water framework directive

Environment Agency

Method statement for the classification of surface water bodies v3

(2012 classification release)

Monitoring Strategy
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Monitoring Strategy briefing note

1. Purpose of this document

This document sets out the classification methodology for classifying surface water bodies under the Water Framework Directive (WFD). It is intended to provide an overview of the process and does not go into detail on how specific tools or classification databases work.

Documents explaining the methods for classifying groundwater bodies, both chemical and quantitative, are available on our website.

1.1. Version control and updates

Version 1 of this document was issued in December 2008 and explained the methodology behind the draft classifications. Most of the information given in that document is also relevant to the 2009 baseline classifications that fed into the first cycle River Basin Plans (RBPs). Some decisions however, particularly those made after the draft classifications, weren't captured in the method statement. Version 1 should therefore be treated with caution.

This current version (v3.0) has been updated to include finalised methods from the 2009 plans and revised or additional methods from the 2010, 2011 and 2012 round of classifications.

2. Classification in summary

The Water Framework Directive specifies the quality elements that are used to assess the ecological and chemical status of a water body. Quality elements are generally biological (e.g. fish, invertebrates, macrophytes) or chemical (e.g. heavy metals, pesticides, nutrients).

Classifications indicate where the quality of the environment is good, where it may need improvement, and what may need to be improved. They can also be used, over the years, to plan improvements, show trends and to monitor success.

There are two status classifications which are commonly reported, ecological and chemical.

2.1. Chemical status classification

Chemical status is assessed from compliance with environmental standards for chemicals that are priority substances and/or priority hazardous substances. These are known as 'Annex X' substances as they were originally listed in Annex X of the Water Framework Directive. This has now been superceded by the Environmental Quality Standards Directive (2008/105/EC). A list of priority substances can be found in Appendix I (see also the Chemical Standards database on our website). Chemical status is recorded as 'good' or 'fail'. Chemical status for a water body is determined by the worst scoring chemical (one-out-all-out approach).

We generally monitor for priority substances only in water bodies where there are known discharges of these pollutants. Water bodies without discharges of priority substances are reported as being at good chemical status.

2.2. Ecological status classification

Ecological status classifications can be composed of up to four different types of assessments:

1. An assessment of status indicated by a **biological** quality element such as fish, invertebrates or algae (see table 1 in section 3). We also assess for the presence of invasive species as a separate test.
2. An assessment of compliance with environmental standards for supporting **physico-chemical** (phys-chem) conditions, such as dissolved oxygen, phosphorus and ammonia (table 3)
3. An assessment of compliance with environmental standards for concentrations of **specific pollutants**, such as zinc, cypermethrin or arsenic (these are known as 'Annex VIII' substances)

And in determining high status only:

4. A series of tests to make sure that **hydromorphology** is largely undisturbed

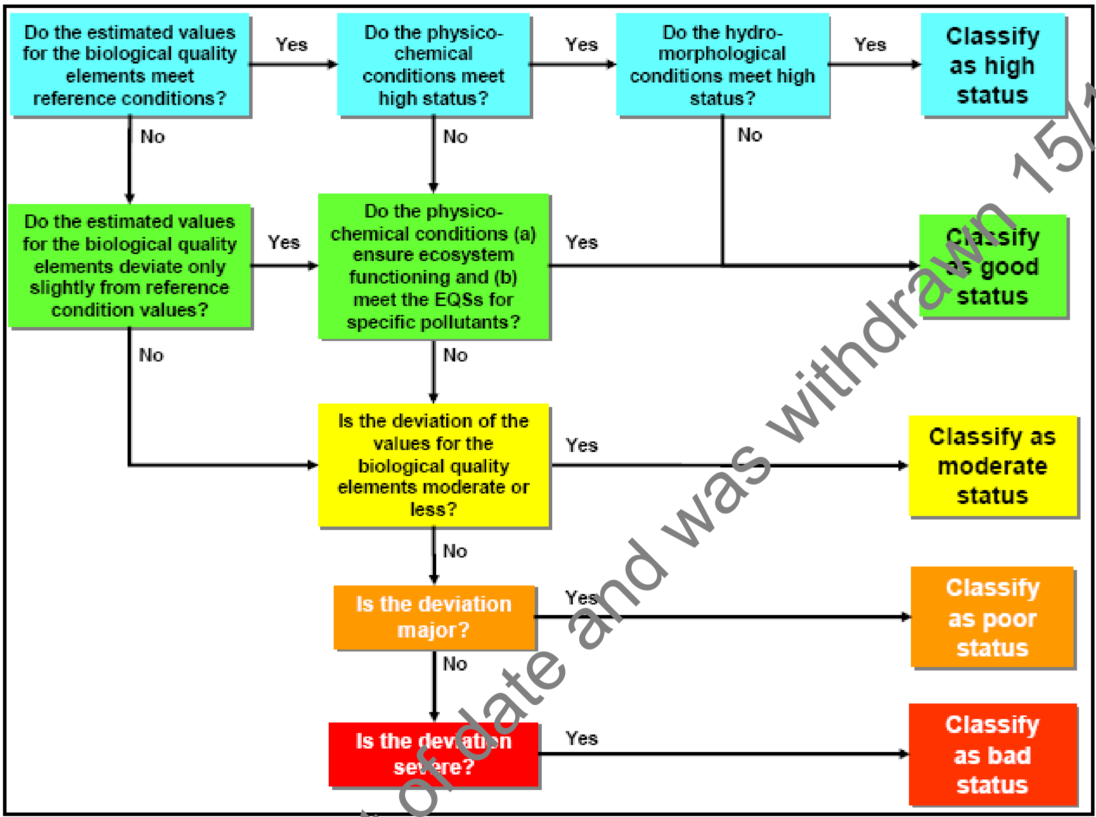
We do not always have these assessments for our water body classifications. Expert judgement was used to assess water bodies where monitoring data was unavailable for the 2009 RBPs. These assessments were carried forwards into subsequent classifications where we had no new monitoring data (see section 6.2.)

Ecological status is recorded as high, good, moderate, poor or bad. 'High' represents 'largely undisturbed conditions'. Other classes show increasing deviation from undisturbed or reference conditions. This deviation is expressed as an ecological quality ratio (EQR) which ranges from zero at the bad end to one at the high status end.

As with chemical status, the ecological status of a water body is determined by the worst scoring element (one-out-all-out approach).

Ecological status is the main classification reported by us internally and to the public and many of our partners and stakeholders. Our corporate scorecard measure is based on ecological status. These classifications are described in more detail later in this document and shown in summary in the flow diagram figure 1.

Figure 1. Decision tree illustrating the criteria for determining the different ecological status classes



2.3. Biological status

Biological status is a sub-set of ecological status where we look only at the results of the biological quality elements (and so ignore physico-chemical parameters, Annex VIII substances and hydrolomorphology). The one-out-all-out rule is applied again here to give a biological status classification.

2.4. Overall status

Overall status is a composite measure that looks at both ecological status and chemical status. So, it takes into account all four assessment types under ecological status (biology, physico-chemical, Annex VIII substances and hydromorphology) as well as incorporating the results of the chemical status assessment (priority substances). The one-out-all-out rule is applied again here, so a water body must be **good or better** ecological status, and **good** (pass) chemical status assessment to be given a good overall status.

We report overall status to the EU as part of our 6-yearly statutory reporting of results and our customers, particularly Defra and WAG, are interested in the results of this assessment.

3. Ecological status in more detail

3.1. The role of biological elements in ecological status

Biological quality elements assessed across all surface waters are shown in table 1. These elements were chosen because they respond to the pressures identified in the risk assessments carried out under Article V of the Water Framework Directive.

For **river** and **lake water bodies**, one or more biological quality elements can be used in ecological status classification. Annex V of the WFD refers to macrophytes and phytobenthos as a single quality element but in practice, macrophytes and phytobenthos (diatoms) have been used separately for classification in the UK and other parts of Europe.

The biological monitoring of **transitional and coastal water bodies (TraC)** is focussed on a subset of surveillance water bodies. In 2010, operational monitoring in respect to nutrients was started. This approach increases our knowledge of those water bodies we have selected, but for the time being, limits the number of waters that we can classify using biological elements.

Table 1. Biological quality elements monitored for each water category

Category	Quality element	Description
Rivers	Macrophytes and phytobenthos - diatoms	Microscopic diatoms (algae) found on rocks and plants
	Macrophytes and phytobenthos - macrophytes	Water plants visible to the naked eye, growing in the river
	Macroinvertebrates	Insects, worms, molluscs, crustacea etc living on the river bed
	Fish	Including eel
Lakes	Phytoplankton	Free-floating microscopic plants
	Macrophytes and phytobenthos - diatoms	Microscopic diatoms (algae) found on rocks and plants
	Macrophytes and phytobenthos - macrophytes	Water plants visible to the naked eye, growing in the lake
	Macroinvertebrates	Insect larvae, worms, molluscs crustacean etc. living on the lake bed.
TraC	Phytoplankton	Free-floating microscopic plants
	Macroalgae	Seaweeds visible to the naked eye
	Angiosperms	Sea grasses and saltmarsh plants
	Benthic invertebrates	Worms, molluscs and crustacean etc living in or on the bed of the estuary or sea
	Fish (transitional only)	Fish which spend all or part of their life in transitional waters

Each biological quality element is capable of responding to many of the pressures acting on the environment, but classification tools have been developed to indicate a particular pressure when possible (table 2). This has been successful for organic pollution, nutrient enrichment and acidification. But some tools, such as the fish-based tools, respond to many pressures in combination and can be thought of as indicators of general disturbance.

Our operational biological monitoring is designed to capture information on those biological elements that are most sensitive to the pressure(s) acting on a water body. This is what we mean by 'risk based monitoring'. Further details about operational monitoring under WFD is provided in section 5.

The UKTAG list of primary pressures and sensitive elements was also used to guide selection of quality elements to monitor in relation to risk assessments.

Table 2. Pressures indicated by quality elements

Category	Quality element	Pressure description
Rivers	Macrophytes and phytobenthos - diatoms	Primarily nutrient enrichment
	Macrophytes and phytobenthos - macrophytes	Sensitive to nutrient enrichment and morphological alterations
	Macroinvertebrates	Sensitive to organic enrichment, pollution by toxic chemicals, acidification, abstraction of water
	Fish	Primarily sensitive to abstraction of water and morphological alterations
Lakes	Phytoplankton	Nutrient enrichment
	Macrophytes and phytobenthos - diatoms	Nutrient enrichment
	Macrophytes and phytobenthos - macrophytes	Nutrient enrichment
	Macroinvertebrates	Nutrient enrichment Acidification
TraC	Phytoplankton	Nutrient enrichment
	Macroalgae	Nutrient enrichment, hazardous chemicals
	Angiosperms	Nutrient enrichment, morphological alterations
	Benthic invertebrates	Organic pollution, hazardous chemicals and some morphological alterations
	Fish (transitional only)	Organic enrichment (dissolved oxygen), habitat destruction

3.2. The role of physico-chemical supporting quality elements

Supporting elements are the physico-chemical factors such as pH, dissolved oxygen and nutrients that are required to support a functioning ecosystem. For example, fish cannot survive and reproduce unless there is sufficient dissolved oxygen and suitable habitat.

Class boundary values have been developed for these supporting elements corresponding to high, good, moderate, poor and bad status. In classification, however, **supporting elements can only influence status down to moderate**. Only biological elements can determine poor or bad status (see figure 1). The quality elements that we use in producing classifications are shown in table 3.

Table 3. Physico-chemical quality elements monitored for each water category

Quality element	Rivers	Lakes	TraC
pH	✓	✓[3]	
Ammonia (total as N)	✓	✓	
Phosphate	✓[1]	✓[2]	
Dissolved inorganic nitrogen			✓
Dissolved oxygen	✓	✓	✓
Specific pollutants (Annex VIII)	✓	✓	✓
Acid neutralising capacity		✓	
Temperature	✓		

[1] Reactive phosphorus (unfiltered orthophosphate)
[2] Total phosphorus
[3] In lakes Acid Neutralising Capacity is assessed

Biochemical oxygen demand is not part of our formal classification process, but we will still use it for regulation such as setting permit limits. As persistent and gross organic pollution of rivers is now rare, dissolved oxygen is the better assessment of environmental conditions.

Temperature is assessed in rivers as part of the phys-chem suite, but is not used to classify water bodies. There are two temperature standards in the Directive. We currently only assess against the annual 98-pecentile standard.

There are 19 specific pollutants. These are listed along with their standards in the UKTAG document *Proposals for environmental quality standards for Annex VIII substances*

3.3. Quality elements that determine high status

A water body is only classified as high status if it has passed all three additional tests for high status. The three tests are:

1. A hydrological/tidal regime that reflects totally, or nearly totally undisturbed conditions (see table 4)
2. Morphological conditions that reflect totally, or nearly totally undisturbed conditions (see table 5)
3. No evidence of established populations of alien species

Table 4. Hydrological and tidal regime

	Rivers	Lakes	Transitional waters	Coastal waters
Quantity and dynamics of water flow	✓	✓		
Connection to groundwater	✓	✓		
Residence time		✓		
Freshwater flow			✓	
Direction and speed of dominant currents				✓

Table 5. Morphological conditions

	Rivers	Lakes	Transitional waters	Coastal waters
River continuity	✓			
River depth and width variation	✓			
Structure and substrate of river bed	✓			
Structure of the riparian zone	✓			
Lake depth variation		✓		
Quantity, structure and substrate of lake bed		✓		
Structure of lake shore		✓		
Depth variation			✓	✓
Quantity, structure and substrate of estuarine bed			✓	
Structure of the intertidal zone			✓	✓
Wave exposure			✓	✓
Quantity, structure and substrate of coastal bed				✓
Direction of dominant currents				✓

UKTAG guidance has listed 3 categories of alien species. The guidance states that a water body will be classed as worse than **high** status if there is evidence that one or more species on the high impact list has become established over a significant spatial extent of the water body (i.e.0.5km of contiguous length or 5% by length (river) or 5% by area (lakes and TRAC waters). The guidance also states that a water body will be classed as worse than **good** status if there is evidence that an alien species on the high impact list is causing the biological quality elements to deviate more than slightly from their reference conditions.

The Environment Agency records the presence of alien species in water bodies, but does not have data on the length or area of coverage. So, for candidate high status water bodies we have taken a more stringent approach. Where a water body is at high status for all other assessed quality elements, we have queried our archives to check that no alien species have been recorded during surveys. If no alien species have been recorded, the water body has been kept at high status. If there has been evidence of alien species present, we have downgraded the water body to good status

<u>3.4 Producing overall water body ecological status from all the available strands of evidence</u>

This part of the classification process is prescribed by the WFD. The quality element with the lowest (worst) status for a water body determines the overall ecological status. This is known as the one-out-all-out approach.

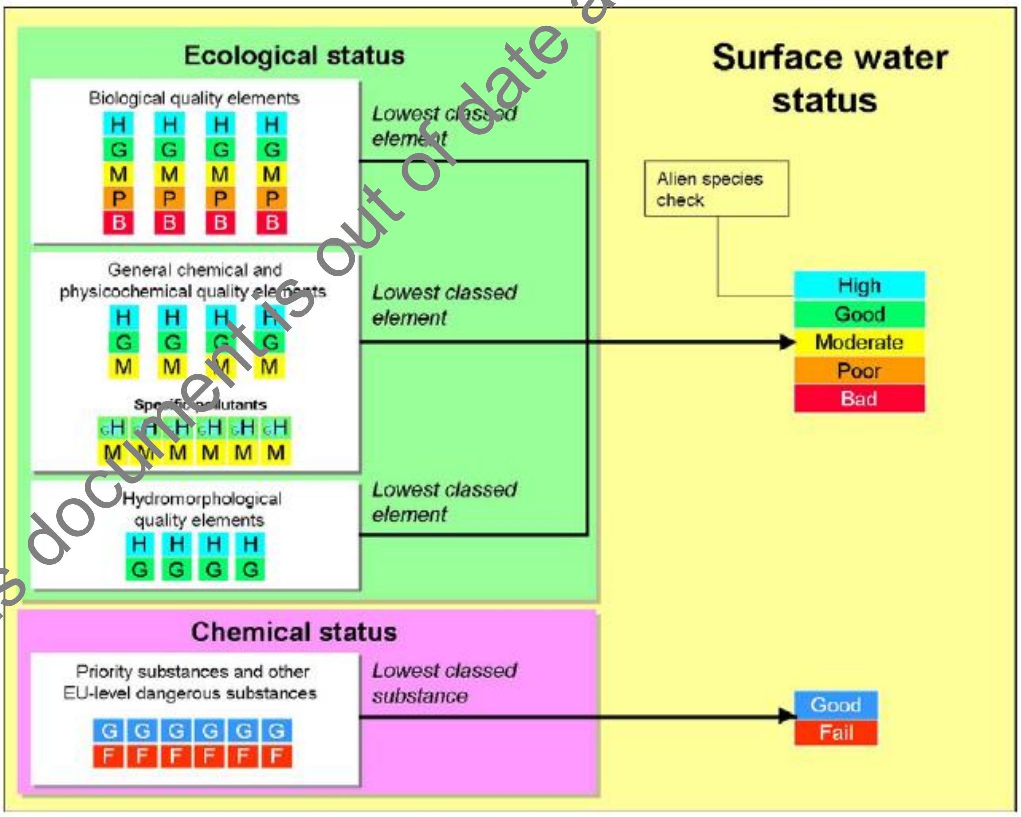
In combination with biological classifications, supporting phys-chem elements including specific pollutants (Annex VIII substances) can result in high, good or moderate status but **do not** determine poor or bad status.

When combined with biological quality elements, hydrology and morphology assessments determine high status only. They do not determine good, moderate, poor and bad status. This is because the Environment Agency is following Common Implementation Strategy (CIS) guidance which indicates that biological evidence is required to determine poor and bad status.

If all other quality element classifications suggest that a water body is at high status, we must ensure that alien species are not established in the water body in question.

This is summarised in figure 2.

Figure 2. Bringing all the strands of classification together



4. Ecological potential in heavily modified and artificial water bodies

The WFD recognises that in some water bodies it may be impossible to achieve good ecological status because of modification for a specific use, such as navigation, recreation, water storage and flood protection. Artificial water bodies are bodies of surface water created by man where no water body previously existed. In these cases Member States are required to aim to achieve good ecological **potential** instead of status. The ecological potential of a water body represents the degree to which the quality of the water body's aquatic ecosystem approaches the maximum it could achieve, given the heavily modified or artificial characteristics of the water body that are necessary for the use or for the protection of the wider environment.

A number of different factors need be considered when making an assessment of the ecological potential of heavily modified or artificial water bodies (HMAWBs). These factors are flow, mitigation measures and quality elements. We can therefore think of the assessment of HMAWBs as a three stage process, each stage considering one of the factors in turn as described below. The process is also summarised in a flow diagram (figure 3).

4.1. Flow

For rivers we need to firstly consider an assessment of flow as this determines which quality elements can be used to help classify an HMAWB's ecological potential.

If flow conditions pass the standard then we assess HMAWBs based on a combination of mitigation measures and, if available, an assessment of **non-sensitive** quality elements. Non-sensitive quality elements are those elements that are not affected by the modified or artificial nature of the water body. These are listed in table 6.

If flow conditions fail then ecological potential is based on the worst result of either the mitigation measures assessment or **any** of the quality element assessments.

4.2. Mitigation measures

The UK has adopted the 'alternative approach' to classifying HMAWBs (refer to UKTAG documentation on classification of HMWBs). This approach is based on the mitigation measures that are in place. Assessments of mitigation measures present in HMAWBs have been made.

If mitigation measures are in place then ecological potential is good. If mitigation measures are not in place then ecological potential is moderate.

These results can still be further modified if an assessment of a non-sensitive element is less than good, in which case ecological potential will depend on the grade of the lowest quality element.

4.3. Biological quality elements

We cannot use biological quality elements in assessing HMAWBs in the same way as we do for normal surface water bodies. This is because some biological elements are sensitive to the water body modifications. Under normal circumstances we look at non-sensitive quality elements in the assessment of ecological status for HMAWBs. Sensitive quality elements are used only if flow conditions fail the standard. The following table shows which quality elements are used to assess ecological potential based on sensitivity to hydromorphological pressures (table 6).

Table 6. Sensitivity of quality elements in assessing HMAWBs

	Non-sensitive quality elements	**Sensitive quality elements**
Rivers	Physico-chemical conditions Specific pollutants Diatoms	Macrophytes Invertebrates Fish
TraC	Physico-chemical conditions Specific pollutants Phytoplankton Macro-algae Benthic invertebrates (quality)	Sea grass (extent) Fish (Transitional waters only) Benthic invertebrates (extent)
Lakes	Physico-chemical conditions Specific pollutants Phytoplankton Diatoms Invertebrates	Macrophytes

In some cases we will still monitor for, and assess, biological elements that are sensitive to the physical modifications. Although these element assessments are ignored for the purpose of determining a water body status they are not ignored operationally. We must be sure that biology failures are due to physical modifications, not because of other pressures acting on the water body e.g. chemical pollution or the impact of invasive species. If other pressures are affecting the biology then these pressures need to be addressed.

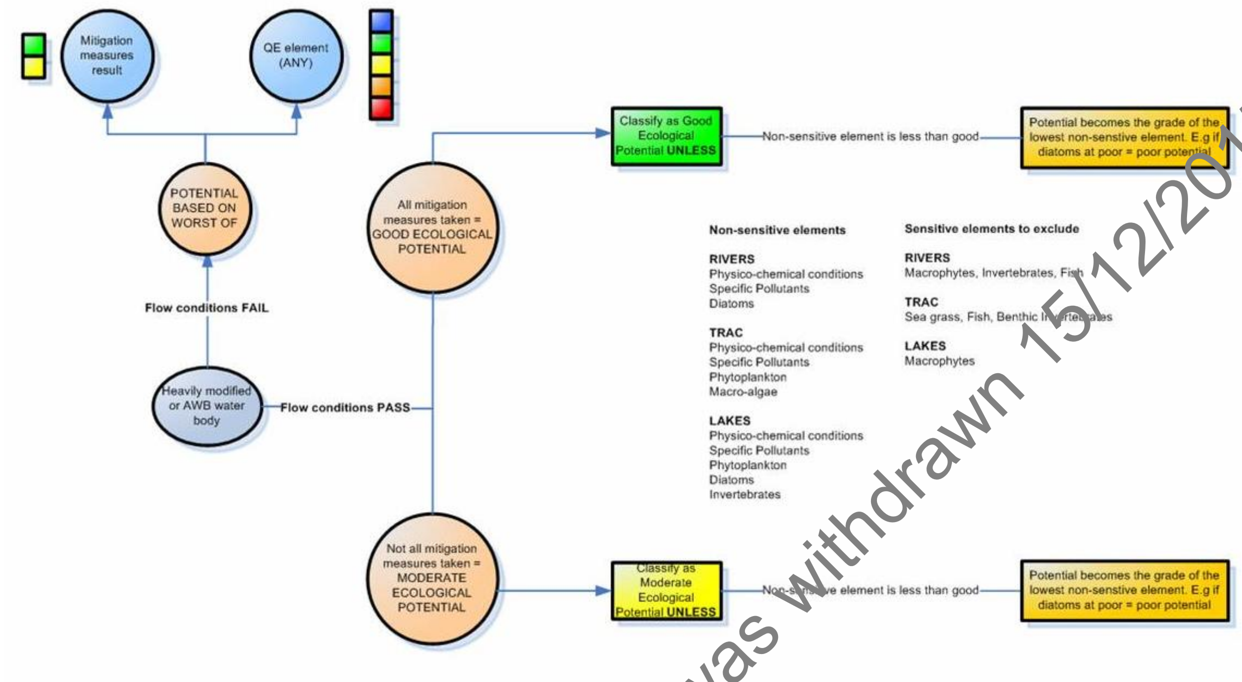


Figure 3. Flow chart detailing the process of classifying HMAWBs

5. Monitoring and data selection

5.1. Operational monitoring under WFD

Operational biological monitoring under WFD is generally carried out in three-yearly cycles but is dependant on the specific assessement tools (e.g. 6-yearly cycles for fish in rivers). The first cycle of operational monitoring in rivers occurred between 2007-2009. Data collected up to the end of December 2008, and in some cases data obtained prior to 2007 fed into the classification results published in the first cycle RBMPs. TraC monitoring initially focussed on surveillance sites, with operational monitoring starting in 2010.

Water **chemistry monitoring** (phys-chem) is more frequent and is carried out on a monthly (or sometimes quarterly) basis every year.

At water bodies chosen for the **surveillance monitoring** network we aim to collect data for all quality elements. One of the objectives of surveillance monitoring is to look for signs of impact from any pressure in order to validate the risk assessments. So in many surveillance water bodies we will have evidence from all biological quality elements.

The programme of operational monitoring for 2010-2012 is largely informed by the results of the previous cycle of monitoring (classification results published in the RBMPs) and risk assessments. Where we know we have good status water bodies or where we have high levels of certainty in failing elements we will refocus monitoring effort to investigative programmes. Under risk based principles our 2010-12 operational monitoring has therefore been targeted towards increasing confidence in our results.

Over time we will start to re-introduce monitoring in water bodies where measures are being put in place so that we can track the success of these measures and to check on 'no deterioration'.

5.2. Selection of data

A lot of monitoring programmes, particularly water chemistry, have been in place for many years. But some programmes only began in 2007 (e.g. TraC phytoplankton). This means that some of the classifications reported in the first RBPs need to be treated with caution. Over time, our results will become more robust as we gather more biological data to support the classifications.

The classifications published in the first RBPs used **biological and chemical** data primarily from the preceding 3 years, but in a small number of cases **biological** data going back to 2004 was used. This was so we could establish a 2009 baseline that was based as much as possible on actual sampled data. In some cases, where no monitoring data was available, expert judgement was used to classify a water body (see section 6.2).

For the **2010 and subsequent classification updates of rivers** a three year data window was used for both chemical and biological elements. The exception to this rule was fish; in this case a 6 year window was used. For TraC waters a possible six year window was used for biological tools, although for many tools data was only available for a three year period.

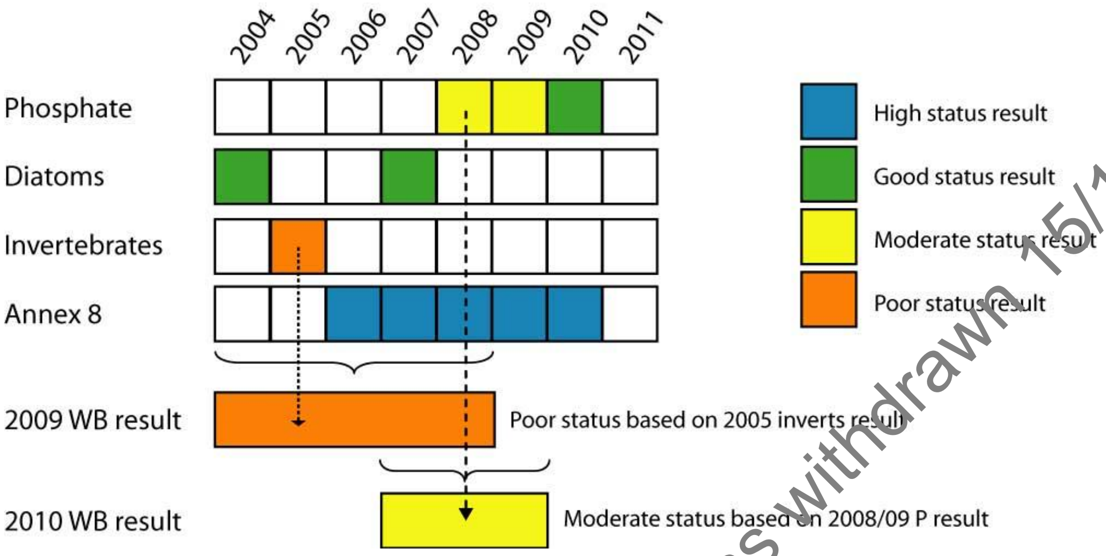
For the supporting phys-chem elements in rivers, the monthly samples are batched up into datasets comprising the most recent three-year's data. For specific pollutants and priority substances, the Environmental Quality Standards Directive (EQSD) monitoring network is used, taking the most recent three years of data.

5.3 Roll forward of 2009 results

Because we have a rolling programme of monitoring combined with a fixed data window, there are instances where data used in older classifications does not fall into the data window for more recent classifications.

In these cases, water bodies may be given a higher status class, as a new (higher status) element becomes the driving element of classification. So that we don't give a false impression of improvement at a water body level, the result for the previously driving element is rolled forward into subsequent classification updates. The roll forward process is illustrated in figure 4.

Figure 4. Why we need to roll forward results



In the example above, the 2009 classification has used data from 2004 to 2008 inclusive. The ecological status (WB level) is poor, because the 2005 invertebrate element result is driving the classification.

Because the 2010 classifications take data from the period 2007 to 2009, the 2005 invertebrate result would not be included. The 2010 result (WB level) is moderate, based on phosphate results from 2008 and 2009. Therefore, we have an 'artificial' improvement in WB status between the 2009 and 2010 classifications.

Unless we have evidence to show otherwise, we should not ignore previously driving element results in subsequent rounds of classifications. In the case illustrated above, the 2005 invertebrate result is rolled-forward to 2010, and the WB classification remains at poor status.

5.4. Water bodies with multiple sample sites

In water bodies where we monitor quality elements at more than one location, the classification results for each location have been used to calculate a classification for the whole water body. This approach is described as option b in the UKTAG classification guidance.

For most water quality results, a median of all site classification confidences is used and for biological quality elements a mean class and associated confidence is calculated. These calculations are explained in more detail below.

5.4.1. Water chemistry sites (ecological and chemical status)

For water chemistry we take the median (the middle value) of all the sample point classifications within the waterbody. This is representative of typical conditions for the waterbody, not the best nor the worst.

We take the median confidence of failing good status and the associated median confidence of being better (or worse) than each class. This is done separately for each water quality element and is achieved by sorting the multiple sample points within each waterbody based on confidence of failing good. The median result for the waterbody is then the midpoint of these sorted results. For example: if there are 5 sample points in a waterbody the median is taken from the 3rd point in the sorted results; or if there are 6 sample points the median is taken as the calculated middle value between the 3rd and 4th sorted results. So in the latter case it is not an actual sample point location but a median result corresponding to half way between the results for the two actual sites.

An example for phosphate in a waterbody with four sample points is shown below:

Mean	StdDev	Num_Results	Good_std	Order (on cf worse Good)	confidence									Compliance	ClassID
					worse_High	worse_Good	worse_Mod	worse_Poor	HIGH	GOOD	MOD	POOR	BAD		
0.11	0.0543	36	**0.12**	1	1.000	0.138	0.000	0.000	0.000	0.862	0.138	0.000	0.000	Comply	4
0.535	2.65	36	**0.12**	2	0.860	**0.823**	0.739	0.150	0.140	0.037	0.085	0.589	0.150	**Quite Certain fail**	2
0.136	0.0622	36	**0.12**	3	1.000	**0.934**	0.000	0.000	0.000	0.066	0.934	0.000	0.000	**Quite Certain fail**	3
0.254	0.0775	12	**0.12**	4	1.000	**1.000**	0.569	0.000	0.000	0.000	0.431	0.569	0.000	**Very Certain fail**	2
		MEDIAN		**2.5**	**0.930**	**0.879**	**0.369**	**0.075**	**0.070**	**0.051**	**0.509**	**0.294**	**0.075**	**Quite Certain fail**	**3**

Where a waterbody has variable quality within it then whatever method we use to present an overall status cannot encapsulate the variability across the waterbody within one set of summary figures. It is therefore important to still look at the sample point results within the waterbody and use these to look at where quality needs improving and to look at the site level confidence of being less than good.

5.4.2. Biological sites

For river invertebrates and diatoms, where there have been multiple sites in water bodies, the environmental quality ratios (EQRs) have been averaged and a value of standard deviation resulting from natural spatial variability has been applied. The mean EQR and its standard deviation determines the class and confidence of class for the whole water body.

The fish-based classification for rivers method takes the classifications for each individual sampling site and calculates the probability of class for the whole water body.

The river macrophyte-based classification method takes separate site classifications and averages the EQRs to produce an overall water body classification.

In general the TraC tools average the data across the waterbody.

This approach does not mean that adverse impacts in part of a water body are unimportant. On the contrary, such impacts may be very important, for example for local interests of nature conservation or recreation. We will continue to use our powers to manage and correct such impacts even though the water body overall may be reported as good status.

5.5. UKTAG spatial criteria

The UKTAG recommendations on surface water classification scheme (Section 5.3 and Annex A.1) give the option of estimating the length or area of a water body that is, say, less than good and using the spatial criteria in Table A1a to make decisions on status.

We have not been able to reliably associate lengths or areas of water body to sampling sites, so have not been able to apply the UKTAG spatial criteria in classification to date. However, we would wish to retain the ability to use these criteria in future as they provide a consistent way of dealing with spatial extent of impact in classification.

6. Water bodies with no monitoring data

The WFD requires all water bodies described as being at risk of failing to meet good status by 2015 to be classified. In the 2009 baseline plans all water bodies, regardless of risk, were given a classification, even those where we had no monitoring data.[1] This was achieved using a combination of expert judgement and groupings/linking sites to water bodies elsewhere in the catchment.[2]

6.1. Linking monitoring sites to water bodies

In 2012 we stopped grouping water bodies using the methodology from previous classifications. Some water bodies will still use monitoring data collected from elsewhere to classify where they do not have their own monitoring data to base an assessment. However, this is now achieved by simply linking (appropriate) individual monitoring sites to whichever water body(ies) they are deemed suitable to classify.

This is a much less crude method of grouping than before. In previous classifications an element result was taken from one water body (the 'parent') and applied wholesale to another water body (the 'child'). The new method of linking sites to water bodies allows us to use only those monitoring sites that may be appropriate for a water body elsewhere in the catchment. So for example, there may be several phys-chem monitoring sites used to classify water body x, but only one of those sites needs to be used (or is appropriate) for water body y. This may results in a different phys-chem status class for water body y, whereas using the previous grouping methodology both water body x and y would have the same phys-chem status.

[1] The majority of river water bodies that are unmonitored drain very small catchments that are often source-to-sea minor water courses. By length these represent less than 4% of rivers.
[2] In the 2010, 2011 and 2012 updates a small number of water bodies were unassessed. This was because previous assessments were made using incorrect sample points which have since been updated leaving the water body with no sample data and no expert judgement to fall back on. Lake water bodies have not been grouped.

The usual considerations have been made when linking a monitoring site to a water body elsewhere in the catchment, as per the grouping methodology. Linked monitoring sites must be appropriate for classifying whatever water body they are linked to based on the typologies and risk assessments of both water bodies (the water body where the sampling site is spatially located and the one which it is classifying). Linked monitoring sites must be in the same River Basin District as the water body they classify.

6.2. Expert judgement water bodies

All available knowledge needs to be used in classifying water bodies with no monitoring data. Expert judgement from national leads (particularly for lakes and TraC) and from local staff has been used in classifying water bodies with no monitoring data. For the purposes of the 2009 river basin plans - where the status was reported next to assessments based on

monitoring data - all such expert judgements were assigned a low confidence, because no statistical assessment had been carried out.

The following options have been used to carry out expert judgement classifications:

(1) Risk assessment data has been used to infer a classification

Risk Category	UKTAG Definition
1a	Water bodies at significant risk
1b	Water bodies probably at significant risk, but for which further information is needed.
2a	Water bodies probably not at significant risk on the basis of available information
2b	Water bodies not at significant risk

Not at risk, or probably not at risk (2a or 2b) = Good Status (low confidence)
At significant risk, or probably at significant risk (1a or 1b) = Moderate Status (low confidence)

(2) Third party data has been used to produce a status assessment. The two main sources are:

a) Natural England/CCW favourable condition assessment where available. This may override the risk assessment (we have access to all SSSI assessments for England but not Wales).

In favourable condition = Good Status (low confidence)
Not in favourable condition = Moderate Status (low confidence)

b) Water company assessment – rules/expert judgement to be decided.

If third party data is sufficiently robust it is used in preference to risk assessments.

(3) In very few cases, where there is an overwhelming opinion coming from expert judgement (from internal or competent external sources) we have overriden risk assessments and/or NE/CCW condition assessments.

(4) For lakes, an expert opinion assessment was made of whether the unmonitored lake was likely to fail its' phosphorus standard. The methodology for this assessment is provided in the document 'Expert judgement assessment of lake classification for Water Framework Directive' (see resources section).

(5) For TraC water bodies, expert opinion on whether an un-monitored water body was likely to fail for dissolved inorganic nitrogen was based on the performance of those water bodies that were monitored. Each un-monitored water body was considered in

turn by national experts and a nutrient classification was applied manually. In TraC water bodies designated as heavily modified, the nutrient expert judgement did not always over ride the mitigation measures classification

In the 2009 baseline plans around 20 per cent of water bodies were given expert judgement classifications. All water bodies had desk-based hydromorphology assessments and, for HMWBs a mitigation measures assessments. These are combined with the expert judgement assessment when producing overall ecological status.

The expert judgement exercise has not been repeated since 2009, although there are plans to review the assessments in the future. Until then, the 2009 expert judgement results will be rolled forwards until actual monitoring data becomes available. If a water body does not have a rolled forwards classification because of past errors in site to water body links, and does not have any monitoring data for the time window concerned, then the water body will be labelled as un-assessed in any annual update until there is a repeat of the expert judgement exercise.

10. Reporting confidence

10.1. Confidence and risk

Even the best classification systems will, on average, assign a water body to the wrong class on 20-30 per cent of occasions. This means that it is important to establish the degree of confidence that the assigned class is correct if we are to use the classification to guide action. Data from our surveillance monitoring programme, taking a cross section of catchments at risk from different pressures, can be used to check the validity of our assessments or show that unexpected risks are having an impact.

We need to recognise that the use of many quality elements, and to assign class by the worst of these, will bias the overall picture towards bad quality unless all those elements are measured with 100 per cent precision. This factor needs to be considered when looking at trends. A move to include more quality elements will lead to more reported failure, even if the true picture has remained unchanged.

This risk is countered by looking at the individual elements, one at a time. When interpreting the classification results, it is important to recognise how confident we are about these results before we take decisions on action.

10.2. Assessing and reporting confidence at an element level

Past assessments (e.g. GQA) have been able to assign class to a single river water body with, on average, 70-80 per cent confidence that the reported class is the right one. A similar degree of confidence exists for classifications reported under WFD.

The following factors affect confidence. The first is generally dominant:

1. The statistical confidence associated with the amount of data used to produce a classification (e.g. frequency of sampling)
2. Errors in the collection process
3. Errors in the measurement process (e.g. accuracy of laboratory techniques)
4. For a particular water body, how close the true class is to a class boundary - the numerical value at which status changes.

We generally use two key pieces of information when assessing confidence in our classification results. The first is the percentage confidence of being in each class. An example of this is shown in figure 5.

Secondly, we need to know how confident we are that a quality element result is worse than the default objective of good status. The thresholds for the different levels of confidence are shown in table 8.

Figure 5. Percentage chance of the true status being in each class

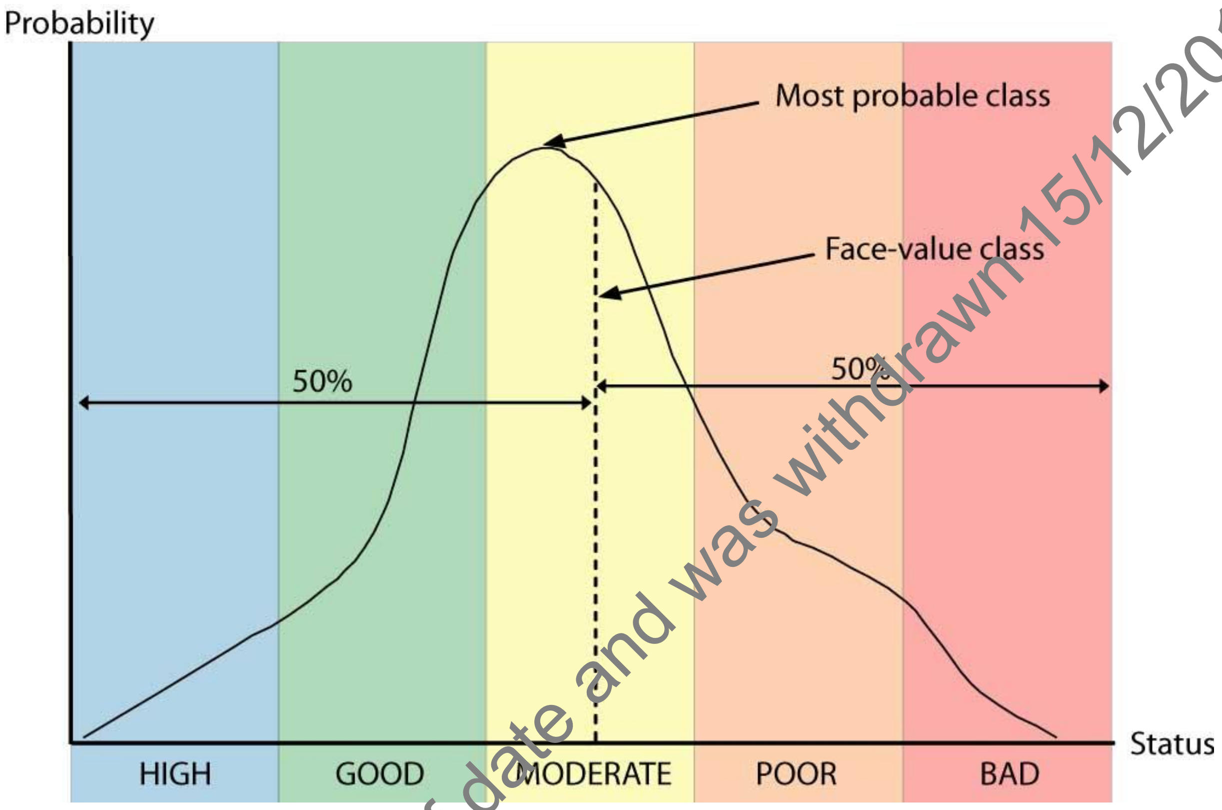
ConfHigh	ConfGood	ConfModerate	ConfPoor	ConfBad
83	16	1	0	0

Table 8. Thresholds for the different levels of confidence in being less-than-good status

Confidence of less-than-good status	Threshold
Very certain	≥ 95%
Quite certain	75% to 95%
Uncertain	50% to 75%

When reporting confidence we use the face-value classification. This is the class at which 50% probability is first exceeded working from either end of the x axis (see figure 6). This is the best option for reporting a central estimate of class in any reporting relevant to taking action. Face value class is not necessarily the class with the highest probability.

Figure 6. Definition of face-value class



For the example shown above the face value classification is moderate status, as the point at which we have greater than 50% confidence of being right is first exceeded. The classification boundaries are evenly distributed, and this is representative of most classification tools. However, when the spacing for each status along the x axis is not even, the status at which we have more than 50% confidence does not always match with the status at the highest point in the probability distribution (the most probable class).

10.3. Combining confidence for different quality elements

Where we report class using more than one quality element, we use the confidence shown by the quality element producing the worst face value class. Where there are two or more quality elements showing the same status, our expression of confidence is determined by the assessment with the highest confidence of being at less than good status.

An example is shown in table 9. Here, a water body has been assessed using three quality elements. The overall status and confidence is set by the results for invertebrates: poor ecological status, with high confidence (>95%) that the water body is less than good status.

Table 9. Example of combining confidence for multiple quality elements

Quality element	Face-value status	Confidence of being less-than-good
Dissolved oxygen	Moderate	Very certain
Fish	Poor	Uncertain
Invertebrates	Poor	Very certain

However, in taking decisions to improve a water body, we look at the individual quality elements in turn, according to which of them best measures the damage we seek to correct. In terms of confidence, it is the most costly of actions that require the greatest confidence that the reported class is worse than it needs to be. For river water bodies at risk from nutrient pressures, a weight of evidence approach has been used to determine the certainty of being worse than good.

10.4. The relationship between confidence and our operational monitoring programme

We take a risk-based approach in determining where to sample. This helps us target our resources where they are needed most in the environment. In practical terms it means the following:

- Where we have good element status we will stop monitoring.
- Where we are certain of less-than-good status we will stop monitoring.
- Where we are unsure of failures we will continue to monitor.

The above three scenarios set out, in a simplified way, our current approach to monitoring under WFD (for the 2010-12 programme). These scenarios are explained below:

Good status

If we know that an element is at good status or better, and we have no reason to suggest that status will deteriorate, we will stop monitoring in that water body and re-allocate the monitoring resource where it is needed more. We still have a duty to ensure that good status water bodies do not deteriorate over time, and there is a separate policy that covers this.

High confidence of less-than-good status

Where we have failing elements we need to have a reasonable level of confidence in our results before we start to implement measures (actions). This becomes especially important when we need to justify expensive or unpopular actions on water bodies. We would normally expect to be ‘quite certain’ that a quality element is failing before moving to such measures.

Some measures, such as continuous point source discharges, will require us to be ‘very certain’.

Where our monitoring has given us a sufficient level of confidence in element failures we will stop monitoring in that water body and re-allocate the resource where it is needed more (e.g. where we are uncertain of our results, or re-focus into short term, targeted investigative monitoring).

Low confidence less-than-good status

It is important that we are confident in our results before justifying costly actions, however we need to ensure that we are doing all we can to improve the environment even if we do not yet have an appropriate level of certainty in our results. There are many cases where we can start to implement low-cost, uncontroversial measures in water bodies where we are less than 'very certain' of a failure.

We will generally continue to monitor for elements where we are uncertain about the failure. As more data becomes available, and our confidence improves, we can then start to move to more stringent measures if appropriate.

In some cases we may never be able to collect a sufficient amount of data (through our operational programme) to reach a high enough level of confidence to implement measures. For example, routine physico-chemical monitoring where there are intermittent point source discharges with transient impacts. In these cases we will need to consider other options, such as local investigative monitoring, modelling, or a weight of evidence approach.

11. Resources

11.1. Contacts

Queries from external parties should be directed in the first instance to the Environment Agency's National Customer Contact Centre (NCCC). Internally, queries can be sent to the EnvMonHelp e-mail helpdesk where they will be logged and allocated to the appropriate member of the classifications delivery team.

http://www.environment-agency.gov.uk/contactus/default.aspx

11.2. Supporting and additional documents

Decision document for 2010 WFD classifications: Rules for assessing water body status and potential (internal document)

Classification of water bodies using expert judgement (Internal briefing note)

Groundwater chemical status assessment (classification) and trend assessment (http://www.environment-agency.gov.uk/static/documents/Research/GW_Chemical_Classification_150110.pdf)

Groundwater quantitative status assessment (classification) (http://www.environment-agency.gov.uk/static/documents/Research/GW_Quantitative_Classification_140110.pdf)

Proposals for environmental quality standards for Annex VIII substances (http://www.wfduk.org/UK_Environmental_Standards/LibraryPublicDocs/final_specific_pollutants)

Chemical Standards database (http://87.84.223.229/ChemicalStandards/Home.aspx)

England and Wales Ministerial Directions on typology, standards and classification

UKTAG environmental standards reports and method statements:
http://www.wfduk.org
http://www.wfduk.org/UKCLASSPUB/LibraryPublicDocs/gep_hmwb_final

APPENDIX I: Annex X / EQS Directive priority substances

CAS number[I]	EU number[II]	Name of priority substance[III]	Identified as priority hazardous substance
15972-60-8	240-110-8	Alachlor	
120-12-7	204-371-1	Anthracene	X
1912-24-9	217-617-8	Atrazine	
71-43-2	200-753-7	Benzene	
not applicable	not applicable	Brominated diphenylether[IV]	X
32534-81-9	not applicable	Pentabromodiphenylether (congener numbers 28, 47, 99, 100, 153 and 154)	
7440-43-9	231-152-8	Cadmium and its compounds	X
85535-84-8	287-476-5	Chloroalkanes, C10-13 [IV]	X
470-90-6	207-432-0	Chlorfenvinphos	
2921-88-2	220-864-4	Chlorpyrifos	
		(Chlorpyrifos-ethyl)	
107-06-2	203-458-1	1,2-Dichloroethane	
75-09-2	200-838-9	Dichloromethane	
117-81-7	204-211-0	Di(2-ethylhexyl)phthalate (DEHP)	
330-54-1	206-354-4	Diuron	
115-29-7	204-079-4	Endosulfan	X
206-44-0	205-912-4	Fluoranthene[VI]	
118-74-1	204-273-9	Hexachlorobenzene	X
87-68-3	201-765-5	Hexachlorobutadiene	X
608-73-1	210-158-9	Hexachlorocyclohexane	X
34123-59-6	251-835-4	Isoproturon	
7439-92-1	231-100-4	Lead and its compounds	
7439-97-6	231-106-7	Mercury and its compounds	X
91-20-3	202-049-5	Naphthalene	
7440-02-0	231-111-4	Nickel and its compounds	
25154-52-3	246-672-0	Nonylphenols	X
104-40-5	203-199-4	(4-nonylphenol)	X
1806-26-4	217-302-5	Octylphenols	
140-66-9	not applicable	(4-(1,1',3,3'-tetramethylbutyl)-phenol)	

608-93-5	210-172-5	Pentachlorobenzene	X
87-86-5	201-778-6	Pentachlorophenol	
not applicable	not applicable	Polyaromatic hydrocarbons	X
50-32-8	200-028-5	(Benzo(a)pyrene)	X
205-99-2	205-911-9	(Benzo(b)fluoranthene)	X
191-24-2	205-883-8	(Benzo(g,h,i)perylene)	X
207-08-9	205-916-6	(Benzo(k)fluoranthene)	X
193-39-5	205-893-2	(Indeno(1,2,3-cd)pyrene)	X
122-34-9	204-535-2	Simazine	
not applicable	not applicable	Tributyltin compounds	X
36643-28-4	not applicable	(Tributyltin-cation)	X
12002-48-1	234-413-4	Trichlorobenzenes	
67-66-3	200-663-8	Trichloromethane (chloroform)	
1582-09-8	216-428-8	Trifluralin	

(i) CAS: Chemical Abstracts Service.

(ii) EU number: European Inventory of Existing Commercial Substances (EINECS) or European List of Notified Chemical Substances (ELINCS).

(iii) Where groups of substances have been selected, typical individual representatives are listed as indicative parameters (in brackets and without number). For these groups of substances, the indicative parameter must be defined through the analytical method.

(iv) These groups of substances normally include a considerable number of individual compounds. At present, appropriate indicative parameters cannot be given.

(v) Only Pentabromobiphenylether (CAS number 32534 81 9).

(vi) Fluoranthene is on the list as an indicator of other, more dangerous polyaromatic hydrocarbons.