Research for Policy support

Contract n° 022603 (SSPI)

EAQC-WISE

European Analytical Quality Control in support of the Water Framework Directive via the Water Information System for Europe

Specific targeted Research Project

Scientific Support to Policies (SSP)

WP 2: Research and standardisation needs and recommendations

D28: Final recommended approach addressing research and standardisation needs

Due date of deliverable: Month 29
Actual submission date: Month 32

The deliverable authors are responsible for the content

Start date of the project: 1 December 2005 **Duration: 36 months**

AUTHOR:	Jaroslav Slobodnik
AFFILIATION:	EI
ADDRESS:	Okruzna 784/42, 97241 Kos, Slovak Republic
TEL.:	+421 46 5420719
E-MAIL:	slobodnik@ei.sk, projects@ei.sk
FURTHER AUTHORS:	WP2 partners

Revision [1]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Contents

1. Introduction

1.1. General objectives

The QA/QC tools required to provide reliable data for the WFD implementation are often the product of research and standardisation. New devices or new analytical methodologies for on-site or *in situ* measurements are emerging and their use will inevitably lead to alternative monitoring strategies aiming to improved efficiency in surveillance, operational and investigation monitoring. This implies that there is a need of innovation in appropriate QA/QC tools linked to these emerging analytical methodologies. Furthermore, quality standards and requirements on the QA/QC for already existing methodologies may also change, resulting in a need for new or improved QA/QC tools and/or procedures.

The main objective of WP2 is to describe to various stakeholders what underpinning research/standardisation has been delivered so far and what will be needed in the future with regard to QA/QC tools. It also describes approaches for prioritisation and commissioning such research/standardisation, both at the European and national level. An important outcome is to prevent duplication of research and standardisation efforts in EU Member States, and to facilitate the development and implementation of harmonised QA/QC tools and approaches that meet the requirements of European environmental regulations, in particular the WFD and its daughter directives.

1.2. Specific objectives

Regarding the above, one of the main tasks of WP2 was to describe the current situation and to identify the QA/QC knowledge gaps via a survey, which involved interviews with pre-selected target groups and projects and also a thorough review of selected projects using a template reflecting the key issues of the draft Commission Directive on technical specifications for chemical analysis and monitoring of water status.

The report of the survey has been used to formulate recommendations for future underpinning research and standardisation for QA/QC tools. The recommended approach will be then published at the pan-European QA/QC information portal and the CIRCA website.

1.3. Scope of the work and the survey

To collect the opinion of stakeholders an interview-based survey was conducted. Prior to this survey, the WP2 specific target groups of RTD projects were identified (for a list, see Table 1 below). It has been agreed that the selection of target groups and projects should preferably cover the following areas:

- *On-going or recently completed RTD projects dealing with AQC schemes;*
- *European research networks, projects or protocols dealing with specific WFD matrices (soils, sediments, suspended particulate matter, groundwater, coastal and transitional waters, drinking water (abstracted from surface water);*
- *EU-funded, national and basin-wide research projects related to the implementation of WFD for surface/ground/coastal/transitional waters.*

Table 1. List of organisations and projects selected for an interview within WP2.

PROJECT ACRONYM	CONTACT PERSONS/ORGANISATIONS-interviewEE-s	InterviewER-s
SWIFT	B. Roig, EMA	BRGM
METROPOLIS	INERIS (deliverables)	BRGM
NORMAN*	V. Dulio, INERIS	EI
HORIZONTAL*	B. Gawlik, JRC IES	BRGM
EVISA	J.P. Ghestem, BRGM	BRGM
QUASH*	S. Miserocchi, IGM	NIC
QUACHA*	E. Prichard	NIC
QUA-NAS	R. Morabito, ENEA	NIC
SEDNET	L. Amalric	BRGM
AQUATERRA*	D. Barcelo, CSIC	BRGM
BRIDGE	BRGM	BRGM
QUASIMEME	J. De Boer, RIVO (IVM)	NIC
OSPAR	P. Roose, MUMM	BRGM
WEKNOW*	KIWA	EI
ELBE*	UBA	IWW
RHINE*	RIVO, IVM, UBA	IWW
ODER*	UNIWAR	Warsaw University
The Netherlands – transitional waters		RIVO (IVM)
DANUBE	ICPDR	EI, IWW, NIC
Danube Delta*	Danube Delta Institute	EI
Baltic Sea*	UBA, UNIWAR, SP	Warsaw University
North Sea*	RIVO, IVM, WRc	NIC
Mediterranean Sea*	CSIC, ENEA, JRC	NIC
Black Sea*	Black Sea Commission	EI
FRANCE - groundwater	BRGM	BRGM
AUSTRIA - groundwater	IFA Tulln	IFA Tulln
The Netherlands - Chemistry and biology for environmental studies**	S. van Leeuwen, Vrije Universiteit, IVM	NIC
France - Inorganic Chemistry for environmental studies**	J.P. Ghestem, BRGM	BRGM
France - Organic Chemistry for environmental studies**	L. Amalric, BRGM	BRGM
IdentVal**	P. Balsaa, IWW	IWW
MODELKEY**	P. Leonards, IVM	IWW
Sava River Basin: Sustainable Use, Management and Protection of Resources**	R. Milačič, Jožef Stefan Institute, Slovenia	NIC

* Projects/organisations either did not deal with AQC issues or not responding.

** Projects/research areas identified as additional candidates for an interview.

In addition to the above, a larger group of organisations and projects were addressed via a common questionnaire (D 13) developed in cooperation with WP1, 3 and 4.

The interviews have resulted in information on the aims of the projects, on their key findings, and on some ideas about current QA/QC research gaps and needs. However, this information was difficult to categorise and to use. Serious concern arose whether the expressed views (of the persons interviewed) were sufficiently representing the state of the art and the conclusions and opinions of the whole consortia of the reviewed projects. Furthermore, some of the information on current results and future research needs was not directly connected to QA/QC issues in support of the WFD and other European environmental policies. It was therefore decided to carry out a second round of this review focussing on the "official" deliverables (reports, publications) of selected key projects. The criteria for selecting the key projects were:

(i) Significance of the project outcomes for the WFD implementation;

(ii) The extent of QA/QC issues addressed within the project;

(iii) Significance of the project outcomes for monitoring of the water status in line with the Article 8 WFD and for river basin management in general.

The second review searched for results and formulated research needs that are closely related to QA/QC issues in support of the WFD. For this purpose, a specially tailored template had been developed as a guideline for "information mining" in reports of selected research projects. The structure had been derived by use of:

- Draft Commission Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status;
- Elements of the blue print for a pan-European QA/QC system (as far as it can be foreseen at the current state);
- Results of the first stage of the survey in WP2.

The design of the template took into account that the applicability of the results or developed QA/QC tools will often be limited to:

- Specific type of monitoring (e.g., surveillance monitoring, operational monitoring, investigative monitoring, monitoring in protected areas);
- Specific matrix (water, biota, SPM or sediment);
- Specific type of water body (e.g., ground water, surface waters, coastal waters…);
- Specific type or group of parameter(s), e.g., priority substances (or some of them), "other pollutants", physico-chemical parameters.

The list of the reviewed projects/activities along with an indication of the extent of the QA/QC gaps identified by the reviewers is shown below. The assessment of the level at which the QA/QC gaps were identified was based on the amount of the relevant information extracted through the process. In practice, the information content of the review depended on how far the QA/QC issues were dealt with by the reviewed project and on an extent of QA/QC gaps formulated in project documents..

Project	Project scope	Reviewed by	QA/QC gaps identified * (level covered by the review)
QUASIMEME	Development of a holistic quality assurance program for marine environmental monitoring information in Europe	NIC	low
SWIFT	Development of screening methods for WFD compliant monitoring	BRGM	high
BRIDGE	Background criteria for the identification of groundwater thresholds	BRGM	low
SARIB	QA/QC practices in the Sava River Basin	NIC	low
CEEAM	Centre of Excellence in Environmental Analysis and Monitoring	UNIWAR	low
SEDNET	European Sediment Research Network	EI	medium/high
DANUBS	Nutrient management in the Danube basin and its impact on the Black Sea	EI	low
ICPDR	QA/QC practices in the Danube River Basin	EI	medium
IdentVal	Analytical Quality Control in the identification of organic trace compounds	IWW	medium

*** The level of QA/QC gaps identified is based on an overall expert judgment on how far QA/QC issues were addressed within the reviewed project and what is an extent of QA/QC gaps formulated in project documents.**

Information collected during both reviewing rounds was compiled into this report. The structure of this report is based on the structure of the questionnaire used in the second round.

2. Monitoring programmes

Focus of the review was given to the issues concerning the design of monitoring schemes (e.g., strategies and tools for development or definition of a conceptual model, identification of different monitoring zones, criteria and procedures to check for representativeness of monitoring zones and locations), identification, selection or prioritisation of monitoring parameters as well as the execution of monitoring programmes for water status assessment and/or load assessment.

2.1. New screening methods

SWIFT project dealt with the integration of screening methods/emerging tools (SMETs) into EU, national and local monitoring strategies and with the assessment of the impact of these methods on decision making. In the WFD context, SMETs have limited potential to be used in surveillance and operational monitoring – apart for passive samplers, multiparameter probes and sensors that might play some role; potential applications of SMETs are more significant in investigative monitoring where more flexibility is available and the environmental problems and uncertainties to be investigated are expected to be highly diverse. However, within future monitoring systems, they have a potential to deliver better information on water quality and thus enable enhanced decision making. Better information should receive more attention because of its long-term implications – as opposed to sufficient (minimum) information for reporting and for complying with the requirements of the WFD that receives most of the attention of countries when designing their WFD monitoring programmes.

Portable sensors could provide cost savings in countries with high labour costs and, passive samplers could provide additional information on water quality for decision makers at much lower costs than could be obtained by spot sampling. SMETs often can provide more comprehensive information on the status of the aquatic environment. But it is unclear how this information can be used in the decision making process and whether better information effectively leads to better decision and ultimately better water quality. Investigating this further would require understanding uncertainties along the information chain from the collection of data, their analysis, reporting, use of the data for policy decision and selection of actions, the implementation of actions and their monitoring and evaluation. It is interesting to note that the link between better information and decision making would require more attention and research, the same issue and the value of additional monitoring was also discussed in the European policy arena, for example in the context of the adoption and implementation of the groundwater directive or of the marine strategy.

2.2. Sediments

One of the objectives of the SedNet project was to identify and quantify those 'emerging pollutants' that are relevant for the aquatic system (and sediments), to determine their behaviour in the aquatic system and incorporate them in models at the river basin scale.

The following recommendations on sediment monitoring design were drafted: frequency of sediment monitoring should be specified further, and could range from once or twice per year to once every 5 to 10 years depending upon the sedimentation rate. Sediment samples could be collected randomly at the designated sampling point and the location of each should be recorded. Samples should be collected at the same time of the year for each sampling occasion, the time being chosen according to local circumstances, bearing in mind the aim of monitoring trends in the concentration of contaminants. The purpose of sediment monitoring guidelines is to assess long-term trends in impacts of anthropogenic pressures and to ensure no deterioration limit is reached and that comparable data are collected.

In case ecological criteria of the WFD are not met, a check may be needed on the role of sediment contamination. This requires sediment-quality assessment approaches (cause-impact analysis) that can be linked to the WFD.

It is essential that the quantitative objectives are determined before any monitoring programme is started. For instance, the quantified objective could be to detect an annual change of 5% within a time period of 10 years with a power of 90% at a significance level of 5% with a one-sided test. The necessary or possible power of a monitoring programme will vary with the purpose of the investigation and with the contaminant, matrix and area being investigated. It is thus not possible to specify values for all situations. It is the duty of the programme manager to specify the extent of the changes the monitoring programme is expected to identify and at what power, or for the programme executor to estimate what is possible to achieve.

Other recommendations were:

- SedNet recommended criteria to select the target compounds to be monitored in sediments. The selection of target compounds to be monitored in sediments should be based on:
  - Persistence;
  - Bioaccumulation/adsorption;
  - Toxicity;
  - Relevance at the large scale (river basin);
  - High fluxes (tendency to increase concentrations/fluxes on a long-term basis).

  Addition or replacement of pollutants should be based on the results of present and future monitoring programmes and on the results achieved by RTD projects where the identification of new or emerging contaminants takes place.
- Sediments and/or suspended particulate matter (SPM) should be included in river monitoring plans. Substances which tend to accumulate in the geosphere and are transported bound to particles may better be measured in the SPM than in the water phase, which is particularly important for some new groups of compounds included in the WFD, such as flame retardants (PBDEs). It is clear that transfer of contaminants from the sediments to the water column through processes of diffusion, advection and sediment re-suspension is a major factor. SedNet recommends that a river monitoring plan should necessarily include monitoring of the SPM, in order to obtain a holistic picture of the contamination status of the whole river basin. In this respect the contaminants in SPM generally represent “current” rather than historical pollution, as they will ultimately lead to “new” deposits of contamination, and newly settled material is the main food source for detritivorous benthic organisms.
- Monitoring should include assessment of the bioavailable fractions of contaminants, in both the laboratory and the real field situations. The relation between sediment quality and risks is complex and site specific, requiring assessment methods based on bioavailable contaminant fractions and bioassays results rather than on the traditional total contaminant concentrations.

2.3. Groundwater

Organisation of the groundwater monitoring networks is very diverse and differs from a country to another. These differences probably derive from the definition of a “monitoring network”. The network organisation is of major importance to understand QA/QC issues. From a network to another, analytical strategies will be different (different involved laboratories, different requirements for sampling and analysis). This is even the case for one single network when, e.g., for practical reasons the network manager asks different labs to perform the sampling and/or analysis.

2.4. Gaps identified

- Interlaboratory comparison to be an integral part of monitoring programmes in the international river basin districts;
- Harmonisation of environmental standards for estimation of quality of sediments;
- Development of guidelines for monitoring contaminants in sediment; Establishment of harmonised approaches to setup monitoring programmes based on quantified objectives.
- Sediments and/or SPM to be included in river monitoring plans;
- Monitoring should include assessment of the bioavailable fractions of contaminants, in both the laboratory and real field situations;
- Further exploration of the potential of screening methods/emerging tools towards providing necessary information on water status.

3. Sampling and sample handling

Reported results in literature generally lack sufficient information on sampling. Often it remains unclear whether the reported results really represent the process being described. Sampling is an integral part of the whole data acquisition process and any uncertainty included increases the total uncertainty of reported data. Therefore, attention should be paid to proper sampling.

There is a large variety of sampling procedures and equipment currently available and new tools are continually being developed. The need of an adequately validated method for a particular matrix (including uncertainty estimation) is recurrent. Different aspects of sample collection and processing were addressed in the enquiry resulting in the conclusions and gaps stated below.

3.1. Surface waters

Within the SWIFT project an evaluation of analytical variability/uncertainties in relation to real environmental changes was conducted on a river (Meuse). In this context, the uncertainty related to the sampling stage was investigated.

The assessment of the impact of sampling on the overall measurement uncertainty could not be treated without considering the analytical measurement associated. Consequently, the first step of the process to follow was the estimation of the analytical uncertainty. The second step was the deduction of the uncertainty due to the sampling process itself from the global uncertainty and third to identify the contribution of each factor listed (before) in this uncertainty.

There were two categories of factors in the global uncertainty of sampling:

- The uncertainty due to the sampling process itself (pumping, tube, flow rates …);
- The uncertainty due to physico-chemical sample preparation (sub sampling effects on the field or in the lab, filtration effect, flask effect …).

A PT exercise on the field for sampling would be very interesting in terms of comparison of results. Sampling protocols have to be adapted according to both the measurand and environmental conditions (river, lake, ground-water) where depth effects could be observed.

The DANUBs project formulated following recommendations for river water sampling within a load assessment programme in an international river basin:

- The results of the study on determination of the bio-available phosphorus forms indicated that the particulate phosphorus and/or its particular fractions are an important part of phosphorus load. Therefore, analysis of the sediment (SPM) bounded phosphorus and/or its particular fractions (leachable with NH_4Cl, NaOH or HCl), should be included in the monitoring network; Implementation and later standardization of such approach would require further investigation on solid phase – based phosphorus pathways and balance. A concerted approach of the assessment procedures on phosphorus loads in future is essential.
- The transects (cross-sections) for load calculations should be selected on the basis of detailed preliminary surveys demonstrating cross-sectional variations in the concentration of the determinants as well as flow velocities, at low-, medium- and high flow conditions. Based on such a preliminary survey, the number and position of samplings should be defined. In general, three locations in the cross-section (left, middle, right) could be sufficient but one sample (from the middle of the river) of a well-mixed cross-section might be enough. The required number of samples may vary also according to the flow conditions (e.g., one sample could be appropriate at high flow but three samples in the cross-section would be needed at low water condition);
- The possibility to use systems for continuous observation of the water quality in order to arrive at accurate load estimates should be investigated;
- Additional sampling during flood events would improve the load calculation of pollutants, e.g. nutrients (total-N and total-P), as the loads could be significantly different during flood period.

3.2. Marine sampling

- There is still need for harmonization of methods among laboratories and for development of related QA/QC procedures.
- Use of passive samplers is a promising field. It still requires further development but allows determining the true dissolved concentration of contaminants in the water column (as mentioned above it is a good alternative to the grab water sampling).
- On-site sample treatment is particularly interesting if high volumes of water need to be extracted, e.g., because of the low concentrations in marine waters. *In situ* extraction of contaminants by, e.g., SPE has been tested and is more elegant than transporting large quantities of water to shore. Also here, there is further room for harmonization of methods and the development of related QA/QC procedures.

3.3. Groundwater

Groundwater sampling requires special methods for, e.g., sampling of the unsaturated zone, sampling of deep boreholes, sampling of mining water and sampling of new types of contaminants. Specific methods have also been developed for sampling and analysing very small groundwater samples, e.g., system Geoprobe, Power Probe, which enables collection of samples while penetrating into the ground vertically or at a determined angle. High-resolution vertical sampling of shallow aquifers can be accomplished using direct-push methods. In deep exploitation wells (>100 m), purging of standing water is difficult and time consuming. In such situations, samples from conventional samplers often do not represent the defined depth interval. Finally, severe difficulties in sampling occur for low-yield monitoring wells. In such cases, several alternative methods of sampling have been proposed: (i) passive diffusion bag (PDB), (ii) minimum-purge sampling and (iii) use of a device to “core” the water column in the well screen without disturbing the water column.

The first progress in estimation of groundwater sampling uncertainty has been reported by the project METREAU (Charlet and Marschal, 2004; Roy and Fouillac, 2004), which has developed a methodology for estimating the uncertainties linked to the entire analytical chain, from the sampling stage up to analytical results. This methodology is based on the use of groundwater chemical logs acquired in the field for evaluating field heterogeneity and identifying water levels to be sampled. The methodology was validated through specifically-designed repeatability and reproducibility tests carried out in the field. These first results illustrate that an international consensus on the best-suited methodology to be applied is strongly required. It was validated through specifically-designed repeatability and reproducibility tests carried out in the field. This study permitted estimation of the representativeness of groundwater sampling and calculation of the associated sampling uncertainties in order to establish an overall evaluation of the impact of field activities compared with analytical measurements. As an example, it was possible to calculate that, for Pb concentrations in groundwater being around 1 µg/l, sampling uncertainty would not exceed 18% of the measured value if a refined sampling strategy and procedure is applied. By contrast, if sampling is limited to a single sample collected at random (“blind sampling”) in the water column, the uncertainty at such a low concentration approaches 100%. The result illustrates the requirement of an international consensus on the methodology best suited to field sampling application. It implies the necessity of a global estimation of the analytical chain uncertainty in order to well estimate the quality of groundwaters, otherwise major inconsistencies and/or erroneous interpretations may arise in environmental monitoring programmes.

3.4. Sediments

It is essential to ensure reproducible sediment collection and sample handling procedures. Sediment samples should be collected at an appropriate frequency that will have to be defined on a local basis, taking into account the sedimentation rate of the studied water body studied and hydrological conditions (e.g., flood events). Typical sampling frequency will vary from once every 1 to 3 years for large rivers or estuaries with high sedimentation rates, to once every 6 years for lakes or coastal areas with very low sedimentation rates. A maximum interval of 6 years is suggested, in order to suit the WFD 6-years cycles.

The locations for sediment trend monitoring should be representative of a water body or a cluster of water bodies. Where possible, sampling should be performed in non-erosion areas, to obtain sediment with a relatively high content of clay and silt that will most likely contain measurable levels of contaminants. For dynamic systems it might be useful to collect SPM for monitoring purposes.

In spatial surveys, sampling points should be distributed throughout the area, taking account of the known distribution of contaminant inputs. If point sources of contamination are of interest, the positioning of the stations should aim at obtaining gradients. The sampling depth should be decided on the basis of the sedimentation rate (if known). Denser sampling grids are required close to point sources than in areas of diffuse contamination, and also in areas of uneven bottom topography compared to more uniform areas. Analysis costs can be reduced by using composite sampling techniques (i.e., pooling of sub-samples). To test the representativeness of a single sediment sample at a given location, several cores or grabs should be taken as a minimum at one or two stations to obtain information on the variability of the sediment contamination by replicate sampling and analysis. In case of heterogeneity of sediment sub-samples, it is advisable to collect several samples at each site and pool them into a composite sample.

As a general principle, the sampling equipment should not unduly alter the properties of the sediment (e.g., by contaminating or disturbing the sample or losing the surface layer). A wide range of sampling devices is in use for sampling sediments. The choice of equipment should be made depending on the local conditions at the site of sampling site (water depth, type of sediment, etc.), bearing in mind the objectives of the sediment sampling. Box or tube corers that are capable of sampling the surface sediments without disturbing the structure and are relatively free from “edge effects” are recommended. Grab samplers (e.g., Van Veen, Eckman-Birge) can only be used provided they do not disturb the sediment. Manual sampling can also be used for shallow waters or tidal areas.

The choice of a relevant sampling depth of the top layer of sediment should be made depending on the local conditions at the sampling site, and should relate to the bio-relevance and to the sedimentation rate. In principle, a sediment top layer sampled should be between 1 and 10 cm thick. The amount of sample collected will have to be adapted to the parameters to be determined at each site. In principle, a sample total size of 100 g wet weight should be sufficient.

During sediment sieving it is necessary to investigate the consistence of a sediment sample, i.e., small particles like silt or clay are heavily loaded whereas large particles (gravel and stones) are almost not polluted compared to their weight. Nevertheless sieving is a severe interference into the natural structure and composition of a sediment sample. Major interferences are:

- Disturbance of layer structure;
- Shifts in oxygen ratio and redox-potential and thus remobilisation of adsorbed substances (e.g. trace metals);
- Losses of pore water, which might be heavily polluted;

On the other hand no further selection of a certain grain size fraction is necessary and thus danger of losses of contaminants is low.

Freeze-drying is a suitable method for VOCs sampling and transport because all water is lost by previous fractioning, which protects samples from losses of volatile compounds (e.g., mercury) and contamination by contact with air. Freeze-drying of sediments facilitates transport and improves storage of sediments. In certain instances, it is absolutely essential for the preservation of contaminants. However, drawbacks are that it may result in contamination and/or losses of contaminants. Inconsistent results have been reported for freeze-drying of sediments as in one case it protects samples against cross-contamination and further losses (GW AUSTRIA) in another case it may result in both contamination and/or losses of contaminants (OSPAR, QUASIMEME).

3.5. Biota

Difficulties that have to be taken into account during biota sampling:

- Can the test organism be found in the reach of the sampling site of interest?
- Is the test organism in a needed stadium of growth?
- Is it possible to achieve comparable results (species, compartments, geographical areas)?
- Sampling depends significantly on season and water discharge;
- There are no common quality criteria at the time.

A useful source of information is the OSPAR guidelines for marine sampling.

3.6. Passive samplers

The use of passive samplers is a rather promising field. However, there is still not sufficient understanding of this sampling procedure. This can affect interpretation of obtained results. Passive samplers are mostly used for determination of true time-weighted average concentration of dissolved contaminants in water, however, further development is still required especially for their calibration and validation. Passive sampling is a useful alternative to the conventional water grab sampling. Other advantages are:

- Low costs;
- Gives good results, if the right questions are asked.

One of the advantages of using passive diffusion bag (PDB) samplers for collecting groundwater samples from monitoring wells is that there is essentially no disruption of the flow in the well during sample collection, because no pumping occurs. The effectiveness of PDB samplers relies on assumptions with respect to vertical flow in the borehole or horizontal flow across the screen. The PDB samplers require sufficient horizontal flow across the screen to obtain representative information about the sampled water horizon. The existence of vertical flow in boreholes with long screens, induced by differences in hydraulic heads, may also yield erroneous results obtained by PDB samplers. PDB samplers were tested also in multilevel monitoring wells. PDB samplers have several limitations and, as a result, are not widely accepted by regulatory agencies for use in groundwater sampling programmes. The primary limitation is that they are suitable for only a relatively small number of VOCs, although they are useful for many other inorganic and organic constituents. The method is rapidly developing and new modifications are recommended as commercial products.

A special case of passive ground water sampling is minimum-purge sampling that offers one of the best alternatives for collecting samples for all categories of naturally occurring substances and dissolved contaminants including VOCs, SVOCs, metals and other inorganics, pesticides, PCBs, other organics compounds, radionuclides, and microbiological constituents. The critical assumption is that vertical flow is absent in the well during sampling.

The project CEEAM tested passive sampling in polluted waters and recommended to improve and design new passive dosimeters. Missing validation of passive sampling procedures was highlighted, which is in line with conclusions from the SWIFT project.

3.7. Gaps identified

- Missing validation of passive sampling procedures;
- Insufficient proficiency testing for sampling;
- Complex approach to be adopted for load assessment sampling with special attention given to additional sampling during flood events (especially for nutrients), as the loads could be significantly different during flood periods;
- Harmonization of sampling methods and development of related QA/QC procedures for all types of waters (surface water and groundwater);
- Initiate development of a community-wide technical guidance on sediment sampling and handling, analytical techniques and normalization procedures;
- Lack of harmonized or standardized sampling validation schemes (e.g., blanks for all type of matrices - biota, SPM, ground water, sediments, on-site sample treatment) and procedures for reasonable estimation of sampling uncertainty;
- Lack of commonly accepted quality criteria for biota sampling;
- Lack of QA/QC criteria and proper validation of time-integrated sampling techniques;
- Missing studies on the effect of freeze-drying on the analytical results and estimation of measurement uncertainty;
- Missing QA/QC studies of influence of sample transport, storage and sample pretreatment on analytical results.

4. Methods of analysis

4.1. Emerging methods

Feedback from interviews indicated that immunoassay might represent an alternative for certain compounds because biological methods (bioassays, biosensors) are increasingly promising and getting able to perform measurement of priority pollutants more rapidly and at the sensitivity levels comparable or better to those of chromatography.

A monitoring of “newly emerging” types of substances requires also appropriate QA/QC measures to determine if the applied analytical methods are fit for purpose. For many substances, this requires significant efforts, such as development of novel analytical methods, interlaboratory studies (e.g., for brominated diphenylethers, C_{10-13} chloroalkanes, nonylphenols, octylphenols, perfluorinated surfactants), training of personnel and the availability of sufficiently characterised CRMs. It was pointed out that with the closure of the EU-Measurements and Testing program (EU-BCR), the availability of CRMs for brominated diphenylethers and alkylphenols is no longer guaranteed, whereas CRMs for C_{10-13} chloroalkanes have not been developed yet.

The main objective of the SWIFT project was to test and assess the performances of screening methods in the frame of the WFD. The tested screening methods (immunoassays test kits, chemical test kits, portable instruments, passive samplers, biological early warning systems - BEWS) appeared to be very powerful and in several cases lead to relevant complementary information on water quality variability and composition, and enhanced the understanding of chemical status of water resources. Some of the limitations (poorly defined uncertainties, difficulties in controlling operational conditions, and dependence on spot sampling) of on-site methods were also identified.

In situ methods have the advantage that they avoid the problems associated with sample handling and preparative steps, but suffer from incomplete validation, susceptibility to matrix effects, and difficulty in standardizing operational conditions. Alternative sampling strategies (primarily based on passive sampling) can provide more representative information on levels of pollution over deployment times of days to weeks, and can bring trace levels of pollutants above the levels of detection, but there is a need for further validation of these procedures. Biological methods (biomarkers, bioassays, and BEWS) provide information that is fundamentally different from that provided by the chemical monitoring tools in that they are not focused on any defined pollutants, and can detect problems caused by interactions between pollutants. However, they are not universally applicable, and do not give an indication of the chemical nature of the problem. Overall, the main strength of the new methods is that they can provide more representative information in a cost effective way (e.g., particularly where rapid or detailed mapping is needed following a pollution event, such as a major chemical spillage).

One of the other objectives of the SWIFT project was also to develop a new generation of sensors for the detection of priority pollutants.

One of the goals was detection of inorganic phosphate by bioelectro-chemistry. Procedures for the optimisation of the sensor and its performance evaluation were proposed. In particular, experimental conditions were optimised according to repeatability performances. LOD in standard solution was evaluated and reference material was used in a first validation approach. The second system concerned the toxicity and PAH detection: two biosensors (light on and light off) based on the same bacteria have been proposed. These tools are still under development and have not been tested on the field yet.

4.2. Analysis of sediments

For most of the priority substances likely to be found in sediment, standardized methods of analysis are available. However, majority of these methods have been developed for (contaminated) soil. It is therefore common practice in routine laboratories to dry the sediment samples and then to treat them in the same way as soil samples. Although this practice may lead to correct results, it is not recommended for sediment monitoring. As not only the digestion methods for the determination of metals but also the extraction methods for the determination of organics are operationally defined procedures, it is absolutely essential that these first steps in the analytical process remain more or less exactly the same over a long period of time. This is particularly true for organics, since there are no field-moist certified reference materials available to verify the recovery of an extraction procedure.

For trend monitoring, the recovery of the extraction procedure should be constant over time; If this can be guaranteed, it is not necessary to know the numeric value of the recovery. In the case of compliance monitoring, the numeric value of the recovery should be known, or a standardised procedure should be specified for each (individual priority substance or group of) priority substances.

The analytical methods applied after extraction or digestion are generally the same for water and sediment samples. Application of standardized methods is recommended, because these methods have been finally validated in interlaboratory trials. The use of a standardized method should only be made mandatory if the analysis or the quantification contains "method-defined" parts. This is the case, e.g., for the selection of congeners of brominated diphenyl ethers, the quantification of alkylated phenols, and both the selection and quantification of C_{10-13} chloroalkanes. For the latter group of compounds, standardization has not even started.

Progress was made also in development of techniques evaluating environmental risk & hazard of sediments based on biological responses such as Effect Directed Analysis (EDA) and Toxicity Identification Evaluation (TIA).

For proper QA/QC procedures, including the determination of measurement reliability, certified reference materials must be available. For many organic priority substances no suitable certified reference material (CRM) are at hand, even not as the commonly dried, milled and sieved materials. A concerted action for development of a series of suitable CRMs is highly recommended, even in the case of sediment trend monitoring.

Furthermore it is recommended that laboratories participate in suitable interlaboratory comparisons. This will already be the case for the most common priority substances. For the less common priority substances a concerted action to set up a scheme for international interlaboratory trials is recommended, because the number of national laboratories involved in sediment monitoring may be quite low.

Normalization is a procedure to correct contaminant concentrations for the influence of the natural variability in sediment composition (grain size, organic matter and mineralogy). Most natural and anthropogenic substances (metals and organic contaminants) show a much higher affinity for to fine particulate matter compared to the coarse fraction. Constituents such as organic matter and clay minerals contribute to the affinity of contaminants in this fine material.

Fine material (inorganic and organic) and associated contaminants are preferentially deposited in areas of low hydrodynamic energy, while in areas of higher energy, fine particulate matter is mixed with coarser sediment particles which are generally unable to bind contaminants. This dilution effect will cause lower and variable contaminant concentrations in the resulting sediment. Obviously, grain size is one of the most important factors controlling the distribution of natural and anthropogenic components in sediments. It is, therefore, essential to normalize for the effects of grain size in order to provide a basis for meaningful comparisons of the occurrence of substances in sediments of variable granulometry and texture within individual areas, among areas or over time.

When analyzing whole sediment (i.e. < 2 mm fraction) for spatial distribution surveys, the resulting maps give a direct reflection of the bedded sediments. If samples used for a spatial survey consist predominantly of fine material, the influence of grain size distribution is of minor importance and may probably be neglectable. However, in areas with varying grain size distributions, a map of contaminant concentrations will be closely related to the distribution of fine-grained sediments, and will obscure the true spatial distribution of contaminants. Also in temporal trend monitoring, differences in grain size distribution can obscure trends.

Two different approaches are widely used to correct for variable sediment compositions:

- Normalization can be performed by relating the contaminant concentration with components of the sediment that represents its affinity for contaminants, i.e. binding capacity. Such co-factors are called normalisers. Normalization can be performed by simple contaminant/normaliser ratios or linear regression. Another procedure takes into account that the coarse sediment fraction contains natural metal concentrations in the crystal structure. Combinations of co-factors, possibly identified from multiple regression analysis, can be used as normalisers.
- Isolation of the fine fraction by sieving (e.g. <20 µm, <63 µm) can be regarded as a physical normalisation to reduce the differences in sediment granulometric compositions. It is applicable to both metals and organic contaminants. Consequently it removes the coarse particles, which usually do not bind anthropogenic contaminants. Then, contaminant concentrations measured in these fine fractions can then be directly compared. Subsequently, the geochemical differences in sediment composition due to geochemical nature remaining after sieving can be further corrected for by the use of co-factors.

Further details on normalisation are provided in the technical annex of JAMP guidelines for monitoring contaminants in sediments (OSPAR, 2001). Statistics on the normalisation procedure can be found in an annex to a report of a working group on marine sediment of ICES (International Council for the Exploration of the Sea): http://www.ices.dk/reports/MHC/2002/WGMS02.pdf.

4.3. Gaps identified

- Appropriate validation procedures are often missing - a well-documented toolbox containing an appropriate range of validated, fit-for-purpose monitoring tools would facilitate the cost effective implementation of the WFD across Europe;
- Lack of standardized protocols for the application of the tested screening methods, though standards are available for some toxicity tests (e.g., ISO 11348 for the Microtox assay, and BSI PAS61 for passive sampling). This area must be addressed, if these methods are to become more widely accepted by the regulatory monitoring community;
- Development of quality-assurance procedures for some of the emerging methods to allow harmonious monitoring across Europe for all emerging techniques to ensure reliability and comparability of data is an essential issue. The classical approach to this, as used in accrediting classical laboratory analytical procedures, is not universally applicable (e.g., in passive sampling where large volumes (hundreds of litres) of reference materials would be needed). This would be prohibitively expensive

using available reference materials. A different approach is necessary, and this might involve the use of reference sites, or novel types of reference materials, such as pelletized reference compounds, that can be suspended to produce large volumes of homogeneous standard solutions. This would enable the use of proficiency testing schemes to establish the uncertainties associated with these methods. Only when this has been achieved, such methods will become acceptable in compliance monitoring. For on site spot sampling methods, the main issue is to develop quality assurance procedures for the sampling stage;

- There is a need to develop validation procedures and also to propose appropriate RMs for biological methods evaluation;
- Lack of knowledge about matrix effects on *in situ* sensors and on-line analysers;
- Development of a series of suitable CRMs for sediment analysis;
- Laboratories participate in suitable interlaboratory comparisons. This will already be the case for the most common priority substances. For the less common priority substances a concerted action to set up a scheme for international interlaboratory trials is recommended, because the number of national laboratories involved in sediment monitoring may be quite low;
- Missing data about method performances and measurement uncertainties for metal analysis at very low concentration level;
- Missing PT schemes at low concentration level and for speciation analysis;
- Lack of various specific contaminant-matrix CRM;
- Missing procedures for background level determination in water and sediments;
- Absence of harmonisation in analytical techniques for sediments.

5. Minimum performance criteria for methods of analysis

The current version of the draft Commission Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status stipulates that Member States shall ensure that the minimum performance criteria for all methods of analysis applied are based on an uncertainty of measurement of 50% or below (k = 2) estimated at the level of WFD relevant environmental quality standards and a limit of quantification equal or below a value of 30% of the WFD relevant environmental quality standards.

Requirements on data quality depend on the purpose of the data use. Trend analysis may require other quality aspects than compliance checking. Thus the pursuer of the data has to lay down minimum quality criteria in advance. These criteria should however comply with the existing approaches, methodologies and guidelines. There can be a pressure to adapt temporarily the requirements to the monitoring information available, e.g. if the quality of the data or the performance of existing methods cannot be increased within short time periods.

As a methodological help OSPAR has developed a toolbox for trend analysis and checking against background concentrations and environmental assessment concentrations. Contracting Parties to OSPAR are required to submit information on quality assurance along with the monitoring data.

Determination of threshold values for different compounds is a rather complicated process. In an analytical method the measurement uncertainty affects the interpretation of a result. When comparing the analysed values with a given threshold value, the measurement uncertainty must be taken into consideration at the interpretation of the results. This is particularly critical when the TV (threshold value) is near the LOQ (limit of quantification). The nearer the concentrations are to the LOQ, the higher are measurement uncertainties. The most important validation parameters concerning threshold values and the estimation of the measurement results are limit of quantification and measurement of uncertainty.

5.1. Identification of organic trace compounds at low concentration levels

Usually, an evaluation of the fitness-for-purpose of analytical methods (and the competence of laboratories as well) is mainly based on the performance with respect to the criteria “trueness” and “precision”. It is usually not evaluated whether a substance has been identified correctly or not.

The aim of the project IdentVal was the development of performance criteria of analytical methods to assess the reliability of analytical data with respect to the correct identification of organic trace compounds at low concentration levels (close to the detection limit). This is of special importance as for a number of priority pollutants of the WFD, EQS values are close to (or even below) the detection limit of the currently available methods. For measurements at this level, the correct substance identification is a matter of concern.

Numerous factors have been investigated with respect to their impact on the correctness of the identification of organic compounds at trace levels. Two statistical criteria have been developed that can be used to evaluate the reliability of the correct identification of organic compounds. Statistical models have been used to investigate the effect of external factors on the dispersion of these criteria. The two criteria that have been identified as useful tools relate to the variation in relative retention times [z_{RT}-score], and the variation in relative signal intensity [z_I-score]. Mathematical procedures have been developed that can be used for internal QA/QC procedures in analytical laboratories, e.g. by control charts. The advantage of the developed identification criteria is that they can be derived/calculated from information that is usually available from common QA/QC routine procedures in analytical laboratories, without any additional measurements or tests (e.g. control samples).

A common system or set of identification rules is desirable for any standardised method that is used to monitor EQS values at low concentration levels. The development of such identification rules should be linked to the implementation of a QA/QC system. The findings of the IdentVal project indicate that without such a system, there will be an alarmingly high rate of false negatives and false positives for concentrations close to the LOQ. Differences in performance of laboratories with regard to the correct identification will range over approximately two orders of magnitude, which will not become evident from common PT schemes.

Therefore, the implementation of performance criteria related to the correct identification of substances into a pan-European QA/QC system seems desirable. However, the applicability of the approach developed in this project needs to be checked in more detail. In particular, the applicability to all those analytical methods should be checked where requirements of the WFD are challenging the potential even of state-of-the-art methods. The applicability of the approach to other sample/water matrices also needs to be investigated in more detail.

5.2. Gaps identified

- Ensure a coherent approach to the development of minimum performance criteria for all methods of analysis applied for WFD compliant monitoring of water status in line with the Commission Directive on technical specifications for chemical analysis and monitoring of water status;
- Need of harmonization of practices on the estimation of limit of quantification;
- Development of a common system of identification rules for all standardized methods at low concentration levels. The development of such identification rules should be linked to the implementation of a QA/QC system;
- Implementation of performance criteria related to the correct identification of substances into a pan-European QA/QC system.

6. Quality assurance and control

6.1. Quality of environmental data

Thematic network METROPOLIS ("Metrology" in support of EU policies"), funded under the 5th Framework Programme (Growth Programme) in the field of Measurement and Testing concluded that the quality of data available from environmental measurements is still highly variable. The reasons of this poor data quality come from different sources:

- Lack of traceability of data: data are not sufficiently documented and not containing reliable references;
- Lack of harmonization of procedures applied by the laboratories: from the sampling step on the field to data given back (concentration measurements accompanied with their uncertainty);
- Lack of representativeness (data not reflecting the reality);
- Too high level of uncertainty for several parameters (when expressed, sometimes it is too high to take a decision);
- A lack of metadata (useful information provided with the data, necessary for the interpretation and comparison of data: from the sampling step (what, how, when measurements were made) to the data given. It comes to a lack of traceability of data along the analytical chain.

6.2. Identification at low concentration levels

A PT scheme (and the required mathematical/statistical tools) to evaluate the capability of laboratories to perform a correct identification of organic trace compounds at concentration levels close to the limit of detection has been developed and tested in a number of interlaboratory studies within IdentVal project.

The mathematical tools to use the identification criteria (z_{RT} and z_I, as reported in the preceding section) in proficiency testing schemes have been developed and improved in a number of inter-laboratory studies. It is possible to perform PTs on the correct identification of trace pollutants in environmental samples, and to perform a sound and consistent evaluation of the performance of analytical laboratories with respect to their “identification” abilities.

Tools have been developed and successfully tested to derive minimum performance requirements for identification adjusted to:

a) The intended purpose and

b) the current state-of-the art from the results of such PTs.

Tools to evaluate the performance of laboratories with respect to the correct identification of priority substances at concentrations close to the LOQ are desirable for monitoring activities under the WFD.

Therefore, in addition to the already existing requirements on LOQ and uncertainty of measurement a) requirements related to the identification might be formulated/derived, and b) tools for surveillance or performance testing of laboratories involved in monitoring under the WFD might be implemented in a pan-European QA/QC system.

PT schemes (and the required mathematical and statistical tools) for both processes have been developed and tested in the project IdentVal. Nevertheless, the applicability of this approach and the mathematical/statistical tools has only been tested with a limited number of substances and matrices. It still needs to be tested whether this approach actually is generally applicable to all sorts of priority substance monitoring under the WFD.

In particular, the applicability to all those analytical methods/priority substances should be checked where requirements of the WFD are challenging the potential even of state-of-the-art methods.

Apart from the actual approach developed in the IdentVal project, it seems necessary that a QA/QC system for monitoring under the WFD includes requirements on the correct substance identification (and guidance on pertinent approaches/tools), because this aspect is:

a) Essential for reliable results, in particular in case of substances where EQS values are close to the LOQs that can be achieved by state-of-the-art methods, and

b) not covered by the requirements on method and laboratory performance that have been defined in the WFD and relevant QA/QC documents so far.

To our knowledge, no other research activities on this issue have been carried out, neither on the national nor the European level.

6.3. Emerging methods - reference materials and PT schemes

Novel approaches for the preparation of Reference Materials for analysis of organic compounds in water (PAHs and pesticides) were explored and tested through the SWIFT project. WFD PTs provided positive results. These data could serve for future developments in the field of Reference materials for organic compounds in water. Such quality control tools are, at present, missing because of still unsolved technical difficulties related to the stability of these substances in the water matrix.

In particular, in case of organic compounds the following was investigated: i) the possibility to directly spike the materials immediately before their dispatch, ii) the feasibility to leave the material unfiltered for PAHs analysis, iii) the possibility to spike the material for pesticides using a newly developed technique patented by the Institute Pasteur de Lille. The achieved results are promising; all the produced RMs, even in case of volatile analytes and low concentration values, proved to have satisfactory characteristics of homogeneity and stability of the analytes and to be suitable for being used for the evaluation of analytical performances at European level. On the other hand, in many cases the produced RMs were not suitable for screening methods, for several reasons, but above all because much higher volume (tens of liters) of sample would be generally needed. The experience achieved along the project testifies that more efforts should be put in the development of new technologies for the production of RMs suitable for SMETs quality control. The produced RMs allowed the evaluation of analytical performances at EU level at different levels of concentration, in different matrices (river water, spring water) with different composition for the target analytes. Furthermore the production of multi-component blind solutions allowed the evaluation of the performances of the instrumental analytical step. The results achieved put in evidence the needs of further improvements in the overall analytical performances of the WFD related monitoring laboratories; i.e. identification of more problematic analytes, development of more sensitive analytical methods, matrix interference problems, etc.

There was limited participation by laboratories using the new (emerging) tools (three screening tools for determination of trace elements, nitrate, and pesticides respectively) in PTs. The comparison of screening methods with classical methods based on the results of the three SWIFT-WFD PTs demonstrated that some of them may be considered to be under control (provide reliable results), and thus are suitable to participate in not-specifically designed PTs, in particular for samples at fortified level of pollution but with generally higher uncertainty associated with the result. However, in general the validation and quality control of these methods are far from being achieved. The main limitations are the non-satisfactory limit of detection (insensitivity), the lack of specificity/selectivity, being prone to matrix effects, and the scarce repeatability and reproducibility. The scarce motivation of laboratories in the validation and external performance evaluation of SMETs also has to be mentioned. This may be due to the fact that these methods are not yet extensively applied in monitoring and that the Directives usually do not mention the possibility of their application in monitoring. By now, SMETs are mainly applied in research laboratories, and not in the routine laboratories. Mentioning in the Directives the possibility of applying these methods in monitoring, would certainly contribute to a more diffuse application of these methods outside the academic world.

Efforts should be made in producing reference materials for qualitative responses, toxicity index, etc. These efforts, however, are mainly related to the design of production the technology being already available. The European Commission could put efforts in funding projects aiming to support the diffusion of SMETs in routine laboratories and to develop RM production technology to overcome the constraints of SMETs. There is also an urgent need for more laboratories to become involved in PT schemes provided the alternative monitoring tools are to become recognized and accepted by regulatory agencies.

Problems in submission of results during the PTs were evidenced in case of all the exercises on pesticides determination (with only about 50% of submitted results) and for PAHs and trace elements determination in complex matrices and at low concentration levels (low fortification at ng/L for PAHs and natural levels for trace elements). The major problems were generally evidenced by trace elements (especially at natural levels), but also by diuron and endosulfan (among pesticides), total P, nitrate and even conductivity (among major components). It should be also stressed that some particular pesticides could not be scored due to the very low number of submitted results even for multi–component standard blind solutions (chlorfenvinphos, chlortoluron, chlorpyrifos, glyphosate), testifying the poor state-of-the-art for the analytical determination of these analytes in water samples. Minor problems were observed for the remaining major components and, unexpectedly, pesticides (with the exception of diuron, endosulfan and the others mentioned above)

In relation to the matrix complexity, the SWIFT-WFD PTs experience clearly indicates the very high negative impact on performances in presence of a natural complex matrix. This gives a clear indication on how a realistic evaluation of laboratories performances should be necessarily carried out on real matrices that reproduce the same analytical difficulties of the routinely analysed samples. The necessity to harmonize the choice of a reference value that might be crucial to obtain a comparable performance evaluation of monitoring laboratories in all the European Countries among different Proficiency Testing schemes was pointed out as well as the use a preset deviation units higher than 30%.

Results from the interlaboratory study based on the recombinant yeast assay (RYA) demonstrated that a certified reference material such as 17β-estradiol for intercomparison exercises on estrogenic activity would be useful but so far this does not exist. A fairly large variation could be seen and future work should include the development of further suitability or quality control tests so that it is confirmed that the system is always under control.

6.4. Joint approach for international river basins

An example of the applicable concept is the AQC programme for the Trans-national Monitoring Network (TNMN) in the Danube River Basin involving actively 13 European countries. To ensure the quality of the monitoring data a basin-wide analytical quality control system is regularly organized by the International Commission for the Protection of the Danube River (ICPDR). The reports on the analytical quality are published annually and indicate the precision and accuracy of the results produced within the TNMN. The analytical methodologies for the determinands applied in TNMN are based on a list containing reference and optional analytical methods. The National Reference Laboratories (NRLs) have been provided with a set of ISO standards (reference methods) reflecting the measurand lists, but taking into account the current practice in environmental analytical methodology in the EU. It has been decided not to require each laboratory to use the same method, providing the laboratory would be able to demonstrate that the method in use (optional method) meets the required performance criteria. Therefore, the minimum concentrations expected and the tolerance required of actual measurements have been defined for each measurand, in order to enable laboratories to determine whether the analytical methods currently in use are acceptable. It was found as a good practice that defines the standard of the accuracy, which is necessary for the task in hand. Therefore, two key concentration levels - the minimum level of interest and the principal level of interest - have been defined for each measurand. These levels define the aims of the monitoring programme and can be used to establish the performance needed from analytical systems used in the laboratories involved in the TNMN, assuming that the aims of the programme will be satisfied provided that:

- Relatively few results are reported as "less than" the minimum level;
- The uncertainty achieved at the principal level is not worse than ± 20% of the target value.

Performance testing was recognized to be a key factor for improvement of analytical quality of the monitoring data under the ICPDR. To achieve improvement of PTS performance the following actions have been recommended within the ICPDR and can serve as an inspiration:

- Basic measures:
  - Verification of the calibration curve using the control chart;
  - Preparation of fresh calibration standard solutions;
  - Construction of a new calibration curve, and
  - Double-check of the whole operational procedure (e.g., extraction, sample pre-concentration, quantitative transfer of the extract, etc.).
- A common understanding, among the countries/laboratories, should be reached regarding the warning and acceptance limits and comparing their performance achieved in other performance testing schemes;
- Provision of CRMs, or at least a larger amount of RM (see under the next item) to the laboratories, or some of the laboratories, should be considered;
- In the future, availability of larger number of samples of sufficient volume (as Danube basin RMs), allowing recovery testing and repeated analysis, should be considered, however, it should be noted that this would require the PTS organizer to homogenise significantly large amounts, which would increase the related costs;
- A description of quality control measures (including chromatograms, etc.) can be asked from the participants in order to get as much information as possible for better evaluation of problems.

6.5. Sediment analysis

In order to perform quality assurance protocols and develop standard operational procedures there is a continuous need of developing reference materials, especially for organic contaminants in addition to more interlaboratory studies on different sediment matrices, including relatively clean sediments, highly contaminated sediments and various types of dredged material. As compared to water inter-laboratory studies, there is still a lack of information concerning sediments interlaboratory studies. Only by ensuring a good quality performance of the analytical methods we will be able to establish monitoring programmes along EU and other parts of the world and to compare the data generated. If we are not able to perform the intercomparison studies between laboratories in that area we will not be able to compare the monitoring data generated under various monitoring programmes.

6.6. Gaps identified

ISO 17025 offers the possibility to laboratories to use, instead of standards methods, their own developed methods. In the draft Commission Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status the use of standards methods is not mandatory except for "operationally defined parameters": methods have to be validated according ISO 17025. In order to assure harmonization of data, there is an important need for harmonization of practices in the field of validation method and especially a need for development of very practical and fit for purpose tools (some already exist and should be tested).

- Improve the traceability of data providing sufficient documentation and reliable references – developing a commonly agreed format may be a solution;
- Too high level of uncertainty provided for parameters in some cases (this can be solved by the new Commission Directive);
- A lack of metadata provided with the data, which are essential for an appropriate interpretation and comparison of data;
- Development is needed of new technologies for the production of reference materials suitable for screening methods/emerging tools (SMETs) quality control;
- Projects should be supported aiming to promote the use of SMETs in routine laboratories;
- Tools to evaluate the performance of laboratories as to the correct identification of priority substances at concentrations close to the LOQ are needed;
- In addition to the already existing requirements on LOQ and uncertainty of measurement the requirements related to the identification of a organic substance should be formulated/derived;
- Tools for surveillance or performance testing of laboratories involved in monitoring under WFD might be implemented in a pan-European QA/QC system.

7. Reporting and data handling

Requirements on data quality and metadata should be an integral part of the reporting format.

7.1. Metadata

Recommendations were made to accompany:

1. On-site groundwater measurements with following metadata: chemical logs before and after pumping and water collection, location (GPS), depth of water sample

collection, volume of pumped water, pumping flow rate renewal rate of the water in the borehole.

2. The analytical results with following metadata: extraction date, analysis date, uncertainty (to specify if the sampling uncertainty is included and the way it has been obtained, proficiency testing, validation data…), recovery, if the sample has been filtered (and its level) or rough water, GPS coordinates, if the field lab is working under accreditation procedure.

7.2. Data quality

It has been suggested that authorities and control bodies are encouraged to ask for QA/QC data along with the submitted monitoring data. Authorities should be able to judge the quality and reliability of data and support and challenge laboratories to produce requested quality results. QUASIMEME, the former EU-BCR as well as OSPAR were highlighted as good initiatives for that purpose. More recently a detailed description of the data and metadata format (Implementation of Requirements for Priority Substances within the Context of the Water Framework Directive, Common template for data collection, Final version 20th March 2007) has been developed for DG ENV. The practicality of the formats is being actively tested within the database systems of the EU FP6 project NORMAN (www.norman-network.net) and the ICPDR (Water Quality Database). A possibility of ranking the data based on the availability and quality of supplementary QA/QC information should be further investigated. The future collection of WFD monitoring data under WISE has to be built on the experience of these initiatives.

8. Recommended institutional co-operation activities

Apart from the more specific recommendations on current research and standardisation needs (see chapter 9), there are some overarching issues that are related to proposals for co-ordination and common activities at an institutional level. These are outlined in the following sub-chapters.

8.1. Networking of laboratories

The implementation of the WFD is a top priority issue for all river basin managers. WFD sets the environmental objectives, which include achieving a good chemical status. The assessment of a chemical status necessitates having at hand a battery of reliable and robust chemical methods providing accurate and precise data on priority substances and other pollutants. This requires increased efforts of analytical laboratories involved and necessitates a coordinated approach including close cooperation. A laboratory network could be a suitable tool to contribute to such cooperation process by providing the necessary background information as well as guidance on analytical tools including QA/QC. This would be especially helpful in support of the national regulatory processes for the other pollutants. Through the network the water laboratories could have an access to information on key issues such as:

- Sampling procedures and analytical methodologies for emerging substances(“other pollutants” in WFD terminology);

- Information and respective recommendations for internal QA/QC procedures, which are in accordance with EN ISO/IEC-17025 standard or other equivalent standards accepted at international level;
- Interlaboratory proficiency testing schemes;
- List of available/proposed national environmental quality standards for water, SPM, sediments and biota;
- Experience with application of ecotoxicological analyses and their combination with the results of chemical screening methods;
- Technical guidance on analysis of emerging substances.

There are examples of such existing or proposed international cooperation of water laboratories (TNMN under ICPDR, NORMAN – network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances).

The aim of the NORMAN project is to establish a permanent network of reference laboratories and research centres able to ensure, in collaboration with competent authorities, industry, standardisation bodies and NGOs:

- A rapid exchange of data and information on emerging substances on a global scale;
- Better data quality and comparability via validation and harmonisation of common measurement methods (chemical and biological) and monitoring tools for emerging substances;
- An independent and competent forum for the technical/scientific debate on issues related to emerging substances.

NORMAN has already developed and established its core elements, e.g.:

- Three databases: (i) EMPOMAP: a database of leading experts, organisations and projects dealing with emerging substances, (ii) EMPODAT: a database of geo-referenced monitoring and occurrence data accompanied by the ecotoxicological information from bio-assays and biomarkers and (iii) EMPOMASS: a database of mass spectrometric information on provisionally identified and unknown substances.
- A common European framework for the validation of methods for the monitoring (occurrence) and bio-monitoring (effects) of emerging pollutants in a broad range of matrices. The protocol has been tested in different case studies. On the basis of the results, the protocol will be improved and proposed for implementation in the field of European Legislation and Standardisation (e.g. at the CEN level).

Networks of expert and reference laboratories such as the NORMAN network with its core elements dedicated to QA/QC tools and the provision of data with reliable meta-information on their QA/QC status will help to establish a sustainable and efficient culture of QA/QC across Europe. Institutional support of such networks (e.g. by the European Commission and its Joint Research Centres) is highly recommended.

8.2. Comparison trials of monitoring approaches

In the process of implementation of EU WFD it is important to harmonise the approaches used at the national level for monitoring of WFD quality elements and guarantee comparable results, starting from the setting up of the monitoring networks, via the sampling and sample preparation to the chemical analysis. Such harmonization requires a close communication between the European Commission and the Member States as well as among Member States. This process should therefore be accompanied by a series of practical exercises that provide results in order to help adjusting monitoring strategies in a harmonised way.

Therefore EC JRC Institute for Environment and Sustainability organizes technical on-site Chemical Monitoring Activity (CMA) workshops aiming at comparison of different approaches in monitoring from the sampling of single samples to the acquisition of analytical results for single samples. The strategy of the on-site workshop comprises 3 different steps:

- Distribution of analytical standard solutions to estimate contribution of instrumental analysis to total variations;
- Distribution of homogenised sample extracts in order to estimate contribution of sample preparation and matrix effects to total variations;
- Simultaneous sampling of a real river water sample.

During the first CMA on-site event in October 2006 in Ferrara, Italy at the Po River the objective was testing of several aspects of the guidance prepared in view of the implementation of the upcoming WFD Daughter Directive on Environmental Quality Standards.

In this CMA on-site event it was shown that even some of the most challenging WFD priority substances, selected on purpose for this exercise, can be measured at WFD relevant concentrations (0.3 x EQS) with methods currently applied in Member States. However, obtained results were not within proposed data quality limits for most participants and therefore further development of methods and harmonisations of efforts was suggested.

Further joint on-site trials are being planned in the frame of the Chemical Monitoring Activity working group. Such coherent approach to harmonisation of analytical methods and also to the further development of monitoring strategies seems to be an effective way for ensuring concerted establishment of programmes for the monitoring of water status in line with WFD Art. 8. It is also an appropriate way to make sure that the data collected in different river basin districts will be comparable. In future therefore it will be important that more such exercises are carried out, reflecting the needs of Member States and helping to harmonise approaches and their further development on European scale.

8.3. Cooperation under international bodies

Monitoring activities under international riverine (IKSR, ICPDR, IKSE) or marine environment (OSPAR) protection commissions can be considered as unique case studies on joint sampling, measurement and reporting. The products of these cooperation activities, which are guided by the EU legislation as well as by the international legal treaties are outstanding examples of practical application of multilateral harmonization protocols in the field of monitoring and assessment. OSPAR quality assurance procedures can arguably be quoted as the current state-of-the-art.

The OSPAR Quality Assurance Handbook brings together information on policies, procedures and guidelines established by OSPAR which have a bearing on the quality of data and information reported to and handled by OSPAR. It details procedures and guidance both on sampling, analysis, reporting and assessment. It is intended as a resource and basis for:

- Contracting Parties and Observers to act on;
- The OSPAR Committees to ensure their applications;
- OSPAR to conclude on whether all necessary QA procedures are in place and sufficient for purpose.

The QA Handbook is a living document, to be revised when necessary. The contents are not static documents. Good practice requires the regular review of policies and procedures and the Handbook is therefore subject to updating and revisions as new developments require. The Secretariat is responsible for ensuring that the Handbook is kept up-to-date.

The Handbook is a compilation of links and references to agreed procedures rather than a full representation of the various QA arrangements. This makes it easier to keep it updated. The Handbook is available as a publication on the OSPAR website and is accessible through the publication link of each Strategy site.

The cooperation on monitoring and assessment under the international commissions includes setting the framework for harmonization of national QA/QC approaches, which is also beneficiary for standardization process. The structures of analytical quality assurance and control schemes similar to that of OSPAR exist also within other commissions (Elbe, Danube) and represent a unique platform not only for assuring the reliability of monitoring data but also for standardization and joint formulation of future research needs. The cooperation between those commissions on EU level can be an excellent framework for preliminary consensus seeking in support of the EU standardization initiatives.

9. Proposed priority topics for research and standardisation

9.1. Methods for monitoring & analysis

It is necessary to further explore the potential of new methods (screening methods/emerging tools) to provide information on water status required for WFD implementation. Some of them are able to provide reliable results in comparison with laboratory methods. Nevertheless, for pollutants at natural levels, the main limitations of such methods are generally their non-satisfactory level of detection (insensitivity), the lack of specificity/selectivity, being prone to matrix effects, and the scarce repeatability and reproducibility. Research is thus necessary to improve the technologies implied in such methods in order to reach analytical performances in compliance with the EQS defined by the WFD.

Appropriate validation procedures should also be developed, and a full QA/QC toolbox should be made available ensuring reliability and comparability of monitoring data collected in EU. Such a quality-assurance toolbox may need approaches different from those currently considered as state of the art. New technologies will have to be applied for the production of reference materials suitable for QC of screening methods/emerging tools (SMETs), especially for passive samplers. To enable practical dissemination of the knowledge, projects should be organized promoting the use of SMETs in routine laboratories provided they have been successfully validated and the QA/QC tools mentioned above are available. A prioritised list of the most promising SMETs and the missing QA/QC tools is provided in

Table 1.

The production of standardized protocols for their application have to be considered, though standards are available for some toxicity tests (e.g., ISO 11348 for the Microtox assay) and for passive sampling (BSI PAS61). The process is under way: a new part of the standard ISO 5667 dealing with passive sampling is under preparation (ISO/CD 5667-23- Water quality — Sampling — Part 23: Determination of priority pollutants in surface water using passive sampling) as well as a British standard for the use of on site methods (BS 1427 Guide to on-site test methods for the analysis of waters).

The development of properly tailored QA/QC tools is necessary. As far as passive samplers are concerned, the use of classical reference materials is not possible. The methods would require large volumes (hundreds of liters) of reference materials, which would be very expensive using available reference materials. A different approach could involve the use of reference sites where passive sampling devices could be deployed or novel types of reference materials, such as pelletized reference compounds that can be suspended to produce large volumes of homogeneous standard solutions.

In general, organisation of specific PTs schemes for SMETs in order to promote such methods or their integration in the existing PTs is highly recommended.

Appropriate validation procedures have to be developed taking into account additional criteria (in comparison with validation procedure for laboratory methods) related to on site measurements such as temperature, seasonal effect, flow rate, effect of biofouling, matrix effect, short-term drift, memory effect, field portability, etc. For biological methods such as bioassays, there is an obvious need to develop validation procedure and also to propose appropriate RMs for their evaluation. Indeed, the performances evaluation is not so easy to investigate due to the measurement principle and practical constraints. The tested screening methods give an answer on a global effect (toxicity) in relation to the presence of pollutants mixture not to a specific pollutant.

Table 1 Prioritised list of SMETs and missing QA/QC tools

Type of method	Missing QA/QC tools	Priority	Possible application in the frame of the WFD(*)
Laboratory-based methods, sensors, chemical-test kits, and immunoassays	Participation in PTs Appropriate validation procedure Standardized protocol for application		Rapid determination of chemical concentrations (O, I) On-site mapping of an area (O, I) Selection of samples requiring additional more accurate results (O, I) Rapid determination of chemical concentrations On-site mapping of an area (O,I) Selection of samples requiring additional more accurate results(O, I)
Passive samplers	Detailed standardized protocol for deployment New reference materials, Reference site		Measurement of time-integrated concentrations (S, O,I) Assess long-term changes, and trends in levels of pollutants (S) Screening of pollutant for presence or absence (with improved LODs) (S, O, I) Speciation of contaminants (S, O, I) Identification of sources of pollution (I) Integrated assessment of pollutant load across national boundaries (S)
Biological methods (biosensors, bioassays, BEWS)	Standardized protocol for application Appropriate validation procedure RMs		Early warning of changes in water quality at sensitive sites (S) Toxicity assessment of effluents (e.g.remediation sites) (O, I) Mapping to identify toxicity hotspots (S, O) Investigate cause/effect relationships (O, I) Detection of “active” or toxic compounds not detected by classical analysis (S, O,I) Mapping after pollution incidents/accidents (I)

S: surveillance monitoring

O: operational monitoring

I: investigative monitoring

(*) extracted from the SWIFT deliverable D25

9.2. QA/QC tools for sampling and analysis of sediments

Sediment monitoring is addressed only marginally in the WFD. One of the reasons is a lack of appropriate “evaluation tools” (QA/QC, etc). Following actions are suggested to be taken to improve this situation:

- Development of guidelines for monitoring of hazardous substances in sediments;
- Preparation of a technical guidance on sediment normalization at the EU level;

- Preparation of CRMs for sediment analysis of the WFD priority and other substances at the concentration levels ranging 1-5 x of the proposed (draft) values on quality standards

9.3. Sampling and sample handling

There is lack of harmonized or standardized validation schemes for sampling techniques (e.g., assessment of blanks for all type of matrices - biota, suspended particulate matter, ground water, sediments, on-site sample treatment) as well as of procedures for correct estimation of sampling uncertainty.

More attention should be given to time-integrated sampling techniques ("complementary methods" in the terminology of the CMA guidance documents). In particular for those types of techniques, there is a need for development of respective QA/QC and validation procedures.

Furthermore, QA/QC studies should be made on the influence of the main steps of sample handling, i.e. sample transport, storage and pre-treatment (e.g., freeze-drying) on analytical results. This should include estimation of an uncertainty.

There is a need for the development (and/or standardisation) of commonly accepted quality criteria for sampling of biota.

9.4. Proficiency testing

Proficiency testing schemes are essential for assessing the reliability and comparability of monitoring data in terms of accuracy and precision. Furthermore they are important for providing evidence of the capabilities of monitoring laboratories, and for training and improvement of less performing laboratories. They must be targeted also among others to sampling techniques, appropriate concentration levels (including correct identification of priority substances at concentrations close to the LOQ) and speciation analysis (where needed). A harmonisation of PT schemes related to the WFD is recommended, and a self-committed network of European PT providers is currently being established as a result of the pertinent discussions held within the EAQC-WISE project.

PT schemes for laboratories carrying out monitoring under the WFD shall be based on samples "representative of collected samples which contain appropriate levels of concentration in relation to relevant environmental quality standards", e.g. including concentrations as low as approx. 50% of the EQS.

There is still a need for research on the feasibility of suitable PTs, in particular for the following issues:

- PTs with whole water samples (containing significant amounts of suspended particulate matter) for non-polar or sorptive compounds (e.g., PAH, PBDE);
- PTs with trace concentrations of dissolved metals close to or below the EQS;
- PTs for sampling techniques, which would be in support of solving the problems referred to in chapter 9.3.

The development, testing and harmonisation of appropriate techniques for the preparation and handling of PT samples with sufficient stability and homogeneity for such PTs is a matter of high priority for future research and standardisation activities.

The current draft Commission Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status points out that results of participation in PTs "shall be evaluated on the basis of the scoring system set out in ISO/IEC guide 43-1 or in the ISO-13528 standard". However, the scoring systems in the mentioned guide and standard do not include an assessment of the laboratories with regard to a required minimum performance.

These requirements on and criteria for minimum performance of laboratories participating in proficiency testing schemes still need to be developed (at the European scale).

9.5. Validation and performance criteria

A harmonised approach to calculate performance criteria is needed, in order to enable a comparable evaluation of compliance with the minimum requirements laid down in the draft Commission Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status. This should include harmonization of practices on the estimation of limit of quantification, measurement uncertainty, and development of a common system of rules for unknown compounds identification for all standardized methods at low concentration levels.

Given that all types of methods (standardised or not) can be applied by monitoring labs, harmonization of validation practices is highly needed in order to assure the equivalence of data. To this purpose, harmonized validation protocols such as the ones developed within the NORMAN co-ordination action should be adopted in the field of standardisation, e.g. as a technical guidance document at CEN, or be integrated in the guidance documents for monitoring under WFD, which have been developed by the CMA expert group.

10. Proposed approach for definition and prioritisation of research and standardisation needs

Within the work package 1.3 of the EAQC-WISE project, research and standardisation needs have been derived and prioritised for methods that are suitable for monitoring under the WFD. This process has been carried out in close co-operation among the EAQC-WISE project (WP 1.3 and 2), experts from the CMA group, and representatives from standardisation bodies. This approach has resulted in a mandate issued from DG ENTR to CEN for the development or improvement of standards in support of the water framework directive. This mandate comprises tasks ranging from research to standardisation, e.g.,

- Pre- and co-normative research;
- Development of standards not yet available;
- Revision and adaptation of existing standards.

Therefore, the process that led to this mandate is a valuable and successful example of how such an approach to define, prioritise and mandate both research and standardisation tasks might work in practice.

In the following, the main steps of this process are sketched in a generalised way that will render it applicable to other issues as well. This process will be described in more detail in the blue print of the pan-European QA/QC system which will be the final deliverable of the EAQC-WISE project. In particular, the question how this process can be institutionalised needs further consideration (e.g., Who is responsible to initiate the process? Who will carry out the necessary steps? How can the output of this process be launched on the agenda of regulators, funding and standardisation bodies? How is the detailed allocation of tasks and responsibilities between the national and the European level?).

A process for definition, evaluation and prioritisation of research and standardisation needs should include the following steps and core elements:

1. Task analysis
   A need for research or standardisation is usually created by a task, onus or obligation imposed by a regulator. The first step is a thorough analysis of the tasks, and should result in a clear description of the tools or methods that are needed to fulfil the requirements. This should include a detailed description of the specifications (e.g., minimum performance criteria) that have to be met by the tools or methods.
2. Investigation / enquiry on existing tools or methods for the task
   This can be done in several steps:
   a. Literature search (scientific literature and standards)
   b. European expert survey
      including academia, monitoring laboratories, standardisation bodies and competent authorities - careful selection of target audience is essential
3. Detailed evaluation and assessment whether the existing tools are appropriate and fit-for-purpose
4. Gap analysis: what is missing
   (compare characteristics of existing tools to requirements derived from tasks)
5. Definition and classification of the work to be done:
   a. Tasks for fundamental research
   b. Tasks for applied, i.e. pre-normative or co-normative research
   c. Tasks for improvement or development of standards based on existing tools/methods
6. Prioritisation
7. Feedback to regulator, funding and standardisation bodies

Glossary

AQC	Analytical quality control
BEWS	Biological early warning systems
CEN	European Committee for Standardization
CMA	Chemical Monitoring Activity of EC
CRM	Certified reference material
DG ENV	Directorate -General for Environment of the European Commission
DG ENTR	Directorate -General for Enterprise and Industry of the European Commission
EDA	Effect Directed Analysis
EQS	Environmental quality standards of the WFD
EU FP6	6^{th} Framework Programme of EU
GPS	Global positioning system
ICES	International Council for the Exploration of the Sea
ICPDR	International Commission for the Protection of the Danube River
IKSE	International Commission for the Protection of the Elbe River
IKSR	International Commission for the Protection of the Rhine River
ISO	International Organization for Standardization
JAMP	Joint Assessment and Monitoring Programme of OSPAR
LOD	Limit of detection
LOQ	Limit of quantification
NGO	Non-governmental organization
NRL	National reference laboratory
OSPAR	International commission for the protection of the marine environment of the North-East Atlantic
PAHs	Polyaromatic hydrocarbons
PBDEs	Polybrominated diphenylethers
PDB sampler	Passive diffusion bag sampler
PT	Proficiency testing
QA/QC	Quality assurance and quality control
RM	Reference material
RTD	Research, Technological Development and Demonstration activities
RYA	Recombinant yeast assay

SMET	Screening methods/emerging tools
SPM	Suspended particulate matter
SVOCs	Semi-volatile organic compounds
TIA	Toxicity Identification Evaluation
TNMN	Trans-national Monitoring Network of the International Commission for the Protection of the Danube River
VOCs	Volatile organic compounds
WFD	EU Water Framework Directive
WISE	Water Information System for Europe of the EC
WP2	Work package 2 of the EAQC-WISE project

Annex I

EAQC-WISE
European Analytical Quality Control in support of the Water Framework Directive via the Water Information System for Europe

Questionnaire WP 2 - Research needs

Interview		
I-Code = I-	Place =	Date =
InterviewER Last Name, 1st Name =		
InterviewEE Title = Last Name, 1st Name = Organisation = Department = Address = Zip + City = Country = Tel = Fax = e-mail = URL =		

Considerations

In the frame of EAQC-WISE activities, a "state-of-the-art" of the quality assurance/quality control tools for monitoring data of pollutants on environmental matrices is to be established in the first six months. One part of this state-of-the-art is to compile what underpinning research **has been delivered so far** and **what will be needed in the future**. This will be achieved through the following questionnaire.

- What are the successful research issues or what are the identified gaps regarding QA/QC related research into the following items:

- ***Sampling, e.g.:***
    - *Sieving of sediments*
    - *Centrifuging of SPM*
    - *Collection of biota*
    - *Use of passive samplers*
    - *On-site sample treatment*
    - *Others…*

- ***Sample transport, storage, e.g.:***
    - *Water on SPE cartridges or membrane extraction disks*
    - *Freeze-drying of sediments*
    - *Groundwater sampling in borehole without perturbation of the medium*
    - *Others…*

- ***Analysis, e.g.:***
    - *Of "difficult" WFD Priority Substances in terms of their detectability (hexachlorobenzene, chlorpyriphos), specificity (e.g., metals and their compounds) or lack of harmonisation (e.g., brominated diphenylethers, C10-13 chloroalkanes, nonylphenols, octylphenols)…*
    - *Others…*

- ***Influence of various WFD matrices;***

- ***Problem of interaction between soils ad water for QA/QC aspects:*** *gaps in leaching tests;*

- ***Identification and monitoring of the river basin specific and emerging pollutant*** *(coordination with NORMAN);*

- ***Minimum requirements on quality of data feeding statistical programmes*** *(e.g. for pollution trend analysis for evaluation of chemical status of ground waters);*

- ***Harmonisation of data reporting (minimum QA/QC requirements – metadata, …)***

- ***Traceability for "on-site" measurements*** *(e.g., parameters that have to be measured on site as pH or dissolved oxygen used at the definition of the ecological status, but, also, screening methods; a link will be established with SWIFT);*

- ***Usability of WFD data obtained under different monitoring schemes*** *(e.g., reference vs. university/research laboratories, centralised vs. regional laboratories).*

- *Which approaches* ***for commissioning such research*** *both at the European and national level?*

End! Thank you very much!

STATUS, CONFIDENTIALITY AND ACCESSIBILITY									
Status				Confidentiality				Accessibility	
S0	Approved/Released	x		PU	public			Work-space	
S1	Reviewed			PP	Restricted to other programme participants (including the Commission Services)			Internet	x
S2	Pending for review			RE	Restricted to a group specified by the consortium (including the Commission Services)	x		Paper	
S3	Draft for comments			CO	Confidential, only for members of the consortium (including the Commission Services)				
S4	Under preparation								