Stakeholder Review – comments and responses: phosphorus standards

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Contents

Overall Summary

Background

In the consultation UKTAG asked for comments on 2 key principles, the majority of respondents made specific responses to these, but all provided a broad range of comments and most sought clarification on particular aspects.

Response to Principle 1: The UKTAG recommends that the new site-specific phosphorus standards for rivers are adopted based on a new model of the relationship between phosphorus and biology.

Response to Principle 2: The UKTAG suggests that the proposed new default phosphorus standards for rivers are adjusted to take account of observed local biology (adjusted standards)

Summary of Responses

The general consensus amongst those who responded to the consultation was that the revision to the phosphorus standards was a welcome improvement and a step in the right direction. The majority of respondents supported the adoption of the new standards, although most expressed a range of reservations, which are dealt with in more detail below.

All respondents welcomed the greater role of biology and several felt that if adopted the new standards should be used in combination with biological assessments, either when determining status or when determining measures (see Principle 2).

The majority of respondents noted the complexity and difficulties involved in establishing standards for phosphorus, given the multi-factorial pressures that determine ecological status. Four respondents felt that given these difficulties it was premature to adopt the new standards and one felt that without a more holistic approach to environmental management the standards would be unlikely to achieve improvements in ecological status.

The majority of respondents felt that biological status should be the main driver for water quality management and some noted the difficulties associated with applying the Directive's one-out, all-out rules for classification, given the uncertainties in the relationship between biology and phosphorus. Of the respondents who supported the adoption of the new standards and who addressed this issue, there was a general acknowledgement that adjusting the standards could prevent unnecessary expenditure. However, the majority felt that more work would be needed given the current levels of uncertainty and that a wide range of issues should be considered when applying any adjustment.

One respondent felt that the proposed standards were still insufficiently precautionary and relaxing standards would not be appropriate. There was no clear consensus on whether default standards should be used for assessment of status, while adjusted standards were

used to plan water quality. One respondent pointed out that applying different standards for status assessment and water quality management would produce practical difficulties and should be avoided.

The most common comments can be grouped into the following two themes; (1) uncertainty of the ecological response and role of other pressures; and (2) regulatory and practical issues.

Summary of issues relating to the uncertainty of ecological response and influence of other pressures

The role of phosphorus in controlling the ecology of rivers is complex and specific effects depend on many other factors. This issue was highlighted by two respondents (Reading University, Hutton Institute) who questioned the need for phosphorus standards at all, commenting on the complex interactions between catchment, water chemistry and biology. The implication was that targets and restoration packages needed to be developed on a case-by-case basis, with full consideration given to local circumstances and other pressures. UKTAG believe that a phosphorus standard is one necessary component of this holistic approach, with particular value for strategic planning and prioritisation of resources. Viewed as part of a broader package, including other biological and chemical assessments, UKTAG believe that the new phosphorus standards will contribute to greater understanding of the pressures on freshwater ecosystems and, therefore, greater certainty in the planning of measures.

As part of the above criticism the importance of nitrogen in freshwater was raised, particularly if there was evidence of nitrogen limitation. UKTAG acknowledge the importance of nitrogen in determining the condition of freshwater ecosystems and will be considering the potential development of standards in preparation for the 3rd cycle of the WFD. However, we do not feel that nitrogen standards would replace the need for standards to control phosphorus, although as part of this work we would intend to consider how interactions between N & P might influence ecological status.

Uncertainty in the relationships between biology and phosphorus

Several comments referred to the statistical model used to calculate phosphorus concentrations required to support good ecological status. Whilst many respondents commented on the inherent uncertainties in the model from which the standards were derived, neither the academic peer-reviewers nor any of those responding to the consultation suggested a feasible alternative that would have had significantly lower levels of uncertainty. Based on information exchanged at a workshop in February 2013, none of the 14 Member States represented used approaches that represented a significant

improvement over that proposed here. Indeed, other participants were interested in the site-specific approach proposed by UKTAG.

Three respondents (Anglian Water, Scottish Water, Welsh Water) suggested that the uncertainties [in the relationship between phosphorus and ecology] were too great to warrant the adoption of these standards in the next WFD cycle and, in particular, cannot justify the implied levels of investment.

UKTAG acknowledges the uncertainty but believes that the flaws in the process by which the phase 1 standards were set necessitate their revision. The uncertainty in the revised standards is no greater than that in the phase 1 standards but is more explicitly acknowledged and, importantly, there is less bias, meaning that the risk of a water body failing on biology but not on phosphorus is now lower. One respondent (Welsh Water) went on to suggest that revising the standards will undermine efforts to achieve good ecological status. We disagree with this suggestion. Available scientific evidence suggested that the phase 1 standards were too relaxed, particularly in lowland, hard water catchments and, therefore, regulating phosphorus to achieve these standards would not, necessarily, lead to achievement of good ecological status. The new standards provide a more secure basis for catchment-level efforts to attain good ecological status, as well as for estimating compliance costs and achievability.

Summary of regulatory issues and practical implementation

One respondent (Welsh Water) specifically questioned the need to revise the standards, arguing that the current downturn affecting the UK economy may have implications for its level of ambition for WFD. What may seem affordable during a time of economic growth may be less realistic during a period of austerity when cut backs are being made by many organisations and families alike. Other respondents (Anglian Water, Scottish Water) emphasised the need to know that measures to improve water body status will results in measurable benefits and question if the current level of understanding was sufficient to provide this. UKTAG acknowledges that these are important issues, but feels these are most appropriately dealt with through the river basin management planning process, when issues such as cost effectiveness and environmental benefits are assessed in setting water body objectives. This process is made simpler if phosphorus standards are based on values that are in line with the broader ecological literature and statistically are the most likely value needed to achieve Good status (i.e. a 50% chance of a water body being at Good status) rather than the current standards where the chance of being at Good status is only 10%.

Regulatory and practical issues

Several respondents commented on potential practical issues of implementing site specific standards and the implications of changing standards when assessing factors such as

deterioration of status. UKTAG considers that these issues can be managed and that they should not prevent the adoption of improvements to standards and assessment systems.

Use of a biology to adjust default standards

There were mixed views about the use of biology to adjust standards at site level. In general, it was welcomed by the regulated industries but others were concerned that the presence of a good status flora alone might not be sufficient to be sure that the P concentrations were non-problematic. There were also concerns about how the approach would operate in practice

UKTAG believes that biological data provide a potential means of identifying sites for which the proposed default standards are too stringent and, if effects from other pressures can be discounted, sites for which the proposed standards are too lax. However, UKTAG also acknowledges that there are a number of challenges involved in using local biological data to check and then adjust phosphorus standards. These include factoring out the effect of variability in sampling results; understanding whether or not sites at which adjustment is indicated are representative of the biology's response to phosphorus across the water body concerned; and managing the application of standards that, as a result, may both increase and decrease in stringency along the course of a river.

Way forward proposed by UKTAG

UKTAG does not propose to change its recommendations on the default standards.

Before make any firm recommendations, UKTAG proposes further trialling of its draft proposals for a biology-based checking procedure to identify where adjusted phosphorus standards may be more appropriate than the default standards

UKTAG will continue work to improve understanding of the factors that can affect the response of biology to nutrients. This work will include consideration of the role of nitrates in freshwaters.

Appendix. Detailed comments

Specific comments: policy and regulatory aspects of the new standards

Comments	Response
In contrast to biological classification methodology, it appears that intercalibration among Member States has not been undertaken for the proposed change to phosphorus classification. We consider this necessary to ensure a consistent approach and level playing field across member states before approval and implementation (Anglian Water)	There is no formal requirement to intercalibrate P standards; however, a comparison of national P standards is under discussion.
Regulatory impact Assessment required before adoption (Anglian Water)	Noted ..
Need case studies to put standards (biological and chemical) into context, would have been better if P consultation followed biological consultation (Anglian Water)	Noted ....We will use case studies to develop rules to guide the use of biologically adjusted standards
We believe a more robust method of making risk-based decisions will be possible by applying adjusted standards. However, further clarification is required on any proposed monitoring schedules and the potential timescales and cost implications this may have for the Regulator and industry.	Noted ..
We note that the consultation includes a peer review element, but we are unsure whether the four peer reviewers consulted by UKTAG are genuinely representative of the range of academic opinion. It would be helpful if UKTAG addressed this issue. (NFU Watercress Association)	Noted. The peer reviewers encompassed a range of expertise, including hydrochemistry, ecology and statistical modelling

Comments	Response
The general tightening of phosphorus standards which would result from adoption of UKTAG's proposals would clearly raise WFD compliance costs. There is already a tension emerging between the objective of good status and the public's willingness to pay, in part as a result of the public participation as required under Article 14. A significant increase in compliance costs would be expected to bring this tension to greater prominence, and hence to a need for greater clarity on affordability and proportionality issues. (NFU Watercress Association) ... the current downturn affecting the UK economy may have implications for its level of ambition for WFD. What may seem affordable during a time of economic growth may be less realistic during a period of austerity when cut backs are being made by many organisations and families alike. (Welsh Water) It will be critically important that the principle of basing investment decisions on the evidence of biological impact is defended (and care needs to be taken in defining this and the relevant metrics). For the polluter/customer/taxpayer to continue funding such investment the monitoring must be in place to measure the (potential) effectiveness of that investment. It is acknowledged that hysteresis means long term (pre and post investment) monitoring programmes need to be encouraged possibly following a principle of adaptive management. (United Utilities)	Noted. This comment highlights the need for meaningful P standards to provide a foundation for assessing the costs and benefits of improvements and then setting objectives accordingly

Comments	Response
It was apparent from the workshop that the combination of changes in the biological (specifically diatom) standard as well as the phosphorus standard and resultant improved picture of compliance was cautiously welcomed by the water industry representatives. The policy of responding to evident ecological harm rather than phosphorus concentrations alone certainly seems appropriate, but then should we not be encouraging a focus on biological rather than phosphorus monitoring? (United Utilities)	Noted. The focus in the future will be on both biological and chemical monitoring in order to provide a broad base of evidence on which to base decisions.
Finally, the intention of UKTAG to report on this consultation in June is understood, but unhelpful for PR14 planning. (Atkins)	We shall consider this point when planning the engagement and consultation on future proposals.
In future consultations, all documents cited should be accessible. (James Hutton Institute)	Where cited documents are not in the public domain we will in future make these available. However all documents cited were made available on request.

Comments	Response
EDF Energy does not support applying the default phosphorus standard alone to make decisions on new discharges or identifying the scale of improvements required for existing discharges. The benefit of proposed changes lies with the risk-based approach, taking into account biology as well as chemical standards. ...the standards should be used in conjunction with all the mechanisms of the WrFD, including considerations of affordability, feasibility, disproportionate cost and relevant principles of other pertinent regulations. An awareness of all the relevant site-specific considerations will allow a pragmatic approach to be taken which considers all factors. EDF Energy believes that a balanced regulatory approach for assessing individual existing discharges or applications for new discharges, that considers both socio-economic and environmental impacts will improve decision making. (EDF Energy) ..the standards should be used in conjunction with all the mechanisms available within the Water Framework Directive, including considerations of affordability and disproportionate cost, other relevant principles of environmental regulation (e.g. as expressed in the Industrial Emissions Directive and Best Available Techniques (BAT) Reference documents) and awareness of all the relevant site-specific considerations that may influence the relationship between water chemistry and biology when assessing individual existing discharges or applications for new discharges, etc. (Energy UK)	Noted ...

Comments	Response
..we understand that at present biological and chemical monitoring data may not always be available. Complete datasets should be sought to progress decision-making, particularly where the existing data suggests that measures may be needed in the second cycle of RBMPs.	Where we have inadequate data we will take steps to obtain the necessary information
The decision on requiring investment in point source phosphorus reduction should be measured against non-point source loads; in many cases it will be an unacceptable and wasteful use of resources to change a point source load, for example, where it may be just 8% in a catchment's total load, when no action is taken to address the other 92%. (South West Water) South West Water agrees [UK TAG's] reservation to avoid unjustified expenditure. Our view is that a whole catchment view must be taken, informed by thorough, effective and conclusive scientific investigations, to ensure that resources are invested first in options which will resolve the cause of the most significant problems.	Noted , we will continue to take a catchment based approach when considering measures.
We would stress that the quantitative value of a standard cannot be considered in isolation from an understanding of how compliance with a standard will be judged and achieved. (Natural England)	We will report the face value status when se assess compliance with a standard. However we will continue to take into account the uncertainty associated with our assessment of status when setting improvement objectives.
We welcome the inclusion of macrophyte quality data when setting standards, as we have long held the belief that standards set soley using diatoms are inadequate. It is critically important that macrophyte quality is part of the test for adverse biological impact when planning improvement action and it would be very helpful if specific advice on this is included in UKTAGs final recommendations to UK administrations	The freshwater task team of UKTAG have provided guidance that emphasises the importance of assessing macrophyte status in high alkalinity rivers.

Comments	Response
Problems with application of site-specific standards (Thames Water)	We consider that the benefits of site-specific standards outweigh their additional complexity. We will evaluate the implications of more stringent upstream standards as part of our water quality planning approach to ensure that benefits are greater than costs at the catchment scale.
How do you obtain biological corroboration in AWB / HMWB where biology might be compromised by other (non-nutrient) factors? (Thames Water) no assessment of impact on HMWB (Anglian)	We would not apply the new standards to artificial water bodies. We would apply the default standards to HMWBs
Impact on no deterioration clauses (Anglian)	Existing UKTAG guidance recommends that changes in classification as a result of changes in our understanding of the environment rather than because of deterioration should not be treated as deterioration of status for the purposes of the Directive.

Comments	Response
there are difficulties in applying [biological overrides] due to a lack of representative monitoring data and information to robustly identify the causative link between discharges to river and the biological impacts... a suggested approach would be to a) Relax the default standards where biological data is better than indicated by the levels of phosphorus, if the biology is in fact at its desired quality then no further work should be proposed other than that to maintain current quality over time. B) Where the biology is worse than expected, either the default standards be applied or no investment is proposed until there is robust information to identify the cause. More investigations are definitely needed where the biology doesn't stack up with the levels of Phosphorus to avoid abortive investment aimed at Phosphorus removal. With reference to investigations and the gathering of robust data, there needs to be agreement on who collects this data, the scope of data collection required to make a robust judgement and also the funding of these investigations. (United Utilities)	UK TAG has noted these suggestions. With respect to the need to collect further data we welcome the opportunity to work with partners to achieve this.
The dual approach of using default standards to assess status and for decisions on new discharges, whilst applying adjusted standards to the planning of improvements to existing discharges has a number of problems and is likely to lead to a number of inconsistencies (UU)	UKTAG agrees that the use of dual standards could be confusing. UKTAG will not be recommending such an approach at this time.

Comments	Response
Agricultural run off contributes significant amounts of phosphorus and other plant nutrients and minerals to the water environment. Average concentrations of phosphorus could be significantly elevated by sampling events which incorporate agricultural run off. Examples such as these could be the cause of mismatches between phosphorus (Scottish Water)	We accept that sampling leads to uncertainties in our assessment of status, which is why we base our assessments on mean values normally collected over at least 3 years.
Phosphorus problems may be long-standing, caused by long term inputs to water bodies and often leaving a legacy of phosphorus in sediments. Consequently, reduction in load can take a number of years to deliver benefit. We would like to understand how recovery time will be considered to ensure that costly measures are not sought where they are not needed. (Scottish Water)	We agree that more work is needed to understand recovery times. Once measures are put in place we will take this into consideration before planning further improvements.
We note that 'discharges' and 'sewage' are mentioned a number of times in the consultation documents yet agriculture, which inputs significant quantities of phosphorus and other plant nutrients to the water environment is not mentioned. (Scottish Water) The consultation documents highlight a great deal of uncertainty in the understanding of the relationships between average phosphorus concentrations in water and biology. The documents do not present an improved understanding of these relationships, nor do they assess the impact of peak phosphorus discharges which are typically associated with rainfall driven agricultural run off. (Scottish Water)	The work we have undertaken to improve phosphorus standards did not aim to improve our understanding of the relative importance of different sources.

Comments	Response
We were told at the workshop that only 4 sites from Wales where the requisite suite of biology and phosphorus sampling had been undertaken. This suggests that the Welsh Government will be asked to decide whether or not to accept UKTAG‟s recommendations without having a proper assessment of the scale of the resultant reduction in Wales‟ compliance with Good Status. The Minister has said publicly that his ambition is to achieve 50% of water bodies in Wales at Good Status by 2015[1]: we fear that UKTAG‟s recommendations could seriously undermine the achievement of this worthwhile goal. (Welsh Water)	It is not correct that only 4 sites from Wales were used. In comparison to data from England, there were fewer sites available for Wales where matched biology and phosphorus data were available, so UKTAG did not split these data. However 61 sites were used and revised tables showing the results for Wales and England will be provided in our final recommendation. These suggest that for Wales there will be an increase in the number of sites at Good status using the new default P standards once the new biology is taken into account. With current standards 29% of sites are good or better, but with the proposed default P standards and new biology, 58% will be good or better. An assessment of the implication for Wales was also provided as Table A6 in the document “A revised approach to setting Water Framework Directive phosphorus standards” summarises the current situation for Wales. According to this, 77% of sites in Wales will not change class as a result of the revised standards. Of Welsh sites currently classified as high or good status, 11.5% will be classified as moderate status or lower using the new standards.
Meeting UKTAG‟s standards might also imply that the Welsh Government and Natural Resources Wales will need to exert much greater control over agricultural practices if Good Status is to be achieved and/or maintained in Wales. Although UKTAG‟s consultation paper on phosphorus standards gives the clear impression that they will only impact point discharges, the Environment Agency‟s own data[2] show that whilst the sewerage sector accounts for about 48% of phosphorus in Welsh rivers, agriculture contributes almost as much, i.e. 45% (the proportions are very different in England). (Welsh Water)	The standards apply to all inputs of phosphorus, both diffuse and point source. We will amend the wording of our final recommendations to avoid any doubt over this.

Particularly given that a significant proportion of Wales' major rivers are Habitats Directive Special Areas of Conservation, we think there is a case for awaiting the development of a combined WFD and Habitats standard, rather than applying an interim standard pending agreement between the UK's environmental and conservation regulators. Such a postponement would have wider advantages for business planning within for sewerage sector and others. The Environment Agency and sewerage undertakers are already considering the programme of work that our industry should be required to carry out during 2015-2020 (AMP 6). The mismatch between Ofwat's periodic reviews and the WFD planning cycles means that, irrespective of UKTAG's latest proposals, there will be some residual uncertainty when Ofwat sets prices in 2014. This uncertainty will be compounded if UKTAG's revised standards are adopted for the next cycle, especially as so little seems to be known about the extent of Welsh waterbodies' current compliance. A delay would also enable an assessment of the benefits that will be delivered by the reductions of phosphates in detergents coming into force during the next few years. Other forms of source control, such as reducing phosphate in food additives, should also be examined. Only after these issues are fully explored should decisions be taken on expensive, energy intensive capital WWTW solutions: the sewerage industry's effort during AMP6 should, instead, be focussed on investigating the impact and practicality of the proposed standards, including in terms of disproportionate costs and technical feasibility. (Welsh Water)	UKTAG's proposals are for standards relevant to assessing and protecting the ecological status or potential of water bodies. The outcome of discussions about phosphorus standards for protected species and habitats will not affect our proposals. The proposal to assess the benefits from phosphorus reduction from other sources has been noted.

It can already be seen through the river basin plans how influential the current phosphorus tests are in the reporting of water bodies with water quality pressures. Tightening the standards as proposed will identify many more water bodies in this way without understanding whether or not phosphorus is the principle cause of a poor ecological status, or whether this is controlled by other (and the combination of different) pollutants in the water body. A lack of consistent biological and water quality monitoring data makes this almost impossible to discern in most locations. (Atkins) It will be critically important that the principle of basing investment decisions on the evidence of biological impact is defended (and care needs to be taken in defining this and the relevant metrics). For the polluter/customer/taxpayer to continue funding such investment the monitoring must be in place to measure the (potential) effectiveness of that investment. It is acknowledged that hysteresis means long term (pre and post investment) monitoring programmes need to be encouraged possibly following a principle of adaptive management. (Atkins) There is also some concern that there should be other indicators used to understand the biology better rather than just using the phosphorus level. (Northumbrian Water)	We agree that biological and water quality data are important and will continue to reflect this in the design of our sampling programmes. As part of our on-going work in this area, we plan to explore the effect of a wider range of factors that may influence biology

It was apparent from the workshop that the combination of changes in the biological (specifically diatom) standard as well as the phosphorus standard and resultant improved picture of compliance was cautiously welcomed by the water industry representatives. The policy of responding to evident ecological harm rather than phosphorus concentrations alone certainly seems appropriate, but then should we not be encouraging a focus on biological rather than phosphorus monitoring? (EDF Energy) .. we understand that at present biological and chemical monitoring data may not always be available. Complete datasets should be sought to progress decision-making, particularly where the existing data suggests that measures may be needed in the second cycle of RBMPs. We do not support the use of the default phosphorus standard alone to make decisions on whether or not to allow new discharges and identifying the scale of improvements required. (Energy UK)	We agree that biological and water quality data are important and will continue to reflect this in the design of our sampling programmes.
EDF Energy understands that at present biological and chemical monitoring data may not always be available. Complete datasets should be sought to progress decision-making, particularly where the existing data suggests that measures may be needed for existing or planned discharges. Further clarification is required on any proposed monitoring schedules and the potential timescales and cost implications this may have for the Regulator and industry.	UK TAG agrees that decisions should be based on comprehensive biological and chemical datasets.

Although the proposed standards are presented as being 'site-specific standards', the recent workshop seemed to conclude that it would have to be adopted on a water body level (or even as sub-catchment / catchment level). We therefore have some concerns / reservations with regards to how the standards will be implemented based both on the limited biology data available and how catchment based improvements would be assessed. (Northumbrian Water)	UK TAG will bear this comment in mind when developing strategies to implement the new standards.
Phosphorus problems may be long-standing, caused by long term inputs to water bodies and often leaving a legacy of phosphorus in sediments. Consequently, reduction in load can take a number of years to deliver benefit. We would like to understand how recovery time will be considered to ensure that costly measures are not sought where they are not needed. For example, where agricultural run off of phosphorus and other plant nutrients and minerals has resulted in impacts to the biological assemblage of a water body but this input has subsequently been reduced or ceased, how will this be captured to ensure that further measures are not sought unnecessarily? It is widely reported in literature that once measures have been undertaken with the aim to improve the condition of the biological assemblage in the water environment, improvements may not be seen for a number of years. The proposed methodology does not take account of this. (Scottish Water)	We recognise these issues but feel that they are aspects that should be considered when implementing the standards and should not affect the levels at which the standards should be set.

high levels of anthropogenic sources of phosphorus in rivers will present a significant challenge to meeting the requirements of Descriptor 5 in the Marine Strategy Framework Directive, the aim of which is to reduce human-induced eutrophication in marine waters, and which specifically mentions that the concentration of nutrients in marine waters is related to nutrient loads from rivers. (Wildlife and Countryside Link)	UK TAG has noted this concern.

Response to comments concerning relationship between biology and phosphorus and other stressors), overview followed by specific comments

Overview

Evidence that phosphorus concentrations influence ecology in running waters

A number of comments were received questioning the relationship between phosphorus and ecology in running waters. These questioned whether phosphorus is the key nutrient limiting productivity and the health of rive systems, whether linking phosphorus chemistry to the response of a limited selection of the biota was appropriate and how the standards related to other sources of phosphorus (e.g. in sediment porewaters).

Macrophytes and phytobenthos were used to derive the standards because we expect these to be the most sensitive to changes in inorganic nutrients. However, this does not mean that other groups of organisms were not involved. Assessment of macrophytes and phytobenthos takes place alongside that of invertebrates and fish to give an integrated picture of ecosystem health spanning several trophic levels. The report gives clear evidence of an association between phosphorus and ecology, both from cited literature (section 2) and analyses based on UK data. We can say with confidence that "good status" ecology is usually associated with low phosphorus concentrations whilst very high phosphorus concentrations are never associated with good ecology. However, the report also acknowledges high uncertainty in this relationship (see **statistical** below) and the possibility of co-limitation with nitrogen. The extent to which this association is based on a causal relationship between phosphorus and ecology is the subject of debate: there is clear evidence of changes in composition and biomass in controlled experiments (Bowes et al., 2007; Liess et al., 2009) and some evidence of changes in taxonomic composition and biomass in response to catchment-level changes (Bowes et al., 2012; Kelly et al., 2009; Suplee et al., 2012). Yet, examples also exist where nutrient reductions have had no obvious benefit (Jarvie et al., 2002; Kelly & Wilson, 2004).

Respondents also commented that the focus of regulation should be on recognising instances of ecological harm. There was concern that there will be situations where the existing biology is better than expected for a given phosphorus concentration and that the approach described by UKTAG would drive significant unnecessary investment to support an ecosystem that is already tolerant of the existing levels of phosphorus in the watercourse. We acknowledge, along with others

(Heathwaite, 2010; Harris & Heathwaite. 2012; Page et al., 2012) that many factors interact to determine health of river ecology and it is over-simplistic to assume a simple dose-response relationship between phosphorus and ecology. For this reason, UKTAG continues to recommend that expensive action to reduce phosphorus concentrations is taken only where there is evidence that the biology is adversely affected.

This links with the comments in the section on policy and regulatory aspects of the new standards, highlighting the need to see phosphorus standards as one part of a wider package of regulatory instruments which can be used to achieve good ecological status.

Bowes, M.J., Smith, J.T., Hilton, J., Sturt, M.M. & Armitage, P.D. (2007). Periphyton biomass response to changing phosphorus concentrations in a nutrient-impacted river: a new methodology for phosphorus target setting. Canadian Journal of Fisheries and Aquatic Science 64: 227-238.

Bowes, M.J., Gozzard, E., Johnson, A.C., Scarlett, P.M., Roberts, C., Read, D.S., Armstrong, L.K., Harman, S.A. & Wickham, H.D. (2012). Spatial and temporal changes in chlorophyll-a concentrations in the River Thames basin, UK: Are phosphorus concentrations beginning to limit phytoplankton biomass? Science of the Total Environment 426: 45-55.

Harris, G.P. & Heathwaite, A.L. (2012). Why is achieving good ecological outcomes in rivers so difficult? Freshwater Biology 57: 91-107.

Heathwaite, A.L. (2010). Multiple stressors on water availability at global to catchment scales: understanding human impact on nutrient cycles to protect water quality and water availability in the long term. Freshwater Biology 55: 241-257.

Jarvie, H.P., Lycett, E., Neal, C. & Love, A. (2002). Patterns in nutrient concentrations and biological quality indices across the upper Thames basin, UK. Science of the Total Environment 282-283: 263-294.

Kelly, M.G., Haigh, A., Colette, J. & Zgrundo, A. (2009). Effect of environmental improvements on the diatoms of the River Axe, southern England. Fottea 9: 343-349.

Kelly, M.G. & Wilson, S. (2004). Effect of phosphorus stripping on water chemistry and diatom ecology in an eastern lowland river. Water Research 38: 1559-1567.

Liess, L., Lange, K., Schulz, F. Piggott, J.J., Matthaei, C.D. & Townsend, C.R. (2009). Light, nutrients and grazing interact to determine diatom species richness via changes to productivity, nutrient state and grazer activity. Journal of Ecology 97: 326-336.

Page, T., Heathwaite, A.L., Moss, B., Reynolds, C., Beven, K.J., Pope, L. & Willows, R. (2012). Managing the impacts of nutrient enrichment on river systems: dealing with complex uncertainties in risk analysis. Freshwater Biology 57: 108-123.

Suplee, M.W., Watson, V., Dodds, W.K. & Shirley, C. (2012). Response of algal biomass to large-scale nutrient controls in the Clark Fork River, Montana, United States. Journal of the American Water Resources Association 48: 1008-1021.

Role of nitrogen

The relevance of using a phosphorus standard in isolation, when there is also evidence of nitrogen limitation under some circumstances was also questioned. UK TAG acknowledges the importance of nitrogen in determining the condition of freshwater ecosystems. There is evidence that primary production in some water bodies in the UK and elsewhere may be limited by nitrogen rather than phosphorus (Maberley et al., 2003; Marcarelli et al., 2008), as well as a growing body of evidence that co-limitation is widespread (see Mainstone, 2010 and references therein). UK TAG is planning to explore the potential for and feasibility of developing complementary N standards for some or all categories and types of fresh waters

Maberley, S.C., King, L., Gibson, C.E., May, L., Jones, R.I., Dent. M.M. & Jordan, C. (2003). Linking nutrient limitation and water chemistry in upland lakes to catchment characteristics. Hydrobiologia 506-509: 83-91.

Mainstone, C.P. (2010). An evidence base for setting nutrient targets to protect river habitat. Natural England Research Report NERR034. Natural England, Peterborough.

Marcarelli, A.M., Bechtold, H.A., Rugenski, A.T. & Inouye, R.S. (2008). Nutrient limitation of biofilm biomass and metabolism in the Upper Snake River basin, southeast Idaho, USA. Hydrobiologia 620: 63-76.

UK approach to assessing ecological status

Respondents commented that a more holistic approach is needed, building on current science understanding of the impact of multiple stressors on whole system ecology if mitigation and management is to be properly targeted. The phosphorus standards are based on an understanding of ecological status that is shared across Europe (Birk et al., 2012). The European Commission organised an intercalibration exercise for all biological methods to ensure that the high/good and good/moderate boundaries were comparable (Birk et al., 2013). Discussions during this exercise enabled UK experts to compare approaches with those adopted in other member states and we are confident that our methods respond as any to changes along gradients of human pressure. UKTAG agrees with the need for a holistic approach and emphasises that the proposed standards for phosphorus are one building block in this holistic approach, alongside assessment of the biology.

Birk, S., Bonne, W., Borja,A., Brucet, S., Courrat, A., Poikane, S., Solimini, A., van de Bund, W., Zampoukasb, N. & Hering,D. (2012). Three hundred ways to assess Europe's surface waters: An almost complete overview of biological methods to implement the Water Framework Directive. Ecological Indicators 18: 31-41.

Birk, S., N.J. Willby, M.G. Kelly, W. Bonne, A. Borja, S. Poikane and W. van de Bund. (2013). Intercalibrating classifications of ecological status: Europe's quest for common management objectives for aquatic ecosystems. Science of the Total Environment (in press)

Specific response to comments concerning relationship between biology and phosphorus and other stressors),

Comments	Response
There has never been any convincing case presented, nor any convincing data demonstrating that P is the key nutrient limiting the productivity, nor the health of river systems. Linking P chemistry to the response of a limited selection of the biota tells us nothing about whole ecosystem health. Macrophytes, for example, acquire their nutrient resource from sedimentary porewaters where P concentrations may be high, access to atmospheric or water column N will be limited,and flow velocities may be key to controlling the species composition and relative abundance. The basic premise of the classification of ecological status in rivers based on P standards is fundamentally flawed and scientifically indefensible. Until this is addressed openly, there will continue to be mismatches betwen P standards and expressed ecology in UK rivers, undermining scientific credibility of the WFD process, public confidence and stakeholder engagement in the process, and misleading efforts and substantial investment in point source and diffuse source mitigation measures (University of Reading).	See Summaries of our responses We accept the broad point that river ecology is controlled by a number of factors but we feel that this overstates the point. Our four academic reviewers all agreed that the proposed default standards were more closely aligned with the wider ecological literature. These standards were never intended to classify ecological status in rivers but to provide realistic targets for the attainment of good ecological status. We note the potential importance of nitrogen and other factors such as water quantity and will consider these during further developments of approaches to the management of ecological status
A more holistic approach is required, which builds on current science understanding of the impact of multiple stressors on whole system ecology if mitigation and management is to be properly targeted and effective, and public and private sector investment in these measures is to be properly and effectively deployed. (University of Reading)	See Summaries of our responses We agree that a holistic approach is required, but believe that with the current state of knowledge and availability of tools the use of the proposed phosphorus standards will assist in the management of a key pressure on the water environment.

Comments	Response
It is widely known that confounding factors, which include but are not limited to the presence of other nutrients such as nitrate and potassium, mineral content, stream bed composition, flow, shade, oxygen level and temperature have a significant effect on the relationship between phosphorus and biology. These relationships remain poorly understood. It is imperative that work is undertaken to better understand these. If the only factor in these complex relationships that is pursued is phosphorus, costly investment will be driven but little or no benefit will be achieved. A holistic approach must be undertaken, which takes into account all of the factors involved. (Scottish Water)	See Summary of our responses. We also plan to do further work on these issues during the 2nd cycle of the WFD
As a minimum, UK needs to fall in line with the rest of Europe and derive meaningful N standards for UK waters. (University of Reading) The absence of N standards remains very problematic however. (James Hutton Institute)	UKTAG intends to review the need for nitrogen standards as part of its future work programme.

Comments	Response
The default standards that have been developed, whilst being more site specific and not being based on broad river types, are similar to the existing standards in that confirmation of the required standard for a particular watercourse is based on its alkalinity and altitude, with no reference to the observed biology, which may be better or worse than expected. Where the existing biology is better than expected, such an approach would drive significant unnecessary investment to support an ecosystem that is already tolerant of the existing levels of phosphorus in the watercourse. In the opposite situation significant investment would be made and potentially no benefits delivered. (United Utilities)	Our proposed default standards are derived from a general relationship between change in biology and change in phosphorus from an expected condition. See our summary of responses concerning the uncertainty in this relationship.
It can already be seen through the river basin plans how influential the current phosphorus tests are in the reporting of water bodies with water quality pressures. Tightening the standards as proposed will identify many more water bodies in this way without understanding whether or not phosphorus is the principle cause of a poor ecological status, or whether this is controlled by other (and the combination of different) pollutants in the water body. A lack of consistent biological and water quality monitoring data makes this almost impossible to discern in most locations. (United Utilities)	We agree that adjusting to a tighter standard should only be considered when there is confidence that the biology is not affected by other pressures. As we further explore the potential to apply the biology-based checking procedure, we will take this point into account. Where we have inadequate data we will ensure that these data are collected in future monitoring programmes.
Causal links with biology? (Atkins)	See Summaries of our responses
Focus should be on ecological harm (Atkins)	See Summaries of our responses
[Criticisms of underlying biological standards] JHI	See Summaries of our responses
there are difficulties in applying this approach due to a lack of representative monitoring data and information to robustly identify the causative link between discharges to river and the biological impacts (United Utilities)	See Summaries of our responses

Comments	Response
Using phosphorus as a proxy for the assessment of status makes the assumption from the outset that phosphorus is the key factor in this complex relationship. Scientific literature and data do not support this. Phosphorus concentrations can however, be useful to identify lengths of water body that require a closer review. (Scottish Water)	See Summaries of our responses
Support use of assessment tool to consider shading, substrate type and nitrogen on macrophytes ... [Anglian]	UK TAG will investigate this possibility.
It is UKTAG's view that the reasons for this poor relationship are likely to include other factors affecting the biology/ecology, sunlight and nitrogen in particular being cited, and this appears probable to us. Another factor which we understand is established as being critical regarding the potential for elevated P to have an impact is low flow velocity - and headwaters are generally narrow and consistently fast flowing. Unfortunately, it appears that UKTAG is not yet in a position to identify and relate the various contributing factors which appear to be confounding the phosphorus/biology relationship. (NFU Watercress Ass.)	UKTAG will investigate this possibility in work to develop a tool kit
Whilst effectively acknowledging that a multi-factorial relationship may exist, at least at some sites, the consultation makes no reference to the academic disagreement surrounding its approach of seeking to establish a simple relationship between phosphate and biology/ecology. We understand that a multi-factorial approach is usual in mainland Europe, and a similar approach may be appropriate for the UK. (NFU Watercress Ass.)	See Summaries of our responses

Comments	Response
Chemical standards under WFD are largely, but not exclusively, a means to the end of achieving appropriate ecological objectives rather than being objectives in themselves. The consultation recognises this and we support UKTA|G's recommendation that expensive measures are not incurred on the basis of chemical standards alone without supporting biological information. (NFU Watercress Ass.)	This is, indeed, the intention.
The methodology for setting phosphorus standards described in the consultation seems not to recognise that some rivers naturally contain 'elevated' concentrations of phosphorus. One example is the Hampshire Avon, parts of which have attracted international designation (SAC) for its ecological interest and value, despite the natural phosphorus. A source of phosphate in the Avon catchment is the greensand aquifer within the Wylie tributary. Levels of phosphate released from greensand have been studied and reported on by Giles Bryan (Environment Agency). (NFU Watercress Ass.) For example, sandstone (with siliceous cement) may weather as fast as calcareous rocks and release a similar flux of P for a very different alkalinity. How can we be sure that the model is not biased by the choice of reference sites? Lowland, alkaline rich stream are likely to be more impacted in the selection of reference sites than upland, base poor streams. A table with proportion of land cover and other chemical attributes for the reference sites would help give more context. (James Hutton Institute)	No general method for estimating reference phosphorus concentrations can be error free. Where the method underestimates phosphorus concentrations, this may produce misclassifications of nutrient status. Overtime, we expect our ability to reliably estimate reference conditions to improve. We recommend that the likelihood of erroneous downgrades is taken into account before action to reduce phosphorus concentrations is considered
There concern that some of the biological tests are deliberately seeking to remove aspects that respond to other pressures. Those other pressures are (from the correlations) clearly relevant to and highly influential on the biological indicator species, but if those pressures are not felt to be sufficiently relevant then why not focus on phosphorus measurements only Atkins	In developing biological tools UKTAG aimed to produce pressure specific responses to aid subsequent management. However UKTAG are aware that the biological tools will also be sensitive to other pressures and that ecological status needs to be determined by a combination of metrics

Comments	Response
It is imperative that measures to improve water body status are based on sound science and will deliver a known and measurable benefit. The likelihood of improvements to the status class of water bodies following the implementation of measures has not been presented. (Scottish Water)	See Summary of our responses
The aim of the Water Framework Directive is to prevent deterioration and restore water bodies to Good Status. Using phosphorus as a proxy for the assessment of status makes the assumption from the outset that phosphorus is the key factor in this complex relationship. Scientific literature and data do not support this. Phosphorus concentrations can however, be useful to identify lengths of water body that require a closer review. (Scottish Water)	See Summary of our responses

Specific comments: statistical basis for model

Comments	Response
Alkalinity is too variable to use as a predictor (Thames Water) .. the use of an equation requiring altitude and alkalinity data will make the computation of standards for comparison with modelling results more complex and more prone to miscalculation. (Atkins)	The intention is to use long-term average alkalinity for a site, in order to iron-out short-term fluctuations. Alkalinity, therefore, will be a site-specific constant in any calculations.
The utility of some of the 'correlations' is perhaps questionable...	The correlations are supported by evidence of causal relationships (see summary of our responses: biological ...)

Comments	Response
The consultation however refers to unexplained error and uncertainty in the model which may lead to a site misclassification, These uncertainties shole be explored further and satisfactorily addressed before the new method is approved or adopted. The inherent uncertainties underpinning UKTAG‟s recommendations strengthen the case for reconsidering whether now is the right time to press ahead with the introduction of more stringent standards. For the reasons given below, Dŵr Cymru believes that these uncertainties are too great to warrant the adoption of these standards in the next WFD cycle and, in particular, cannot justify the implied levels of investment. The uncertainties bolster the disproportionate cost argument under the WFD – for agriculture as well as the sewerage sector. (Welsh Water)	See summary of our responses
How representative are the datasets from which standards were derived? (Anglian)	The standards were derived from datasets spanning all of the UK and several years of data. Quality Assurance systems are in place for both chemical and biological analyses.
Standards are still based solely on the altitude and alkalinity of the receiving watercourse without consideration of the current biological status (United Utilities)	Our proposed default standards are derived from a general relationship between change in biology and change in phosphorus from an expected condition
“We were told at the workshop that there are only four sites in Wales where the requisite suite of phosphorus and biology sampling had been undertaken, so the dataset was too small to extrapolate a Wales-wide picture.”	This is a miss understanding. In our summary statistics 62 sites from Wales were included. We felt that these were too few to provide reliable summary statistics, but we have provided these data in tables in our final recommendations

Comments	Response
The approach taken to reduce mismatches is not appropriate since it makes the assumption that mismatches are a result of the phosphorus standard being too lax. Evidence of this has not been presented. (Scottish Water)	See summary of our responses. We agree that standards tighter than the default standard would not be appropriate unless there was good evidence that the biology was not impacted by other pressures.
The aim of the work that has been carried out by UKTAG appears to have been to reduce the number of mismatches between phosphorus and biology status classes. The reduction in mismatches would be an improvement if it were as a result of an improved understanding between phosphorus concentration and biology. However, the way in which it has been achieved is through tightening phosphorus concentrations in the water environment and making the associated biological assessment more lax. (Scottish Water)	It is true that the model has only provided a small improvement in uncertainty. However the approach makes this uncertainty more transparent and establishes a default standard that reduces the current bias.
At the workshop we learnt that UKTAG has only a 50% certainty that the achievement of the proposed phosphorus standards will deliver Good Status. (Welsh Water)	This is an improvement over the situation for phase 1 standards where certainty is only 10%
There are particular uncertainties surrounding the implications for Wales. (Unlike for Scotland and Northern Ireland) the phosphorus consultation paper includes no separate assessment of the impact on Wales‟ non-compliance with WFD. We were told at the workshop that there are only four sites in Wales where the requisite suite of phosphorus and biology sampling had been undertaken, so the dataset was too small to extrapolate a Wales-wide picture. (Welsh Water)	Table A6 in the document “A revised approach to setting Water Framework Directive phosphorus standards” summarises the current situation for Wales. According to this, 77% of sites in Wales will not change class as a result of the revised standards. Of Welsh sites currently classified as high or good status, 11.5% will be classified as moderate status or lower using the new standards.

Comments	Response
Phosphorus concentrations in water bodies can be very low yet biology is found to be impacted. In others the reverse is found. Additionally, according to table 5 of the consultation document, at 75% of sites across the UK there are classification mismatches. These examples suggest that phosphorus is rarely the key factor in the relationship. (Scottish Water)	See general comments. Our modelling shows that phosphorus explains 33% of the variation which is highly significant.
We note that the proposed default standards are not based on an improved understanding of the relationship between phosphorus and biology but are simply a tightened version of the existing standards, with the aim being to reduce mismatches. As detailed above, we do not support the approach of using phosphorus to determine status. We are concerned that the use of annual mean concentrations to determine reference conditions and site specific phosphorus standards is too simplistic and does not represent the full range of conditions that drive eutrophication. Agricultural run off contributes significant amounts of phosphorus and other plant nutrients and minerals to the water environment. Average concentrations of phosphorus could be significantly elevated by sampling events which incorporate agricultural run off. Examples such as these could be the cause of mismatches between phosphorus and biology status. This could also be the case where agricultural run off impacts biology but is not captured by sampling. (Scottish Water)	The use of annual mean P to summarise the P status of a site gives a good summary of conditions that can be extended to almost all water bodies in the UK. However, we agree that there will be instances where high P events are missed. This is one reason why we are proposing that biological evidence of failure is required before expensive measures are taken.

Comments	Response
The proposal that phosphorus will automatically be assumed to be non–problematic when below Good status, where overall biology is considered of Good Status (or High), is **unacceptable**. In some instances, few biological indicators have been tested to determine overall biological status, and therefore this assumption with respect to phosphorus is potentially misleading. This is not a precautionary approach, and assumes too much understanding of the impact of phosphorus on biology. Specifically, we are **very concerned** by the idea that the phosphorus standard can be weakened to allow higher phosphorus concentrations in the water on the basis that overall biology is currently Good. There is insufficient evidence about the relationships between running water chemistry and biology, not least because there may be a significant time-lag between enrichment and plant response or other factors that may shift triggering the response. (Wildlife & Countryside Link)	Noted ...

General comments: reference conditions

The ability to estimate the phosphorus concentrations expected in the absence of human pressures in a catchment lies at the heart of the modelling process. We received divergent comments on the appropriateness of the reference setting process.

The WFD defines reference conditions as "…. representing the values of the biological quality elements …. for that surface water body type at high ecological status…" (Annex 2, clause 1.3). It goes on to define high ecological status as having "…. no, or only very minor , anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions" and "…. values of biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion." The phrase "no, or only very minor, anthropogenic alterations" offers many possible interpretations. We recognise that no sites in UK are truly pristine due to long history of human engagement with the landscape. The question that arises is how much deviation is

appropriate within a fair interpretation of "... only very minor ...". The intercalibration exercise also raised two practical problems: first, that the process of comparing status class boundaries requires that all Member States agree on the baseline from which deviations are measured. This means that the definition of reference conditions must be consistent amongst Member States. The second issue is that reference conditions provide the denominators in EQR calculations and therefore must be based on statistically-robust datasets. Recognition of these problems during the first round of intercalibration led to establishment of a common set of rules by which reference sites were selected for the second round (Pardo et al., 2012; Birk et al., 2013).

UKTAG notes that no viable alternative methods for establishing reference conditions emerged in either the peer or stakeholder reviews. Two alternative approaches were suggested: Dodds and Oakes (2004) established regressions between nutrient concentrations and land use and used the intercept on the y axis as an estimate of concentrations in the absence of human activities. This assumes that streams can be divided into well-defined "types and that there are no natural variations in expected nutrients within a "type" (which is inconsistent with the River Continuum Concept) and yielded relationships which were, in many cases, no stronger than those obtained in this exercise. Baatrup-Pedersen et al. (2008) explored the possibility of using less impacted streams elsewhere in Europe to establish a reference network for Danish streams. A similar approach was explored by the UK team. However, it is questionable whether a body of near-pristine reference sites exists with biogeographical conditions that are directly comparable with lowland UK, as Baatrup-Pedesen et al. (2008) claim to have found for Denmark. Again, we do not believe that this approach is suitable for establishing reference conditions on the scale required for UK. Nonetheless, both of these approaches may have value as supplementary forms of validation.

We believe that it is important to recognise that the complex interactions between the landscape, climate and man throughout the Holocene means that all discussions about reference conditions involve, to some extent, extrapolation and speculation. There has been, as a consequence, a gradual evolution in the understanding of reference sites in the UK, from pioneering efforts which selected the "best available" from the contemporary monitoring network (Armitage et al., 1984) through to more explicit recognition of the role of nutrients (Kelly et al., 2008 and phase 1 standards) to eventual adoption of the common EU approach for this phase. The principal merit of the UK approach is that it is shared by all other EU states. Nonetheless, it is important not to overstate the importance of reference conditions in the overall process: the good/moderate status boundary for both the macrophytes and diatoms is set by a method that is independent of the reference conditions.

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Baattrup-Pedersen, A., Springe, G., Riis, T., Larsen, S.E., Sand-Jensen, K., Kjellerup Larsen, L.M. (2008). The search for reference conditions for stream vegetation in northern Europe. Freshwater Biology 53: 1890-1901.

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Intercalibrating classifications of ecological status: Europe's quest for common management objectives for aquatic ecosystems. Science of the Total Environment (in press)

Dodds, W.K. & Oakes, R.M. (2004). A technique for establishing reference nutrient concentrations across watersheds affected by humans. Limnology and Oceanography: Methods 2: 333-341.

Kelly, M., Juggins, S., Guthrie, R., Pritchard, S., Jamieson, J., Rippey, B., Hirst, H. & Yallop, M. (2008a). Assessment of ecological status in U.K. rivers using diatoms. *Freshwater Biology*, 53: 403-422.

Pardo, I., Gómez-Rodríguez, C., Wasson, J.-G., Owen, R., van de Bund, W., Kelly, M., Bennett, C., Birk, S., Buffagni, A., Erba, S., Mengin, N., Murray-Bligh, J., Ofenböeck, G. (2012). The European reference condition concept: A scientific and technical approach to identify minimally-impacted river ecosystems. Science of the Total Environment 420: 33-42.

Specific comments – Reference conditions

Comments	**Response**
It is not clear how the 116 reference sites (114 sites in the statistical analyses) were chosen for the development of the P standards: e.g Pardo et al (2012) worryingly interpreted catchment areas with up to 50% intensive agriculture and excessive nutrient concentrations as (near) natural conditions. (James Hutton Institute)	This statement is based on a misinterpretation of Pardo et al. (2012). See summary of our responses
We understand that the reference conditions are meant to be "an estimate of the natural condition of the site". However, natural conditions are not defined. If the aim is to define the condition of the site as untouched by humans, the equations should take into account shade and environmental change. Greater shading as a result of tree cover and a cooler climate would significantly decrease the sensitivity of water bodies to phosphorus. Additionally, the assessment does not take account of the phosphorus which is bound to sediments in the stream bed but leaches into the water column as soluble reactive phosphorus. (Scottish Water)	The primary purpose of reference conditions is to determine a base line status from which change caused by anthropogenic pressure can be measured. Our modelling demonstrated the importance of alkalinity and altitude as natural factors influencing the plant community. We acknowledge that other factors such as shade may influence responses at the site scale and in future work we will explore the potential for inclusion of such additional factors in future models.

Comments	Response
Critical to the effective implementation of the WFD is the correct description of reference conditions. This requires that the sites chosen as references at least fulfil the criteria put forward by Pardo *et al*. (2012).[2] However, we are **concerned** to find that the England and Wales samples have not been subject to this procedure due to lack of resources. (Wildlife & Countryside Link)	To ensure that unscreened sites were not influenced by significant other pressures, supplementary biological screening was undertaken of all putative reference sites (based on biotic screening) to ensure that sites with abnormally low numbers of species, high overall cover, high algal cover, or established populations of invasive species were excluded.. In addition the biology in reference sites was modelled initially only for those sites that met the strict abiotic screening. This model was then extrapolated to determine the expected scores for sites lying beyond the envelope of conditions covered by the existing population of reference sites. The position of candidate but unscreened reference sites was then compared with their expected position based on the extrapolated model. Since these sites were found to fall within the error of the existing model they were included as reference sites. In practice by themselves they have little influence on the model, merely confirming that extrapolation within sensible limits generates values that are observable in practice.
Given that reference conditions for such rivers are likely to vary from that predicted by UKTAG's generalised approach, the apparent lack of adequate understanding of natural conditions in individual rivers is at risk of leading to misclassification of water bodies and hence the setting of inappropriate objectives. (NFU Watercress Ass.)	UKTAG believes that understanding of reference conditions is adequate for most river types in UK although it accepts that there may be a small number of stream types where more work is still needed on this issue.

General comments: conservation objectives

UKTAG recognises concerns expressed about the absence of a clear strategy for establishing phosphorus standards for protected sites in the current proposals. This is the subject of ongoing discussions.

Comments	Response
We are **very concerned** about the ongoing failure to take action to meet the standards applied by the conservation agencies to protect the highest quality Protected Areas, e.g. Special Areas of Conservation and Special Protection Areas. (Wildlife & Countryside Link)	See General comments: conservation objectives
As part of its justification of the review of the phosphorus standard, UKTAG‟s consultation paper says, “The... need to reach agreement on standards with the UK conservation agencies led to this topic being revisited by UK TAG...” However, elsewhere the report concedes that, “in carrying out this work a comparison was also made with phosphorus targets developed by the UK conservation agencies for protecting river habitat in rivers with special wildlife designations...further work is required before clear recommendations can be made. This will be taken forward, together with a similar review of lake P standards and is not included in this extract report.” Thus we can expect a further revision of the phosphorus standard to be applied to many of the major rivers in Wales – again this compounds uncertainty. Against that background, the Welsh Government may want to opt for further research in Wales. Much more baseline data needs to be collected if Welsh Government is to be in a position to understand the impact that the proposed standards would have on Wales‟ non-compliance with Good, including the Minister‟s 50% goal. Collection of that data should be a priority for Natural Resources Wales in the WFD‟s second cycle. Particularly given that a significant proportion of Wales‟ major rivers are Habitats Directive Special Areas of Conservation, we think there is a case for awaiting the development of a combined WFD and Habitats standard, rather than applying an interim standard pending agreement between the UK‟s environmental and conservation regulators.(Welsh Water)	See General comments: conservation objectives

General comments: phosphorus analysis

Three respondents were critical to the method used to analyse phosphorus. Molybdate-reactive phosphorus is measured in unfiltered samples, resulting in a determinand that is not consistent with the common understanding of "soluble reactive phosphorus" (SRP). In recognition of this, we refer to the determinand as "(molybdate) reactive phosphorus" or "RP" (Note that the analytical method has not changed since the earlier phosphorus standards and reference there to "SRP" was erroneous. The standards are based on RP rather than SRP because a large quantity of data are available from all over the UK for this determinand.

Comments	Response

Comments	Response
The measurement of SRP should be more rigorous; requiring sample filtration and a well defined methodology including timing the addition of reagent and a specified interval for colour development. The definition of RP seems much too ambiguous. The use of ICP or ICPMS for total phosphorus is challenging with standard approaches often being inadequate and sophisticated ones being too empirical and complex. An agreement to define an analysis protocol based on colorimetry for rivers would be welcomed. (Atkins) We have long been concerned that Agency standard procedure does not involve filtration of samples when analysing for reactive phosphate. The inclusion of lighter particulate suspended matter in the analysis can cause individual results to substantially exceed results for filtered samples, as has been demonstrated by members of the Association in data which has been shared with the Agency. [and more ...] (NFU Watercress Ass.) In its previous consultation on phosphorus standards UKTAG explicitly advocated the use of SRP (ie filtered). We recognise there are cost implications of including filtration, but we understand that Agency practice is out of line with that of other environmental regulators in Europe. (NFU Watercress Ass.) Accordingly we take the firm view that if the Agency persists in using unfiltered determinations, the results should be considered indicative and should not be used for setting standards or for enforcement where accuracy is required. This would be in accordance with the UKTAG recommendation that samples be filtered where necessary to ensure the accuracy of the method. (NFU Watercress Ass.)	Standards are based on the data we have, which is mostly unfiltered molybdate-reactive P

Comments	Response
Accordingly we take the firm view that if the Agency persists in using unfiltered determinations, the results should be considered indicative and should not be used for setting standards or for enforcement where accuracy is required. This would be in accordance with the UKTAG recommendation that samples be filtered where necessary to ensure the accuracy of the method. (NFU Watercress Ass.) We would also point out that in the past the Agency have repeatedly informed the watercress industry that phosphorus would be regulated as SRP. As a consequence, growers have adopted regimes to accommodate SRP, not TRP. (NFU Watercress Ass.)	
We are concerned that the use of annual mean concentrations to determine reference conditions and site specific phosphorus standards is too simplistic and does not represent the full range of conditions that drive eutrophication. (Scottish Water)	Currently UKTAG believe that annual means provide the most robust evidence to assess status. Examination of available data (see Appendix 2 of the UKTAG report "A revised approach to setting Water Framework Directive phosphorus standards.) demonstrated that over the majority of the range of P seasonal and annual mean values were highly correlated and of a similar value. At lower concentrations (<150µg/L) growing season means were less than annual means.