UKTAG River Assessment Method

Phosphorus

River Phosphorus Standards

by

Water Framework Directive – United Kingdom Technical Advisory Group (WFD-UKTAG)

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Health and safety statement

WARNING. Working in or around water is inherently dangerous; persons using this standard should be familiar with normal laboratory and field practice. This published monitoring system does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory guidelines.

It is also the responsibility of the user if seeking to practise the method outlined here, to gain appropriate permissions for access to water courses and their biological sampling.

UKTAG Guide to River Phosphorus Standards

1. Introduction

This method statement describes how to determine the WFD class boundary values for the supporting element phosphorus in rivers. UKTAG first made recommendations on phosphorus standards for rivers in 2008 (UKTAG 2008). Those standards have been revised for RBP Cycle 2 to ensure they are in line with changes made to the assessment of the biological elements macrophytes and phytobenthos (UKTAG 2013a). The new standards are calculated on a *site specific* basis.

Phosphorus standards are used in managing the risk of adverse ecological impacts. Where rivers are already adversely affected, phosphorus standards (as class boundary values) can indicate the likely degree to which phosphorus concentrations would need to be reduced (e.g. by reducing concentrations in discharges) to improve ecological quality. Where a new discharge is proposed, phosphorus standards can indicate whether or not the river is likely to be able to accommodate the additional inputs without significant risk of adverse ecological effects.

The relevant standards for nutrients must also be met for a river to be classed as being at good or high ecological status. Although boundary values for moderate/poor and poor/bad status have been derived, to inform management decisions, these do not drive overall classification of status below moderate, as this is determined only by the status of biological elements.

2. Phosphorus standards

The phosphorus standards (class boundary values) for a site are calculated using the equations below. The standards are expressed as the boundary between each status class, and this value represents the phosphorus concentration required to support biological status in each class. Thus the terms “standard” and boundary value” are used interchangeably – e.g. the High/Good boundary value represents the phosphorus concentration that must be achieved for the water body to be in High status. More details on the derivation of the standards are given in UKTAG (2013b). The equations produce standards in the form of *annual mean concentrations* of reactive phosphorus in µg/l.

“Reactive phosphorus" means the concentration of phosphorus as determined using the phosphomolybdenum blue colorimetric method. Where necessary to ensure the accuracy of the method, samples are recommended to be filtered using a filter not smaller than 0.45 µm pore size to remove gross particulate matter[1].

The calculations can be carried out manually, but a calculator spreadsheet in MS Excel has

[1] Previous UKTAG standards were referred to as soluble reactive phosphorus (SRP). Most analyses by UK agencies are of molybdate reactive phosphorus in unfiltered samples from which large particles have been allowed to settle and referred to here as “reactive phosphorus” (RP). In practice, the difference between RP and SRP is usually minor.

been created to aid the calculation process for multiple sites. The most recent version of this spreadsheet is available on the UKTAG website.

NB: As revisions are likely to be made and the calculator updated over time, it is important to check that the most recent version is being used.

2.1. Calculation of the site specific reference value

"Reference phosphorus" means the reactive phosphorus concentration at near natural conditions, and is estimated from:

Reference phosphorus = 10^(0.454 ($\log_{10}$alk) – 0.0018 (altitude) + 0.476)

Where:
"Alk" is mean alkalinity, expressed as $CaCO_3$ in mg/l.
For sites with an alkalinity greater than 250 mg/l $CaCO_3$, alkalinity is set to 250. For sites with an alkalinity less than 2mg/l $CaCO_3$, it is set to 2.

"Altitude" is the site's altitude above mean sea level, in metres.
For sites with an altitude greater than 355 metres, altitude is set to 355 metres.

If the predicted value of reference phosphorus is < 7 µg/l, reference phosphorus value is set to 7 µg/l.

Note: The alkalinity value should be fixed for each site, it should be the long-term average for the site and it is assumed it represents the natural (reference) alkalinity. Care should thus be taken to check that sites are not significantly influenced by discharges, particularly in lower alkalinity rivers or ones with high proportions of effluent. Ideally the alkalinity value used for a site should be the same as that used for biological tools, and should be derived from a minimum of one year of monthly sampling, as alkalinity will vary with season. The alkalinity is used as a surrogate for catchment geology and thus natural fertility, site altitude is taken as a surrogate for stream energy.

2.2. Calculation of the site specific boundary values

The values (in ug/l reactive phosphorus) for the site specific High/Good, Good/Moderate. Moderate/Poor and Poor/Bad class boundaries are calculated from the following equations:

a) High/Good Standard = 10^((1.0497 x $\log_{10}$ (0.702)+1.066) x ($\log_{10}$ (reference Phosphorus)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

b) Good/Moderate Standard = 10^((1.0497 x $\log_{10}$ (0.532)+1.066) x ($\log_{10}$ (reference Phosphorus)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

c) Moderate/Poor Standard = 10^((1.0497 x $\log_{10}$ (0.356)+1.066) x ($\log_{10}$ (reference Phosphorus)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

d) Poor/Bad Standard = 10^((1.0497 x $\log_{10}$ (0.166)+1.066) x ($\log_{10}$ (reference Phosphorus)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

Where reference Phosphorus is calculated from the equation given in (2.1) above and is expressed in ug/l P

2.3 Assessment of phosphorus status

Phosphorus status is assessed by comparing measured phosphorus data with the derived standards. Samples for analysis of reactive phosphorus should be collected from a location representative of the water body being assessed. In complex water bodies, with multiple potential phosphorus sources, more than one sampling station may be necessary. Samples should ideally be taken at evenly spaced intervals e.g. monthly, over the course of a year or years. Sampling and laboratory analysis should conform to relevant CEN/ISO standards.

Confidence of classification for supporting elements such as phosphorus should be reported, and is calculated using standard procedures for water quality assessments.

3 Example Calculation

3.1 Determine the mean alkalinity and altitude of the site:

Mean alkalinity of site = 22.0 mg/l $CaCO_3$

Altitude of site = 115.0 m

3.2 Calculate the **reference phosphorus:**

Reference P = 10^(0.454 ($\log_{10}$(22.0) – (0.0018 x 115) + 0.476

Reference P = **7.6 µg/l** (this value is > 7.0 and so does not need to be re-set to 7.0)

3.3 Calculate the phosphorus standard for the lower class boundary of ***High*** status (i.e. the High/Good boundary)

H/G Boundary P = 10^((1.0497 x $\log_{10}$ (0.702)+1.066) x ($\log_{10}$ (7.6)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

H/G *Boundary P* =13.6, rounded to **14.0 µg/l**

3.4 Calculate the phosphorus standard for the lower class boundary of ***Good*** status (i.e. the Good/Moderate boundary)

G/M *Boundary P* = 10^((1.0497 x $\log_{10}$ (0.532)+1.066) x ($\log_{10}$ (7.6)- $\log_{10}$(3,500)) + $\log_{10}$(3,500))

G/M *Boundary P* =29.36, rounded to **29.0 µg/l**

3.6 Calculate the phosphorus standard for the lower class boundary of ***Moderate*** status (i.e. the Moderate/Poor boundary)

M/P *Boundary P* = 10^((1.0497 x $\log_{10}$ (0.356)+1.066) x ($\log_{10}$ (7.6)-$\log_{10}$(3,500)) + $\log_{10}$(3,500))

M/P *Boundary P* =90.9, rounded to **91.0 µg/l**

3.6 Calculate the phosphorus standard for the lower class boundary of ***Poor*** status (i.e. the Poor/Bad boundary)

P/B*Boundary P* = 10^((1.0497 x $\log_{10}$ (0.166)+1.066) x ($\log_{10}$ (7.6)-$\log_{10}$(3,500)) + $\log_{10}$(3,500))

P/B *Boundary P* =767.9, rounded to **768.0 µg/l**

4 References

UKTAG (2008); UK Environmental Standards and Conditions; (Phase 1); Final report (SR1 –2006), April 2008.
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http://www.wfduk.org/sites/default/files/Media/UKTAG%20Phosphorus%20Standards%20for%20Rivers_Final%20130906_0.pdf