the boundary between high and good is set above the point at which concentrations of labile aluminium begin to elevate. The other boundaries are positioned at appropriate places on the gradient of labile aluminium. The poor-bad boundary is placed just below maximum concentrations of labile aluminium¹ [2].

Under most instances, the recommended standards provide the same class as the class suggested by the biological data. Where there is disagreement it is most commonly by only one class. There is a slight bias towards a lower class for biology. This might be expected because the biological data provides an integrated record, and the chemical records describe the conditions at the times of sampling – the biology may be shaped by extreme events not picked up in chemical samples that were taken.

As noted above, the ANC and pH fulfil different roles in describing the impact of acidification. ANC provides an indication of buffering capacity that is useful in the context of national and international management of acid deposition; it forms the basis of approaches based on critical loads, forestry plantings and the modelling of scenarios for the impact of acid deposition. The pH is a measure of overall acidity and is strongly correlated with the concentrations of labile aluminium. However, it does not help distinguish between natural and anthropogenic acidification.

Comparison of current and recommended standards for acidification

To help with the comparison, the current percentile standards have also been shown in Table 24 as estimates of the corresponding annual means². The new standards are tighter for clear waters but laxer for humic waters.

Table 24: Comparison of current and recommended standards for pH and ANC						
Class	Current standards ³		Recommended standards			
	All waters		Clear waters		Humic waters	
	pH		pH	ANC	pH	ANC
		(indicative mean)	(annual mean)			
High	6.0 (5-percentile)	5.79	6.60	80	5.10	80
Good	5.2 (10-percentile)	5.37	5.95	40	4.55	50
Moderate	4.7 (10-percentile)	4.91	5.44	15	4.22	10
Poor	4.2 (10-percentile)	4.43	4.89	-10	4.03	5

¹ Covering most concentrations of dissolved organic carbon.

² Using data on typical values of the standard deviation and assuming a normal distribution and a coefficient of variation of 0.075, the average for Welsh rivers.

³The current standards for high status also include a test set to protect against elevated pH – an annual 95-percentile of 9. No change is proposed for this.

An assessment using water-bodies in Scotland shows that the recommended standards produce broadly similar results in classification. The UKTAG believes that this outcome would be replicated across the UK where acidification pressures exist.

Movement of water-bodies between classes is shown in Tables 25a and 25b. In 267 clear waters there would be 15 downgrades and 9 upgrades following the use of the new standards in classification. In 37 humic waters there would be 1 down-grade and 16 upgrades. The net outcome is an upgrade for humic waters and a downgrade for clear waters.

Table 25a: Movements in class in clear waters as a result of new standards							
Current standards		Recommended standards for clear waters					Totals
		High	Good	Moderate	Poor	Bad	
	High	229	13				242
	Good	7	12	2			21
	Moderate		1	2			3
	Poor			1	0		1
	Bad					0	0
	Totals	236	26	5	0	0	267

Table 25b: Movements in class in humic waters as a result of new standards							
Current standards		Recommended standards for humic waters					Totals
		High	Good	Moderate	Poor	Bad	
	High	20		1			21
	Good	8					8
	Moderate	6					6
	Poor	1	1				2
	Bad						0
	Totals	35	1	1	0	0	37

Implications

The issues that will be affected by failure of the standards are the control of power stations that use fossil fuel. Most of the necessary controls are already in place through other drivers. There is also the adoption of policy on land-use that directs appropriate forestry in sensitive areas – areas that have a naturally low buffering against acid events.

REFERENCES

GENERAL

[1] UKTAG (2008); UK Environmental Standards and Conditions; (Phase 1); Final report (SR1 – 2006), April 2008.

http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%201_Finalv2_010408.pdf

[2] UKTAG (2008); UK Environmental Standards and Conditions (Phase 2); Final (SR1 – 2007); March 2008.

http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%202_Final_110309.pdf

[3] UKTAG (2008); Proposals for Environmental Quality Standards for Annex VIII Substances; Final (SR1 – 2007) January 2008; (Revised June 2008).

http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Specific%20pollutants%20proposals_Final_010608.pdf

[4] UKTAG: Proposals for a Groundwater Classification System and its Application in Regulation: Final draft (SR1– 2007), October

2007. http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Proposal%20for%20groundwater%20classification%20system_Final_100308.pdf

[5] UKTAG (2007); Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Directive.

http://www.wfduk.org/sites/default/files/Media/Assessing%20the%20status%20of%20the%20water%20environment/GWChemical%20Classification_FINAL_2802121.pdf

[6] Mainstone, C.P. (2010c); An evidence base for setting nutrient targets to protect river habitat. Natural England Research Reports, Number 034. Available at:

www.naturalengland.org.uk

[7] Mainstone, C.P. (2010a) An evidence base for setting flow targets to protect river habitat. Natural England Research Reports, Number 035. Available at: www.naturalengland.org.uk

[8] Mainstone, C.P. (2010b) An evidence base for setting organic pollution targets to protect river habitat. Natural England Technical Information Note 076. Available at:

www.naturalengland.org.uk

[9] UKTAG (2012a) Technical report on Groundwater Dependent Terrestrial Ecosystem (GWDTE) Threshold Values;

http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/o_-_groundwater/technical_gwdtespdf/ EN_1.0 &a=d

SPECIFIC POLLUTANTS

[1] UKTAG (2008). Proposals for Environmental Quality Standards for Annex VIII Substances. Final Report January 2008 (revised June 2008) (SR1 –

2007). http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Specific%20pollutants%20proposals_Final_010608.pdf

- [2] UKTAG (2012). Proposals for Further Environmental Quality Standards for Specific Pollutants.
http://www.wfduk.org/sites/default/files/Media/UKTAG%20Specific%20Pollutants_final_011412.pdf
- [3] Environment Agency (2005). Implementation of a Framework for Standards. Cartwright N G, Batty J, Corbishley C and Whitehouse P.
- [4] Environment Agency (2007). Wilkinson H, Sturdy L, Whitehouse P. Prioritising chemicals for standard derivation under Annex VIII of the Water Framework Directive. SC040038/SR
<http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Prioritising%20chemicals%20annex%20viii.pdf>
- [5] UKTAG (2012). Technical reports on specific pollutants, Chemistry Task Team of the UKTAG: Scoping Study for Dangerous Substances Directive List II Chemicals.
http://www.wfduk.org/sites/default/files/Media/Dangerous%20Substance%20scoping%20study_final_200412.pdf
- [6] UKTAG (2012). Technical reports on specific pollutants, Chemistry Task Team of the UKTAG: Proposed EQSs for Water Framework Directive Annex VIII substances.
<http://www.wfduk.org/stakeholders/phase-3-environmental-standards-stakeholder-review-201213>
- [7] Merrington G, Peters A, Brown B (2012). The development and use of the manganese screening tool; SC080021/1g-1; UKTAG: Edinburgh.
<http://www.wfduk.org/sites/default/files/Media/Development%20and%20use%20of%20the%20manganese%20screening%20tool%20-%20UKTAG.pdf>
- [8] Peters A, Merrington G, Brown B (2009); Using biotic ligand models to help implement environmental quality standards for metals under the Water Framework Directive; SC080021/SR7b; Environment Agency: Bristol.
<http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/biotic%20ligand%20models%20implement%20EQS.pdf>
- [9] Merrington G, Peters A (2012). The development and use of the copper screening tool; SC080021/8u; UKTAG: Edinburgh.
<http://www.wfduk.org/stakeholders/phase-3-environmental-standards-stakeholder-review-201213>
- [10] Brown B, Merrington G, Crane M (2012). Implementation of copper and zinc environmental quality standards in freshwaters: accounting for bioavailability and natural backgrounds; SC080021/8e; UKTAG: Edinburgh.
<http://www.wfduk.org/stakeholders/phase-3-environmental-standards-stakeholder-review-201213>
- [11] European Commission (2011). Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance document No. 27, Technical Guidance for deriving Environmental Quality Standards; Technical report –2001 – 055. Available at:
http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/tgd-eqs_cis-wfd/EN_1.0_&a=d
- [12] International Standard ISO 5667 -20 Water Quality –Sampling – Part 20: Guidance on the use of sampling data for decision making – Compliance with thresholds and classification systems.

http://www.wfduk.org/sites/default/files/Media/ISO_5667-20_2008%28E%29-Character_PDF_document.pdf

GROUNDWATER

[1] UKTAG: Paper 11b(i). Groundwater chemical classification. Revised paper on the procedures for translating the definitions of good groundwater chemical status into an operational classification system. March, 2012.

http://www.wfduk.org/sites/default/files/Media/Assessing%20the%20status%20of%20the%20water%20environment/GWChemical%20Classification_FINAL_2802121.pdf

[2] UKTAG: Application of Groundwater Standards to regulation. March, 2011.

http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Groundwater_Reg%20standards_Final_140312.pdf

[3] UKTAG: Technical report on Groundwater Dependent Terrestrial Ecosystem (GWDTE) Threshold Values; UKTAG 2012

http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/GWDTE%20chemical%20values_Final_230312.pdf

[4] Common Implementation Strategy (CIS) for the Water Framework Directive (WFD). Technical report on groundwater dependent terrestrial ecosystems. Technical Report 6. December 2011.

http://circa.europa.eu/Public/irc/env/wfd/library?!=/framework_directive/thematic_documents/o_-_groundwater/technical_gwdtespdf/EN_1.0_&a=d

[5] UKTAG: Paper 11b(i). Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Directive. February, 2007.

<http://www.wfduk.org/resources%20/paper-11bi-groundwater-chemical-classification-feb-2007#>

[6] The first consultation was the development of the Environment Agency's 2003 guidance on Hydrogeological Risk Assessment for Landfills and the Derivation of Groundwater Control and Trigger Levels. The second consultation was as the Environment Agency's 2010 Guidance on Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control Levels and Compliance Limits (H1 - Technical Annex to Annex j).

[7] Appendix 8 of the Technical Annex to Annex (j) - HRA for Landfills and the Derivation of Groundwater Control Levels and Compliance Limits - in the H1 Technical Guidance, December 2011. Accessed via: <http://publications.environment-agency.gov.uk/PDF/GEHO0212BULU-E-E.pdf>

[8] UKTAG (2011) Characterisation of Risks to Groundwaters for the 2nd River Basin Cycle; 14 March 2011.

http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Characterisation%20of%20risk%20groundwater_Final_010312_0.pdf

[9] Joint Agencies Groundwater Directive Advisory Group (2012) Methodology for the determination of hazardous substances for the purposes of the Groundwater Daughter Directive (2006/118/EC); June 2012.

http://www.wfduk.org/sites/default/files/Media/120628_JAGDAG_det_meth_final.pdf

[10] SEPA (2010) List of Hazardous substances determined in accordance with Schedule 2 of Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended).

http://www.sepa.org.uk/water/water_regulation/regimes/groundwater/discharges.aspx

[11] Environment Agency (2008) Groundwater trigger levels, minimum reporting values and limits of detection; 30 April 2008. http://www.environment-agency.gov.uk/static/documents/Business/mrv_factsheet_v1_2031927.pdf

[12] Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance Document No. 17 (2007) Guidance on preventing or limiting direct and indirect inputs in the context of the Groundwater Directive 2006/118/EC
<http://bookshop.europa.eu/en/guidance-on-preventing-or-limiting-direct-and-indirect-inputs-in-the-context-of-the-groundwater-directive-2006-118-ec-pbKHAN07017/>

ALIEN SPECIES

[1] McNeely JA, Mooney HA, Neville LE, Schei PJ, Waage JK (eds) (2001). *Global Strategy on Invasive Alien Species*. International Union for Conservation of Nature and Natural Resources, Gland.

[2] UKTAG:Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive June 2009
http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Recommendations%20on%20surface%20water%20status%20classification_Final_010609.pdf

[3]Results of risk assessments coordinated by the Great Britain Non-native Species Secretariat (GBNNS)
<https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51>

[4] UKTAG ALIEN SPECIES GROUP. List of locally absent species. Paper provided by Phil Boon, Head of Ecosystems and Biodiversity Unit, Scottish Natural Heritage, 12 November 2011. Tables subsequently updated with those in Chapter 4 of this report.
http://www.wfduk.org/sites/default/files/Media/Locally%20absent%20species%20paper_final_200412.pdf

RIVER FLOW

[1] SNIFFER WFD 48: Development of Environmental Standards(Water Resources)Stage 3: Environmental Standards. March, 2006. Available at:
<http://www.sniffer.org.uk/project-search-results.aspx?searchterm=wfd48>

[2] UKTAG (2008); UK Environmental Standards and Conditions (Phase 2); Final (SR1 – 2007); March, 2008.
http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%202_Final_110309.pdf

[3] UKTAG:Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive. June, 2009
http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Recommendations%20on%20surface%20water%20status%20classification_Final_010609.pdf

[4] Atkins: Initial Review of Environmental Flow Indicators. Report for the Environment Agency. October, 2010.

[5] SNIFFER WFD82b. Guidance on Environmental Flow Releases from Impoundments to Implement the Water Framework Directive. Validation of Managed flow Standards. January 2008. Available at:
http://www.sniffer.org.uk/Resources/WFD82b/Layout_Default/0.aspx?backurl=http%3a%2f%2fwww.sniffer.org.uk%3a80%2fproject-search-results.aspx%3fsearchterm%3dwfd82b&selectedtab=completed

[6] SNIFFER: WFD21d. Ecological indicators of the effects of abstraction and flow regulation; and Optimisation of flow releases from water storage reservoirs.
http://www.wfduk.org/sites/default/files/Media/Assessing%20the%20status%20of%20the%20water%20environment/WFD21D%20Final%20Report_30%2008%2012.pdf

[7] Booker, D.J. and Acreman, M.C. 2007. Generalisation Of Physical Habitat-Discharge Relationships. *Hydrology And Earth System Sciences*, 11, 141-157.

[8] Dunbar, M.J., Scarlett, P.D., Cadman, D., Mould, D.J. And Laize, C. 2010. Distinguishing the Relative Importance of Environmental Data Underpinning Flow Pressure Assessment 3 (DRIED-UP 3). CEH Report to the Environment Agency.

[9] Mainstone, C.P. 2010. An Evidence Base for Setting Flow Targets To Protect River Habitat. *Natural England Research Reports, Number 035*. Natural England, Sheffield. www.naturalengland.org.uk

WATER LEVELS IN LAKES

[1] UKTAG: Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive June 2009
http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Recommendations%20on%20surface%20water%20status%20classification_Final_010609.pdf

[2] SNIFFER WFD 48: Development Of Environmental Standards(Water Resources)Stage 3: Environmental Standards March 2006
http://www.sniffer.org.uk/Resources/WFD48/Layout_Default/0.aspx?backurl=http%3a%2f%2fwww.sniffer.org.uk%3a80%2fproject-search-results.aspx%3fsearchterm%3DWFD48&selectedtab=completed

[3] SNIFFER WFD49a: Development of Decision Making Frameworks for Managing Alterations to the Morphology of Lakes (July 2005);
http://www.sniffer.org.uk/Resources/WFD49A/Layout_Default/0.aspx?backurl=http%3a%2f%2fwww.sniffer.org.uk%3a80%2fproject-search-results.aspx%3fsearchterm%3dwfd49a&selectedtab=completedand Kirk, R.M. and Henriques, P.R. 1986. Physical and biological aspects of shoreline change: Lake Ohau, South Island, New Zealand, caused by high lake and storm wave run up. *Journal of Shoreline Management*, 2 305-326.

[4] CEN 2011. Water quality: guidance standard on assessing the hydromorphological features of lakes and reservoirs. European Committee for Standardization CEN/TC 230/WG 2/TG5 N67

[5] Jacobs 2010. Development of a loch routing model approach for estimating the impact of lochs on flow statistics. Report produced for SEPA. October, 2010.

INTERMITTENT DISCHARGES

[1] UKTAG: UK Environmental Standards and Conditions:

Phase 1 – final report (SR1 – 2006), April

2008: http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%201_Finalv2_010408.pdf

Phase 2 – final report (SR1 – 2007), March

2008: http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Environmental%20standards%20phase%202_Final_110309.pdf

[2] Urban Pollution Management Manual 1998. Foundation for Water Research, Second Edition, Report No FR/CL0009. The manual is in the process of being updated and made freely available and web based. It can currently be accessed at FWR's site:

<http://www.fwr.org/UPM/>

[3] Water Research Centre: Review of urban pollution management standards against WFD requirements. B Crabtree, J Horn and I Johnson, 2012. The report will be put on the Environment Agency's website in the publications catalogue as a PDF to freely download:

Summary: <https://brand.environment-agency.gov.uk/mb/Cxg6Wa> Report:

<https://brand.environment-agency.gov.uk/mb/EGUMbr>

STANDARDS FOR ACIDIFICATION

[1] Duncan W, Colvill D, Malcolm I A (2012) Acidification Environmental Standards FTT0117

Internal paper. http://www.wfduk.org/sites/default/files/Media/River%20ANC_final_120402.pdf

[2] Malcolm I A, Gibbins C. N, Fryer R.J., Keay J., Tetzlaff D, Soulsby C, 2012 The influence of forestry on acidification and recovery: Insights from long term hydro-chemical and invertebrate data. *Ecological Indicators* *In press*