| Version | Comments |
|---|---|
| 1.0 | First released version of WFD aquatic monitoring strategy for Solway-Tweed River Basin District |

# Solway-Tweed WFD aquatic monitoring strategy

## 1.0 Introduction

### 1.1 Solway Tweed

A River Basin District (RBD) consists of a river basin or several river basins, together with the adjacent coastal waters. This scale is used for both strategic planning and reporting to the European Commission for the Water Framework Directive.

When the Water Framework Directive was transposed into UK legislation, separate provision was made for the Solway Tweed River Basin District. Under the Solway Tweed Regulations the Environment Agency and Scottish Environment Protection Agency (SEPA) are working jointly to deliver a co-ordinated approach to river basin planning in the district.

Joint (UK Technical Advisory Group - UKTAG) guidance for monitoring has been written and applied to design the monitoring networks and water bodies have been assigned to the agencies to lead on. Guidance on classification is being written and will go out to consultation; this guidance will be used to design the classification systems used.

### 1.2 WFD

The agencies have many years' experience in monitoring the aquatic environment, historically concentrating on water quality. The EU Water Framework Directive introduces a holistic approach to monitoring for a range of different pressures.

The Water Framework Directive is a wide-ranging and ambitious piece of legislation with the ultimate overall aim of ensuring that water bodies don't deteriorate in status and that all water bodies achieve at least good status by 2015, unless it is demonstrated that less stringent objectives should apply.

Implementation of the WFD has introduced substantial changes in the overall management and monitoring of activities which influence our aquatic environment.

New risk-based regulatory systems have been put in place, designed so that the extent and intrusiveness of this legislation is as low as possible, whilst ensuring the UK meets the long-term quality objectives identified under the WFD.

The role of the monitoring strategy is to ensure that sufficient environmental information is gathered to enable progress towards attainment of the WFD objectives to be measured and reported with adequate statistical confidence and confirm whether each agencies regulatory approach is delivering as planned.

The Solway Tweed monitoring network was designed within the framework of the WFD using guidance from an EU group on monitoring (the Common Implementation Strategy guidance) and principles laid down by a UKTAG.

The WFD works on six-year cycles; we are obliged to submit our first classification to the EU in March, 2010, with the next classification in 2015. Classification will be required to inform the RBMP reports, published in December 2009. Within the UK, all water bodies will be classified more frequently.

## 2.0 Monitoring design

### 2.1 WFD requirements

The WFD requires all water features in a category (i.e. rivers, lakes, transitional waters, coastal waters and groundwater) above a defined size threshold to be reported as water bodies.

Surface water bodies are grouped into different sub-typologies, according to their physical and chemical characteristics. These types indicate, in very general terms, the flora and fauna likely to be found in those types of water bodies in undisturbed conditions.

The WFD requires that the quality status of every water body must be reported in each successive 'River Basin Management Plan' (RBMP); the monitoring network has to be designed to ensure that this requirement is efficiently delivered.

The WFD specifies three categories of monitoring which have different but complementary purposes: surveillance, operational and investigative. The surveillance and operational networks will be used for status assessments and must produce classifications of "adequate confidence and precision".

1. Surveillance – a geographically distributed network designed to:

- Supplement and validate the impact assessment procedure
- Ensure efficient and effective design of future monitoring programmes
- Assess long-term changes in natural conditions
- Assess long-term changes due to widespread anthropogenic activity

The surveillance monitoring network will remain fundamentally unchanged for the foreseeable future, further extending existing datasets (some of which already have 40 years of data). Surveillance monitoring data will be used in quality status assessments.

2. Operational – driven by risk assessments based on pressure information and located in areas of known risk. Operational monitoring is designed to:

- Establish the status of those bodies identified as being at risk of failing to meet their environmental objectives
- Assess any changes in the status of such bodies resulting from the programmes of measures.

The operational monitoring network will provide much of the data required for WFD quality status assessment. It is intended that changes to the initial network will be limited, but it is inevitable that the network will change. If investigative work reveals that a new (or newly recognised) pressure on a water body is putting it at risk of not attaining its quality objective, then it must become the subject of relevant operational monitoring. Conversely, as 'Programmes of Measures' are implemented, and water bodies improve to the extent that operational monitoring results demonstrate that they are meeting their quality objectives and are consequently no longer at risk, then direct operational monitoring may cease.

3. Investigative – a more variable network responsive to unplanned events and emerging risks, where the source of the risk (the pressure), is not always well understood. Investigative monitoring shall be carried out:

- Where the reason for any exceedances is unknown,

- Where surveillance monitoring indicates that the objectives set out in Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, in order to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives
- To ascertain the magnitude and impacts of accidental pollution,

Investigative monitoring will also be put in place to meet other monitoring requirements, e.g. work to achieve biodiversity objectives and monitoring of water bodies below the WFD reporting size threshold.

The investigative network is, by its nature, reactive and transient. Consequently this network will continue to evolve to meet new monitoring requirements.

The future investigative monitoring network will consume a larger proportion of agencies' resources than its equivalent pre-2007 programme. During the first RBMP it may also encompass method development work, and for the foreseeable future will have substantial emphasis on detailed diffuse pollution studies and the assessment of water resource impacts.

All water bodies will be classified in time for the first RBMP. The Agencies use rolling programmes, scheduled over a three year period, so it may be the case that the results from surveys scheduled for 2009 are not included in the first RBMP report.

### 2.2 Priority substances in freshwaters

The agencies have developed their analytical capabilities significantly to enable monitoring of WFD 'priority substances' and UK 'specific pollutants'. The majority of priority substances have fully developed methods. Ongoing method development work will aim to incorporate priority substances and relevant specific pollutants into the monitoring network within the first cycle.

The 'Scottish Pollutant Release Inventory' and the 'England & Wales Pollution Inventory' returns and effluent screening have been used to ensure that all discharges of 'priority substances' and significant discharges of 'specific pollutants' have been identified. The results of this and current investigative monitoring will ensure that all receiving waters are subject to risk-based operational monitoring in accordance with UK guidelines.

Surveillance monitoring sites will be similarly subject to risk-based monitoring. Priority substances and relevant specific pollutants will be monitored at larger river, bottom-end of catchment surveillance sites across the country. Substances that are only likely to be present in certain areas of the country (e.g. pesticides related to a specific land-use) will be monitored at a relevant subset of surveillance sites.

### 2.3 Revision of existing networks

The pre-2007 monitoring networks were comprehensively reviewed in order to free up resources for the new WFD responsibilities. In particular, WFD monitoring requires confidence and precision to be stated along with assessments of status (necessitating more frequent sampling than is currently the case), as well as requiring more biological elements to be monitored.

The agencies used a 'characterisation database' which holds details of every water body and the pressures upon it. These pressures are separated into primary (likely to cause failure of a water body to meet good status by 2015) and contributory (not, on their own, likely to cause failure to meet good status, but may act in synergy with other pressures to cause failure).

Where appropriate to assess the status of water bodies, the monitoring and reporting needs of other EU directives, the UK Environmental Change Network, Clean Seas Assessment Programme, Harmonised Monitoring (of rivers), European EIONET, and DEFRA and Scottish Government long-term datasets reporting have all been incorporated into the new WFD network.

### 2.3.1 Surveillance network

The surveillance networks for both Scotland and England have been designed to represent all the different pressures, sub-typologies and statuses of water bodies at a national scale.

Some priority substances will be monitored at a different frequency per year over the river basin planning cycle than outlined in the Directive (the Directive recommends sampling 12 times a year for at least one year in 6). There will be a risk based screening to determine which water bodies need to be monitored; although monitoring will be at a lower annual frequency, within a RBMP more samples than recommended in the Directive will be taken.

#### 2.3.1.1 Freshwater surface-water surveillance

The bulk of the new surveillance monitoring network comprises long-established sites meeting the needs of OSPAR, other EC directives, UK Environmental Change Network, UK Harmonised Monitoring and long-term quality trend assessment. Additional sites have been added to represent smaller catchments or under-represented typologies.

These surveillance sites will be monitored for all relevant quality elements as listed in the Directive. As in most EU member states, the methods for freshwater fish populations' quality classification have not yet been decided upon. Methods for monitoring fish populations in large deep rivers still have to be defined. Collected data will be incorporated into classification outcomes once the metrics to be used are finalised. Hydrology data will be modelled for some of the freshwater sites.

#### 2.3.1.2 Groundwater surveillance

As recommended by UKTAG guidance, high-yielding boreholes have been employed for surveillance monitoring; this effectively limits the surveillance network to public water supply boreholes plus any available sites selected to be representative of key land use and groundwater pathway characteristics.

Groundwater bodies have been grouped and the data obtained will be extrapolated between them.

As well as a core suite of determinands, additional parameters will be selected in accordance with risk assessments and will generally be sampled quarterly.

In Scotland a lesser proportion of drinking water comes from groundwaters than in England, consequently there are fewer abstractions from which to take samples. SEPA will continue to develop the groundwater surveillance network during the coming years with further sites being added during 2007 and 2008 as SEPA refines the network. Quantitative monitoring is being undertaken at a sub-set of sites.

#### 2.3.1.3 Marine surveillance

The marine surveillance monitoring network has built on the long-established "UK National Marine Monitoring Programme" network of sites and aims to monitor each water body type in proportion to its occurrence. Across the UK, the network is representative of all the risk categories and pressure profiles acting on marine waters; all quality elements listed in the Directive will be monitored.

### 2.3.2 Operational network

#### 2.3.2.1 Freshwater operational

The location of operational monitoring is determined by the risk of a water body failing to meet the requirements of the Directive. Operational monitoring has also been deployed to assess the status of those water bodies which are not currently at risk, but which could be at risk of deterioration.

All river water bodies which are at risk from point source pressures (i.e. discharges for which the input point to the water body is known) will be monitored for both physico-chemistry and biology. A monitoring point (or points) representative of the status of the water body have been identified and will be monitored for those quality elements most sensitive to the pressures on the water body (Annex.1).

There are approximately 115 river water bodies which are at risk of failure due to diffuse pollution pressures. Many of these have also been selected for monitoring as part of the point source network; those remaining were grouped (according to geographical proximity and typology) and a representative monitoring site selected. This representative site will be monitored for the quality elements most sensitive to the pressure, and the classification extrapolated to the other water bodies in that group.

Historically, very few EU states have assessed the impact of morphological or hydrological pressures on ecological quality. In the UK, biological classification techniques quantitatively responsive to hydromorphological pressures are still being developed. Consequently, physical status surrogates are being employed to classify all river water bodies at risk of failing due to hydromorphological pressures. Some biological monitoring will be carried out (see annex.1) on water bodies affected by hydromorphology, prior to fully-sensitive biological tools being developed.

Almost half (45%) of the Solway Tweed's river water bodies are not at risk of failing to meet good status standards. However, some may still be at risk of deterioration (e.g. from high to good status), so are being monitored under the operational monitoring network or as part of the surveillance network. Rivers were grouped together, based on geographical proximity, being of a similar typology and with similar pressure profiles. Each group will be classified using data extrapolated from the monitored sites. Macroinvertebrates and the standard suite of chemical parameters will be monitored at these sites, as these tools are sensitive to the widest range of pressures.

Historically, only a limited number of lakes in the Solway Tweed have been classified, using physico-chemistry boundaries. The WFD requires a variety of biological tools to also be applied to determine their ecological status.

Subject to access constraints, all lake water bodies at risk from point source pressures have been selected for both biological and chemical monitoring.

Four other main categories of pressure acting on lakes were identified; diffuse pollution due to acidification, diffuse pollution due to agricultural pressures, hydrology pressures from impoundment and hydrology pressures from abstraction and flow regulation. Morphological pressures were also identified, although in the first RBMP all lakes will be classified for morphology using a surrogate rather than monitoring a biological quality element directly. Where the hydromorphological pressures meet the criteria specified in Article 4(3) of the Directive, then they are being identified as heavily modified, and if there are no other pressures, further monitoring is not required.

Lakes were grouped with others of the same primary pressure category, risk category and the same sub-typology (the WFD lake typology was refined to give 7

different end-groups). For lakes at risk from diffuse agricultural or acidification pressures, 50% of them are monitored. For the lakes at risk from hydrology pressures, 17% are monitored. Of those lakes probably at risk of failure from morphology pressures 17% are monitored for macrophytes, as this is believed to be the biological element most sensitive to morphological pressures. Monitoring effort at 50% and 17% was judged to provide adequate confidence and precision in the overall status assessments whilst maximising the efficiency of the network.

Not at risk lakes are grouped according to typology and 20% of them selected for monitoring; the results obtained will be extrapolated to classify the whole group.

#### 2.3.2.2 Marine operational

Two coastal and transitional water bodies in the Solway Tweed river basin have been grouped (as being "not at risk") and are being classified using data from adjacent water bodies with the same coastal sediment transport cells (a relevant geographical unit for marine ecosystems). All other marine water bodies have been monitored directly.

The relatively large number of monitoring sites shown on the map are a consequence of the UK assessment methods. In contrast to many of the freshwater methods, these require multiple samples to be taken from across a waterbody and the results combined for classification purposes.

#### 2.3.2.3 Groundwater operational

The majority of groundwater monitoring sites are part of both the surveillance and operational networks. The operational network was designed by revising and building on the existing network of Groundwater Regulations and the Nitrates Directive monitoring sites. Monitoring has also been undertaken where surface water interactions are significant. These groups will be classified by the data obtained from the representative monitoring points.

There are historic differences between water supply in Scotland and England, with England relying more on groundwater aquifers. This has resulted in a more developed monitoring network in England. SEPA is expanding the groundwater network coverage and this work is expected to be complete by 2009.

A core suite of chemical parameters has been selected for monitoring at each site, plus additional risk-based parameters.

SEPA will continue to increase the number of groundwater monitoring sites as our understanding of the pressures on groundwater improves.

## 3.0 Monitoring network design

The risk assessments published in the 'WFD Characterisation' reports in 2005, have been continually updated, and the latest numbers are given in Table 1 below. These risk assessments drive most of the monitoring needed, as outlined in section 2.

| Water body category | Risk category | Scotland | England |
|---|---|---|---|
| | | Total number of water bodies | Total number of water bodies |
| River | 1a - definitely at risk | 57 | 45 |
| | 1b - probably at risk | 110 | 70 |
| | 2a - probably not at risk | 54 | 27 |
| | 2b - definitely not at risk | 158 | 0 |
| **Total** | | **379** | **142** |
| Lake | 1a - definitely at risk | 12 | 1 |
| | 1b - probably at risk | 6 | 3 |
| | 2a - probably not at risk | 2 | 3 |
| | 2b - definitely not at risk | 5 | 0 |
| **Total** | | **25** | **7** |
| Transitional | 1a - definitely at risk | 4 | 0 |
| | 1b - probably at risk | 1 | 4 |
| | 2a - probably not at risk | 0 | 0 |
| | 2b - definitely not at risk | 5 | 0 |
| **Total** | | **10** | **4** |
| Coastal | 1a - definitely at risk | 2 | 0 |
| | 1b - probably at risk | 0 | 0 |
| | 2a - probably not at risk | 0 | 0 |
| | 2b - definitely not at risk | 6 | 0 |
| **Total** | | **8** | **0** |
| Groundwater | 1a - definitely at risk | 38 | 2 |
| | 1b - probably at risk | 16 | 0 |
| | 2a - probably not at risk | 11 | 4 |
| | 2b - definitely not at risk | 3 | 0 |
| **Total** | | **68** | **6** |

**(Table 1) The number of WFD water bodies in different risk categories in the Solway Tweed river basin**

Since the characterisation report was published in 2005, the agencies have been gathering data to increase confidence in our risk assessments; consequently the numbers of water bodies in "probably at risk" and "probably not at risk" categories have decreased, compared to the 2005 report.

Although SEPA and the EA have similar numbers of river water bodies, a greater percentage of England's rivers have been assessed as being "at risk", compared to Scotland's.

### 3.1 Surface-water monitoring

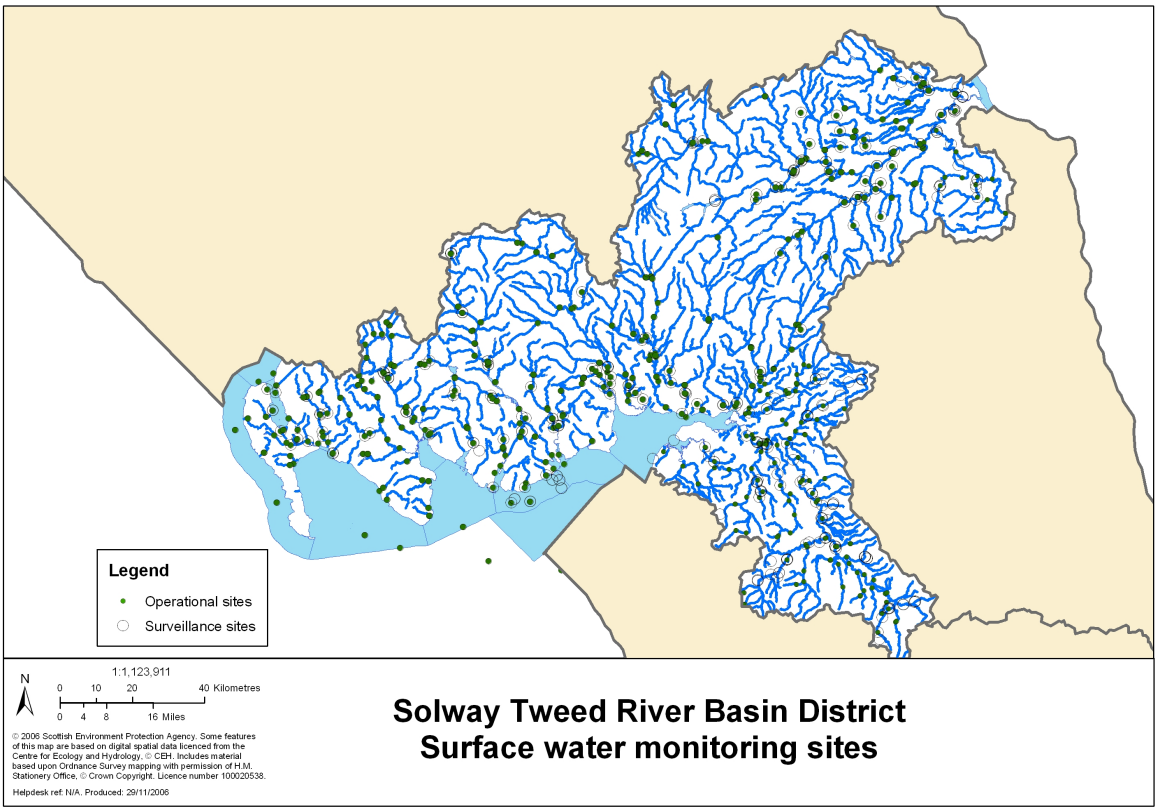


**Figure 1. Operational and surveillance surface water monitoring network for Solway Tweed**

As this is a risk-based network, the majority of freshwater operational sites are concentrated in areas of high agricultural activity or where acidification pressures have been problematic in the past.

Upland river catchments in Scotland have few pressures on them; this has resulted in few monitoring sites in these catchments, with rivers being grouped together on the basis of risk, typology and area and a representative sub-set monitored. The results from these sites will be extrapolated across the other water bodies in the group.

| | Solway Tweed | |
|---|---|---|
| Category | Chemistry | Ecology |
| River | 291 | 252 |
| Lake | 20 | 22 |
| Transitional | 31 | 77 |
| Coastal | 23 | 44 |
| Groundwater | 169 | N/A |

**(Table.2) Number of unique sites per water category, per administration**

Monitoring locations have been chosen to be representative of the water body they are in; generally only one location suffices to represent each water body.

Chemistry and ecology sites are typically paired on water bodies; some biological assessments require data from multiple sites, which may unbalance the relationship. Hydromorphological assessments are carried out at multiple sites in a water body and if a water body is subject solely to hydromorphological pressures no chemical monitoring has been carried out.

| Rivers | Environment Agency | Scottish Environment Protection Agency |
|---|---|---|
| Total number of km's of rivers | 1741 | 4300 |
| Km's of rivers at risk | 1410 | 2067 |
| Number of km's of "at risk" rivers per unique monitoring station | 8 | 6 |

**(Table.3) Monitoring per km of river length**

When considered as “monitoring per km of river”, SEPA has an equivalent density of monitoring to the Environment Agency.

### 3.2 Groundwater monitoring

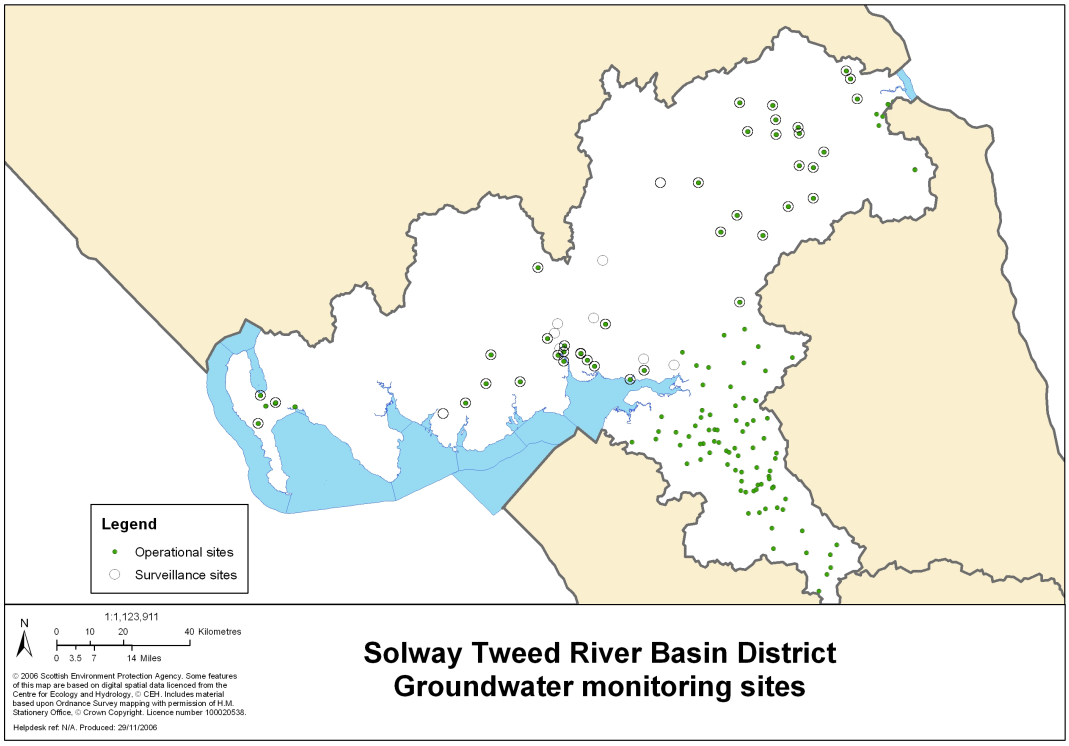


**Figure 2. Operational and surveillance groundwater monitoring network for Solway Tweed**

As shown (figure 2, table 2), there is a greater monitoring density for groundwater in England than in Scotland.

The Permian sandstones of the Eden Valley and the Carboniferous sandstone of the Berwick area are used extensively for water supply. Consequently they are heavily monitored, both to monitor the impacts of water abstraction and to ensure that there are no adverse changes in groundwater quality. With the exception of the Dumfries Basin aquifer, water supply in the Scottish area is mainly met from surface water reservoirs; consequently the monitoring network is less dense.

In accordance with UKTAG guidance, groundwater bodies of the same type and similar risk assessment result were grouped. Each grouping has a characteristic set of pressures and geological materials which form the focus of monitoring. Small areas of uncharacteristic geology or pressure will not generally be monitored. Monitoring points are associated with a particular group of groundwater bodies;

results from any one point in a group will be considered representative of the whole group and will form part of any aggregation of results across the group.

## 4.0 Monitored parameters

The WFD requires that all quality elements listed in the Directive are monitored in surveillance water bodies. For the operational network, the "most sensitive element" to the pressures on that water body must be monitored. Following discussions at UKTAG, the EA and SEPA have made a judgement on the most sensitive elements to different pressures thought to be acting on water bodies.

The tools used are listed in Annex 1. It has proved difficult to develop biological tools sensitive to hydromorphological pressures in time for use in the first RBMP, consequently both the EA and SEPA will be using surrogates to help classify water bodies at risk from these pressures.

For the first RBMP, where suitable historic data are available they will be incorporated into the classification (e.g. physico-chemical data will be monitored monthly for the two years of monitoring before the first RBMP, and one year of historic data also used to classify). For the 2015 and subsequent RBMPs, with 6 years to collect data in, the greater number of data points which will accrue will enable status assessments to be determined with greater confidence.

All the quality elements listed for a particular media will be monitored at surveillance sites, with the exception of phytoplankton in rivers. Fish monitoring in freshwaters has yet to be finalised, as the tool is not yet known.

## 5.0 Classification

The environmental standards have to be combined with the results from the biological and hydromorphological tools and the results of the chemical status assessments to make up an overall classification result.

Guidance on classification has been produced at an EU level and has been expanded on by a UKTAG group. This UKTAG guidance is being published for consultation in November and, once comments are incorporated and the report finalised, will be used to configure the classification system. The guidance will ensure that classification is carried out in a comparable manner between the EA and SEPA in the Solway Tweed. It has been agreed that SEPA will take the lead on those water bodies which form the border (i.e. are shared between the two agencies); SEPA will provide the EA with the results of this monitoring, as well as the raw data.

There is broad agreement between the EA and SEPA on what data/maps should be made available on our websites; an RBMP project has been set up in SEPA which will consult with EA colleagues on what is displayed. Maps for the whole of the Solway Tweed RBMP are likely to be available on a shared website.

## 6.0 Cost and affordability

SEPA and the EA have carried out a fundamental reappraisal of predecessor monitoring programmes and put in place an integrated and cost-effective programme. This exercise has released resources for the new network, which, supplemented by new income arising from the point-source regime and the newly regulated abstraction and engineering activities, will deliver the minimum programme

required to adequately meet our WFD obligations. It is intended that the network should be affordable on an indefinitely long-term basis.

## 7.0 Conclusion

The WFD is a wide-ranging and ambitious piece of legislation. SEPA and the EA have designed cost-effective monitoring and classification networks to meet the demands of the WFD and to provide data of sufficient quality and quantity to enable changes in water body status to be detected and the efficacy of programmes of measures to be determined.

14th of February, 2008

**Annex 1 Summary of biological tools deployed in the Solway Tweed area**

**Table a, Rivers**

| Pressure | Biological Quality Elements | Name of tool |
|---|---|---|
| Organic | Macro-invertebrates | Revised River Invertebrate Prediction & Classification System (RIVPACS) |
| Nutrients | Phytobenthos<br><br>Macrophytes | Diatom Assessment of Rivers and Lakes Environment Quality (DARLEQ)<br>Macrophyte Prediction & Classification System (LEAFPACS) |
| Hazardous chemicals | Macro-invertebrates | RIVPACS |
| Acidification | Macro-invertebrates<br>Phytobenthos | RIVPACS<br>DARLEQ |
| Abstraction | Macro-invertebrates<br><br>Hydrological surrogates | Lotic-invertebrate Index for Flow Evaluation (LIFE index). Not yet developed and tested for general use across the UK. Limited applicability geographically at present.<br>Hydrological surrogates, such as LowFlows2000 evaluation |
| Morphological alterations | Fish<br><br>Macrophytes<br><br>Morphological surrogates | Fisheries Classification Scheme (FCS). Not yet fully tested and capability of diagnosing impact of morphological pressures still be assessed. Would need further development to apply to all parts of the UK.<br>LEAFPACS. Not yet fully developed and tested for use across the UK. Capability to diagnose hydromorphological impacts currently under development.<br>MiMAS and River Habitat Survey techniques |

**TABLE B, LAKES**

| Pressure | Biological Quality Elements | Name of tool(s) |
|---|---|---|
| Organic | No specific tool developed, other tools expected to show response | |
| Nutrients | Phytoplankton,<br>Phytobenthos<br>Macrophytes | Phytoplankton (chlorophyll a & taxonomic composition) DARLEQ<br>LEAFPACS |

| | | |
|---|---|---|
| | Invertebrates | CPET |
| Hazardous chemicals | No specific tool developed, other tools expected to show response | |
| Acidification | Macro-invertebrate | Macro-invertebrate acidification tool 'WFD 60' (expected to be available from summer 2008)<br>CPET |
| Abstraction | Macrophytes<br><br>Hydrological surrogates | LEAPACS (expected to be available from spring 2008)<br>Assessments of flow etc.. |
| Morphological alterations | Macrophytes<br><br>Morphological surrogates | LEAPACS (expected to be available from spring 2008)<br>Lake Habitat Survey |

**TABLE C, TRANSITIONAL AND COASTAL WATERS**

| Pressure | Biological Quality Elements | Name of tool(s) |
|---|---|---|
| Organic | Benthic Invertebrates<br>Fish (transitional only) | Infaunal Quality Index (IQI)<br>Fish UK multi-metric |
| Nutrients | Phytoplankton<br><br><br><br><br><br>Macroalgae<br><br>Angiosperms | Phytoplankton toolbox –<br>a) Chlorophyll biomass index,<br>b) Seasonal succession index (possibly not available for Year 1 reporting)<br>c) Elevated taxa count index<br>Reduced species list (RSL)<br>Opportuntistic algae<br>Seagrass (intertidal only for Year 1)<br>Saltmarsh (classification tool not yet developed) |
| Hazardous chemicals | Benthic Invertebrates<br><br><br><br>Macroalgae<br>Fish (transitional only) | Infaunal Quality Index (IQI)<br>The Vas Deferens Sequence Index (VDSI) – imposex in dogwhelks (TBT specific)<br>Fuccoid extent tool<br>Fish UK multi-metric |
| Abstraction / change in freshwater flow | Benthic Invertebrates<br>Fish (transitional only) | Infaunal Quality Index (IQI)<br>Fish UK multi-metric |
| Morphological alterations | Morphological surrogates | MiMAS technique |