

SEDIMENT AND SUSPENDED MATTER UNDER THE WATER FRAMEWORK DIRECTIVE COMMENTS PREPARED ON BEHALF OF THE WFD NAVIGATION TASK GROUP¹

Summary and Recommendations

1. The following comments are based on a review of a number of related documents² developed under the CIS process. The documents have been prepared in support of the WFD and relate to the quality standards for water as well as for sediment and biota. They have been reviewed together in view of their consistency, interlinking and also the possible evolution in the process of developing further details under the CIS.

Relationships between CIS guidance documents

2. The Group concludes that, although there is a fairly high level of consistency, the relationship between the various documents is complex and therefore not very transparent. This in itself carries the potential for misunderstandings and confusion.
3. The conclusions in the reviewed documents, namely that the relationship between chemical status and ecological quality under the WFD is weak and not well understood, can only be emphasised.

Difficulties in handling complex technical issues in legislative process

4. The Group further concludes that there may be some misconceptions about the (limited) role of EQS for sediment and biota (in support of EQS for water) among the wider circle of users of the referenced documents. We infer this *inter alia* from remarks made by some MEPs during the preliminary review of the list of priority substances and calling for the Commission to come forward with proposals for sediment EQS, which in our opinion should be left to Member States and should be River Basin specific (see below).
5. The complexity of such issues, together with the need to understand state-of-the-art scientific approaches, leads to a situation that is particularly challenging for the legislative process.
6. The Task Group is concerned that this complex and technical legislation has to be dealt with by officials and MEPs who do not have a specialised scientific background. A consequence may be that formal requirements in the Directives have to be corrected later during the comitology phase.

¹ The WFD Navigation Task Group is a 'thematic cluster' of European navigation-related organisations which provides the navigation sector's contribution to the WFD Common Implementation Strategy (CIS). The Group comprises a number of professional bodies, trade associations and other stakeholders concerned with ports, commercial and leisure navigation and dredging, including: Central Dredging Association; European Barge Union; European Boating Association; European Boating Industry; European Community Shipowners' Associations; European Dredging Association; European Federation of Inland Ports; European Sea Ports Organisation; ICOMIA; Inland Navigation Europe and PIANC (the International Navigation Association). Central Commission for Navigation on the Rhine, the Danube Commission and the International Sava River Basin Commission are also invited to attend our meetings as observers.

² Including CIS Guidance Document 19 Guidance on Surface Water Chemical Monitoring (2009); Draft Guidance Document of the CMA Group on Sediment and Biota Monitoring (2010); and Technical Guidance Document on the derivation of Environmental Quality Standards (draft November 2009) as well as the Directives themselves.

Specific issues of sediments and suspended particulate matter

7. Whilst many of the questions raised by the Task Group have been addressed during the process of preparing the CIS documents already referred to, the Group has some outstanding concerns with regard to
 - a. the way in which sediments are considered; and
 - b. the fact that the methodologies used to derive environmental quality standards for water fail to take into account variations in levels of suspended particulate matter.
8. From a practical point of view the Group therefore recommends that:
 - a. the concentration of suspended particular matter in the water column should be normalised for representative concentrations in fresh water and marine water respectively (the current Technical Guidance Document only refers to default values);
 - b. the concept of 'equivalence of standards' for the various compartments should be clarified;
 - c. the current EQS in the Directive 2008/105 should be reviewed in light of the new TGD-EQS;
 - d. it should be clarified that setting (a limited number of) sediment EQS is to be dealt with under the subsidiarity principle and is thus the competence of Member States; and
 - e. sediment monitoring, which is of major importance to downstream countries (e.g. in estuaries) should be handled by Member States, where appropriate on a River Basin scale.

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Detailed Comments

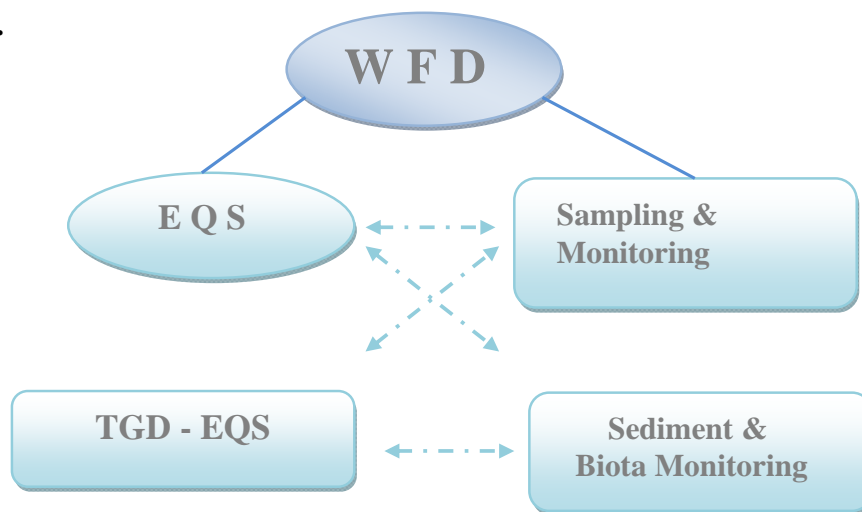
1. General

These observations consolidate remarks of the WFD Navigation Task Group. The Group has already reviewed various documents under preparation or published as guidance documents in support of the Water Framework Directive. As the number of documents dealing with implementation issues grows, the Task Group has combined several of its observations into a single text. The purpose is twofold: firstly to check whether previous comments have been considered, and secondly to review consistency between various texts.

The following documents are relevant for sediment-related issues. The relationship between the documents is illustrated in Figure 1. The left-hand column establishes the criteria, while the right-hand column provides good practices.

- (1) Water Framework Directive 2000/60.
- (2) Daughter Directive Environmental Quality Standards 2008/105.
- (3) Technical Guidance Document on the derivation of Environmental Quality Standards (draft November 2009).
- (4) Guidance Document 19 Guidance on Surface Water Chemical Monitoring (2009)
- (5) Draft Guidance Document of the CMA Group on Sediment and Biota Monitoring (2010).

Figure 1.



2. Requirements and Guidance

In this section we briefly review the requirements and available guidance in the light of our concerns about how sediment and suspended matter are considered (following the numbering above).

2.1 The aim of the WFD 2000/60 is to maintain or restore long term quality of the water bodies. The parameters to monitor the quality are the chemical status (concentration of chemicals) and the ecological status. The monitoring of the chemical status is targeted at the (total) water column, while the ecological status is also affected by the water bottom (sediment) and/or the biotope

Art 16.7 of Dir. 2000/60 specifies: “The Commission shall submit proposals for quality standards applicable to the concentration of the priority substances in surface water, sediments or biota.”

A superficial reading might suggest that such quality standards should be established for all priority substances for all compartments. The wording in Article 16(7) is, however, in the form of an ‘or’ requirement: either water or sediments or biota. The establishment of environmental chemical quality standards (EQS) in sediment or biota should only be relevant for those priority substances that have a tendency to sorb to sediment or to accumulate in biota.

Indeed, this reading of Article 16(7) is in line with Article 3 of the daughter Directive 2008/105 where it states that ‘Member States may opt to apply EQS for sediment and/or biota instead of those laid down in Part A of Annex I in *certain categories of water*.’ However, ‘these EQS shall offer at least the same level of protection as the EQS for water’.

There is still potential for confusion in that Directive 2000/60 calls for the Commission to submit proposals...., but Directive 2008/105 lays the responsibility for setting “equivalent” EQS with the Member States. The responsibility of the Commission is thus limited to providing guidance on the methodology, not the actual values of the sediment EQS.

The overall conclusion is thus that the EQS for water may be substituted by “equivalent” standards for sediment or biota under certain conditions, but the Directive does not call for establishing a complete set of EQS for sediment and biota in addition to the water standards. The question what “equivalent” might mean in this context is discussed below.

2.2 Indeed, the Daughter Directive 2008/105 (2) confirms this reading by stating in recital 15: “For the majority of substances the establishment of EQS values at Community level should (...) be limited to surface water only. However, as regards hexachlorobenzene, hexachlorobutadiene and mercury, it is not possible to ensure protection against indirect effects and secondary poisoning (....). It is therefore appropriate to establish EQS for biota at Community level for those three substances.”

Recital 16 confirms that 'Member States should be able to establish EQS for sediment and/or biota **at national level** and apply those instead of the EQS for water set out in this Directive.' As is clear from the Technical Guidance Document on the derivation of EQS, this provision targets only a limited number of hydrophobic or lipophilic substances.

The Directive then sets EQ standards for currently 33 priority and priority hazardous substances on the basis of concentration in the total water column although EQS for metals are in filtered samples.

The Directive does not resolve any of the issues raised with respect to the 'total water column' and the variation in suspended material; it does not clarify for which substances a EQS for sediment may be helpful. All this is left to the Technical Guidance Document (see 2.3).

At this stage the following potential issues arise:

- *if and when the EQS of the water column may have to be assessed via the sediment or biota compartment, how can equivalence in standards be established? What should be the criterion? The equivalence of biological effects caused by contaminants in sediment poses a challenge since the pathway of priority substances from the sediment to the living biotope is different from the effects via the water column. A mortality rate of 10% in benthos is not 'equivalent' to a mortality rate of 10% in a rare fish species. Is there any other standard of equivalence? Should secondary poisoning via sediment feeders be the basis?*
 - *if the concentration in the total water column is taken as the yardstick, how should strong variations in concentration of suspended particulate material (SPM) be taken into consideration? This is a concern for dynamic transitional water bodies where high concentrations of SPM as well as strong variations within short periods are common. The underlying concern is again the difference in biological pathways between substances dissolved in the water column and sorbed unto SPM: for a water column containing hydrophobic contaminants in low concentrations of SPM, the biological effects would differ markedly from those in a water column with the same average concentration of the contaminant, but this time containing a high concentration of SPM.*
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2.3 The text that supports the EQS Directive is the (draft) Technical Guidance Document (TGD) on the derivation of Environmental Quality Standards. This text develops a risk assessment methodology that builds on the approach taken by Lepper in his initial study (ref.1). The Guidance discusses water, sediment and biota separately, as the method of setting of standards for these compartments differs.

- a) The report deals with the specific issues of how to quantify the EQS. The remarks here below do not address the quantification aspect and the uncertainty associated with that, but focus on the methodological aspect of setting EQS for sediment. The TGD (ch.5.2) suggests that sediment standards can be developed either on the basis of ecotoxicity criteria or by using the equilibrium partitioning theory (EqP).
- The ecotoxicity approach targets primarily the benthos as the threatened species. It is however not at all clear what the relationship is between impacts on the benthos and the chemical quality

of the water body. Available knowledge indicates that there is no direct relationship between the chemicals in benthos and the water column. Rather, the relationship can strongly depend on the feeding strategies of the benthos - for example, a deposit feeder processing sediment or a suspension feeder filtering out suspended matter from the water. The ecotoxicity approach is a reasonable approximation to set standards for benthos. It should, however, in this case be used with caution when the exposure is via a higher fish species or a mammal that feeds on benthos. In such cases the issue of equivalence with standards for the total water column is not clear to us.

- The EqP method has also important uncertainties: in the definition and assessment of partitioning factors, in the role of pore water, in the role of the organic fraction within the total sediment, and the route of uptake of contaminants/the ingestion of sediment by organisms. Some of the assumptions lead to conservatism: the theory assumes that there is an equilibrium between the concentration in the organic fraction and the pore water (questionable in coastal and estuarine sediments) and that the pore water is in equilibrium with the water column. In reality it is not uncommon to find that the concentration in pore water is twice the concentration in the water column. The EqP method reflects a theoretical approach, based on a direct link between concentrations in sediment and the chemical water quality. Moreover, the method emphasises the fact that only substances that sorb on sediment are targeted. The relationship between sediment quality and concentration in the water column is thus not clear.

The TGD discusses most of the issues raised. It clarifies that an EQS sediment is only needed for a limited number of substances and thus confirms the reading of Article 16(7) as given above in section 2.1. The TGD also makes clear that standards based on sediment carry a lot of uncertainty and should only be used if there is no alternative. This is why the London Convention/Protocol and the OSPAR Convention use a set of Action Levels with upper and lower values for dredged material and did not attempt to develop a scheme with a single level.

Notwithstanding that this latter approach arguably provides a better model for dealing with these uncertainties, the Task Group believes that both the setting of any sediment EQS, and associated monitoring should be the responsibility of Member States, applied as appropriate at River Basin level.

In conclusion, we recommend the need for further research into the relative merits of both these and other methods and suggest that any application of either technique is treated with caution and in the full knowledge of its associated limitations.

Further clarification of the link between biota contamination level and water quality standards is desirable.

Any setting of sediment EQS, and associated monitoring, should be the responsibility of Member States.

With regard to the role of suspended material (chapter 3.8), the consideration that needs to be given to the role of SPM in the total water column is critical. Chapter 3.8 gives expressions for

quantifying the difference between EQS in the total water column (including SPM) and EQS dissolved. For the water column the report proposes default values for SPM at 15mg/l for fresh waters and 3 mg/l for marine waters. The report actually points out that monitoring the compliance with total water EQS may also be done via the SPM fraction and that this could well be the preferred approach. The suggested default values for SPM and for the fraction of organic content (0.1) cover normal conditions. However, for the conditions that may occur in e.g. estuaries and transitional waters, the contribution of the SPM phase (for hydrophobic substances) and the water phase could be of the same order of magnitude. This raises again the issue of equivalence as the effects are not additive. In other words, the bioavailability of the SPM fraction can be vastly different from the bioavailability of substances dissolved in the water column. This means that any EQS for hydrophobic substances monitored via the total water samples may not be uniquely defined, as was also argued above under pt.2.2.

This leads to two separate conclusions:

- *The proposed default values for SPM in the total water column may be inaccurate for dynamic transitional water bodies. In any case, when high levels of SPM occur, monitoring via the SPM fraction is more appropriate. Using the default values as basis for normalisation would reduce the variability in transitional waters.*
 - *Further consideration should be given to the possibility to determine the EQS of the total water column for hydrophobic substances by sampling and analyzing the SPM fraction and back-calculating the total water concentration using the SPM concentration for the normalised values (3 or 15 mg/l) rather than by establishing sediment EQS (see also 2.4).*
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2.4 The CIS Guidance Document 19 on Surface Water Chemical Monitoring deals partly with sampling and also with establishing the long term trend in the evolution of the quality of the water body. This type of trend monitoring is also applicable to the sediment phase.

It recalls that metals should not be assessed via the total water column, but as the dissolved fraction (after filtration). For other substances the suggestion is that “whole water data may be generated by analysis of the whole water sample, or by separate determinations on liquid and SPM fractions.” This provision may indeed be helpful, especially for hydrophobic substances, because it offers the option to filter out the SPM fraction and measure the concentration in the solid phase.

Guidance Document 19 reminds also that it is problematic to obtain representative samples in this case of highly variable conditions (p.11). (In a strongly dynamic environment and with higher concentrations of SPM it is very difficult to obtain samples with the representative solid particle fraction). Normalising the SPM fraction solves this problem as well, because it is no longer necessary to collect samples with representative concentrations of SPM.

It seems to us that it is necessary to formalise the proposals in the Guidance Document at Community level, stating that the whole water concentration should be based on total water with values of SPM of 3 or 15 mg/l. Failing this the EQS standard is not uniquely defined for hydrophobic substances.

The problems are partly hinted at in the Guidance: (p.28, 29) “Unfortunately, most available analytical methods have not been validated for water samples containing substantial amounts of SPM. This can result in incomplete extraction of hydrophobic organic contaminants adsorbed to SPM and thus, to an underestimation of the whole water concentration”. Indeed, this is correct, but still does not deal with the issue of different pathways via the solid or the water phase. On p.29 it is also discussed that for extremely low SPM content, hydrophobic contaminants should be analysed as dissolved fraction; (something which is again very problematic, because for many priority substances the analytical techniques are not yet sufficiently sensitive to determine the low concentrations set by the EQS in a reliable manner). Again, one may get around this if the total water column is normalised for SPM: in that case one should establish the concentration of substances in SPM and determine the concentration in the “total” water column via a calculation.

But the Guidance document also confirms in section 6.3 that there are as yet no **standardised** models available for the analysis of sediment/SPM. This makes the whole consideration of how to deal with sediment even more problematic.

2.5 The next provisional guidance document on sediment and biota chemical monitoring (developed by the CMA committee) is only available in draft form thus far. It recalls the provisions of the Directives and reminds that any sediment or biota EQS should provide “at least the same level of protection”, but without discussing how this should be done.

The background is expanded in section 3.1 with the following text:

“The main aim of the WFD is the achievement of the good chemical status for all water bodies and Member States shall decide the matrix that, for a specific substance, is more representative of the chemical quality of a specific water body: e.g. in marine coastal waters the monitoring strategy of sediment and biota matrices, for many substances, is widespread in Europe because these are compartments that better represent the chemical status of marine coastal waters. On the other hand, for many rivers in Europe the choice of sediment matrix for monitoring (...) should be avoided because this matrix cannot guarantee (.....) the protection of the river’s ecosystems...”.

The guidance recalls further that for hydrophobic substances with $\log K_{ow} > 5$ (or a $\log K_{oc} > 5$) the solid sediment or SPM phase is the proper matrix to measure the concentration, in particular for trend monitoring purposes. The priority and hazardous substances from Annex I to Dir 2008/105 that fall in this category are listed in the document.

On the practical aspects, the guidance recommends to analyse the sediment fraction <63 micron.

The guidance in this draft paper is generally useful.

The text concludes (section 7.2) with the observation that the link between chemical and ecological status is poorly understood. It is recommended to develop a better understanding of those tools that establish the relationship between chemical substances in the matrix and the possible biological (ecological) effects (bioassays, biomarkers and other ecotoxicity tests). The issue of bioavailability is a critical one for sediments and also needs to be taken into account.

This observation is at the heart of the matter, because it raises implicitly the same question as to what constitutes “equivalent protection”? If the link between chemical concentrations and ecological quality status is not clear, it would be hard to set EQ standards for sediment and biota that are “equivalent” to those for the water column. As pointed out above, this guidance assumes that the only reason to measure the concentration of certain substances in sediment or biota is in support of assessing the chemical quality in the water column.

References

(1) P. Lepper (2005). Manual on the Methodological Framework used to derive Quality Standards for Priority Substances of the Water Framework Directive. Fraunhofer Institute for Molecular Biology and Applied Ecology.