Technical Report No. 7

EUROWATERNET

The European Environment Agency's Monitoring and Information Network for Inland Water Resources

Technical Guidelines for Implementation

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1. INTRODUCTION

The **European Environment Agency** (EEA) has a political mandate from the EU Council of Ministers to produce objective, reliable and comparable information to allow the Commission, Member States and the general public to judge the effectiveness of policy and the needs for policy development. The EEA and the European Environment Information and Observation Network are created to be the main European system for supporting development and implementation of policy through the interactions of networking, moving from monitoring to reporting and the establishment of the EEA as the Reference Centre for environmental information. This Monitoring, Data, Information, Assessment and Reporting chain (MDIAR) therefore forms the backbone of the EEA's activities.

The European Topic Centre on Inland Waters (ETC/IW) has designed and tested an information and monitoring network, called **EUROWATERNET** (EEA Topic Reports 10 and 11). EUROWATERNET will provide the **European Environment Agency** (EEA) with information that it needs to meet the requirements of its customers including the European Commission, other policy makers, national regulatory bodies and the general public. Information is required on:

- the status of Europe’s inland water resources, quality and quantity (status and trends assessments); and,
- how that relates and responds to pressures on the environment (cause-effect relationships).

EUROWATERNET will provide information on **water quantity** as well water quality issues. These guidelines primarily deal with **quality** issues. Further work is being undertaken by the EEA and ETC/IW to develop detailed proposals with EUROSTAT for the collection of **comparable water quantity information** at the required level of detail and aggregation (e.g. catchment level). Recommendations and guidelines on the **water quantity aspects of EUROWATERNET** will be distributed to Member Countries at a later stage.

Monitoring is expensive and is unlikely to be undertaken purely for the “European need.” It is essential therefore that EUROWATERNET is firmly based on national programmes as the ‘zero’ or ‘low cost’ option. By and large national networks are likely to be more than adequate (in terms of numbers of stations, frequency of monitoring and determinands monitored) to meet the EEA’s need.

This document provides National Focal Points, National Reference Centres and other national experts with guidelines on how **rivers and lakes** should be selected for EUROWATERNET. It also provides guidelines for the **design of a groundwater** monitoring network for EUROWATERNET.

The approach for rivers and lakes is **different** from that for groundwaters. This is because river and lake national monitoring networks are generally more established than those for groundwater. Thus whilst the basic network for rivers and lakes is based on existing monitoring networks, for groundwaters EEA Member Countries might have to **develop their existing network** to provide information on their national groundwater resources. If the guidelines for monitoring groundwaters were followed then the network would provide Member Countries with a **representative view of their groundwater bodies**. The key groundwater aspects of EUROWATERNET are being tested in a few volunteer countries and recommendations for a **basic network** for groundwater will emerge from these tests. Further guidance will then be given to Member Countries.

The immediate aim is for Member Countries to establish **basic networks** for rivers and lakes, and **to test** the proposal for the groundwater network. This will lead to transfer of the requested monitoring information from the local, regional and national levels to the EEA using the EIONET structure. In the short term the ETC/IW will provide worked examples of the operation of EUROWATERNET to National Focal Points and national experts at an EEA **workshop** due in **October 1998**. In the longer term Member Countries will be asked to extend the basic network to all water types, and to test and develop a network **fully representative** of general status issues and to answer more specific questions.

The proposed EU Framework Water Directive (COM(97) 49 final) is a major piece of legislation affecting the water environment. It will require the **integrated** management of **water quantity and water quality**. EU Member States will need to collect information on the status of, and pressures on, rivers, lakes and groundwaters. EUROWATERNET incorporates water quality and quantity information and is **fully compatible** with the reporting **needs of the FWD**. The relationship between the assessment, monitoring and reporting requirements of the Framework Water Directive and EUROWATERNET are described in Section 4.

2. DEFINITION AND CONCEPT OF EUROWATERNET

EUROWATERNET is:

“the **process** by which the EEA obtains the information on water resources (quality and quantity) it needs to answer **questions** raised by its customers”.

Questions may relate to statements on general status (of rivers, lakes and groundwaters) or specific issues (e.g. water stress, nutrient status and acidification at a **European** level.

The key concepts of EUROWATERNET are:

It samples existing national monitoring and information databases;

- It compares like-with-like;
- It has a statistically stratified design ‘tailor-made’ for specific issues and questions; and
- It has a known power and precision.

The network is designed to give **a representative assessment** of water types and variations in human pressures within a Member Country and also across the EEA area. It will ensure that similar types of water body are compared. The need to compare like-with-like is achieved with a stratified design with the identified and defined strata containing similar water bodies. The use of the same criteria for selecting strata and water types across Member Countries will help to ensure that valid status comparisons will be obtained.

A **basic network** of river stations and lakes based on the relative surface area of countries is proposed as the first step for Member Countries. However, it is likely that these will not answer all the questions raised by the EEA’s customers or perhaps not with the desired precision and confidence.

Therefore, it is likely that a flexible approach will also be required for the selection of other monitoring stations included in national networks in order to be able to answer more specific questions, such as “what is the extent of acidification in Europe” or “what is/will be the impact of the Urban Waste Water Treatment Directive on water quality”. This is because the stations required for these questions may not always be located on the same water bodies/catchments as the basic network stations. In addition, more specific and detailed pressure information might be required. Thus to meet some of the EEA’s information needs, site selection within each country must be issue or question driven. This, if necessary (in the light of experience), will form the **impact network** of EUROWATERNET.

A network **fully representative** of the differences in, and variability, of quality, quantity and pressures found in all water body types across Europe would be expected to answer most questions asked of the EEA. It is the **long-term aim** to make EUROWATERNET fully statistically representative. This will be achieved through the experience gained in implementing the basic and impact networks. This development will need to take into account the number of stations required to answer questions with defined, or at least known, levels of precision and confidence, and with knowledge of any inherent bias (for example, towards the most polluted water bodies) in the selected river stations, lakes or groundwater sampling wells.

Member Countries will be asked to provide aggregated data with supportive descriptive statistics which will enable an assessment to made of the precision and confidence of the information. As part of the development of EUROWATERNET the precision and confidence obtained from different numbers of stations are being assessed. At present a precision of 10% of mean or percentile values (as appropriate) with a confidence of 90% would appear to be appropriate, or at least possible in some countries. Thus the selection of the required number of stations or water bodies would also have a statistical basis such as:

How many stations/rivers/lakes/sampling wells do you need to select to be within 10% of the true status of the total river, lake or groundwater body population within Europe with 90% confidence, and to be able to detect 10% change between (5 year) reporting periods?

3. QUESTIONS TO BE ANSWERED BY EUROWATERNET

Table 3.1 summarises the European Prominent Environmental Problems and some questions the European Commission and other customers might ask the EEA to answer.

Table 3.1 Summary of the aims, policies, questions and information needed for Europe's prominent environmental problems

Problem/aim	Policy (examples)	Questions	Example of indicators
Quality of surface water	Dangerous Substances Directive, etc.	What are the levels and significance of, and what are the spatial differences and temporal trends of: pesticides, organic pollution, pathogens, heavy metals in, Europe's surface waters; and, how do these relate to human activities?	concentrations of BOD, COD, cadmium, mercury, atrazine, PAHs catchment: land use; population density; loads from point and diffuse sources.
Eutrophication	UWWT Directive Nitrates Directive	What is the level and significance of, and what are the spatial differences and temporal trends of nutrients in Europe's surface waters; and, how does this relate to human activities?	nitrogen and phosphorus concentrations chlorophyll a concentrations, trophic status catchment: same indicators as above
Reduction and control of pollutant discharges	5th EAP	What are the loads of contaminants entering the estuaries and seas of EEA area?	River flows, Flow related concentrations of nutrients, heavy metals, organic material, synthetic organic substances such as pesticides.
Quality and quantity of groundwater	GAP Nitrates Directive	What is the level and significance of, and what are the spatial differences and temporal trends of: pesticides, nutrients, pathogens, heavy metals in, and availability of, Europe's groundwater; and, how do these relate to human activities?	pesticide and nitrate concentrations, quantity, volumes abstracted, land use usage of pesticides and fertilisers
Physical changes	5th EAP proposed WFD	What is the scale and importance of physical interventions in the hydrological cycle?	Degree of modification of rivers, lakes by, for example, damming and flood prevention works.
Ecological quality	5th EAP proposed FWD	What is the level and significance of, and what are the spatial differences and temporal trends of ecological quality in Europe's surface waters; and, how does this relate to human activities?	invertebrate, fish, and plant communities, physicochemical indicators, flow reference ecological conditions
Acidification	5th EAP SO_2/NO_x Directives UN-ECE protocols	What is the level and severity of, and what are the spatial differences and temporal trends of acidification in Europe's waters; and, how does this relate to human activities?	pH, invertebrate communities, catchment soil, characteristics sulphur and nitrogen oxide deposition in the catchment

Notes

GAP Groundwater Action and Management Programme
WFD Water Framework Directive
5th EAP 5th Environmental Action Programme
UWWT Urban Waste Water Treatment Directive

4. THE RELATIONSHIP BETWEEN EUROWATERNET AND THE PROPOSAL FOR A FRAMEWORK WATER DIRECTIVE (COM(97) 49 FINAL)

The proposal for a Framework Water Directive (COM(97) 49 final) (FWD) will require the integration of:

- water resource management with the protection of the natural ecological state and functioning of the environment;
- water quality and water quantity management;
- surface water management (including coastal waters) with groundwater management;
- measures such as emission controls, with environmental objectives.

The European Environment Agency (EEA) has been consulted by the European Commission (DGXI) during the technical discussions on Annexes II, III and V of the FWD proposal carried out under the Luxembourg and UK Council Presidencies. It has been the intention as far as possible to make the monitoring and assessment requirements of the proposed Directive compatible with the aims of EUROWATERNET. This should ensure that Member States do not have to develop two incompatible monitoring and assessment systems, and enables the EEA and DGXI to have a common source of information for their different needs. EU Member States will have a legal requirement to provide the European Commission with specified information under the FWD.

Annex II of the current working document on the directive (ENV/98/105, dated 30 April 1998) requires EU Member States to characterise surface water bodies (rivers, lakes, transitional and coastal waters) and groundwater. For surface waters this will entail the identification of the different water body types within River Basins using obligatory and optional factors that determine the characteristics of rivers and lakes, and hence the biological communities living therein. The obligatory factors for rivers include size (based on catchment area) and altitude. The de-minimis for river size is 10 km^2 and the size categories for small, medium, large and very large rivers are not exactly the same as those used in EUROWATERNET. The obligatory typology proposed in the FWD is to enable Member States to identify the ecotypes of rivers and lakes, and to enable appropriate and comparable reference conditions to be established across the EU. The importance of this apparent difference between the river size categories should be evaluated once information has been received from EUROWATERNET. Actual catchment sizes (rather than categories) are being requested for EUROWATERNET which should make this evaluation possible.

Member States will also be required to collect and maintain information on the types and magnitude of anthropogenic pressures to which surface and groundwater bodies in each River Basin District are liable to be subject. This will include significant point sources and diffuse sources of pollution. This will potentially provide the type of pressure information at the catchment and subcatchment level required by EUROWATERNET. The ETC/IW is also undertaking work on emissions to water as part of its 1998 workprogramme.

Annex V of the FWD requires the monitoring and assessment of the status of surface waters (ecological and chemical status) and of groundwater (quantitative and chemical status). This requirement should also provide information on the status of rivers, lakes and groundwaters that should be of use to EUROWATERNET. Three types of monitoring are described in Annex V: surveillance, operational and investigative monitoring. Surveillance monitoring should provide information on the general status of rivers, lakes and groundwater as long as all types (sizes, altitude classes and depths) are included. To that end the proposal states that *"Surveillance monitoring shall be carried out of sufficient surface water bodies to provide an assessment of the overall surface water status within each catchment or sub catchments within the River Basin District. In selecting these bodies Member States shall ensure that, where appropriate, monitoring is carried out at points where:*

- *the rate of water flow is significant within the river basin district as a whole; including points on large rivers where the catchment area is above 2500 km^2;*
- *the volume of water present is significant within the river basin district, including large lakes and reservoirs;*
- *significant bodies of water crossing a Member State boundary;*
- *sites identified under the Information Exchange Decision 77/795; and*
- *such other sites as are required to estimate the pollutant load which is transferred across Member State Boundaries, and which is transferred into the marine environment.*

However this description of surveillance monitoring might imply that just monitoring in large rivers/water bodies is required. If Member States interpret the text in this way then the monitoring will not give an assessment of the overall surface water status within each catchment or subcatchment. There is, therefore, **a potential gap** between FWD requirements and the needs of EUROWATERNET for information on a wide range of water body sizes and types.

For groundwater the proposal states that *"the groundwater monitoring network shall be designed so as to provide a coherent and comprehensive overview of groundwater chemical status within each river basin and to detect the presence of long term anthropogenically induced upward trends in pollutants"* and *"sufficient monitoring sites shall be selected for each of the following:*

- *bodies identified as being at risk following the characterisation exercise undertaken in accordance with Annex II;*
- *bodies which cross a Member State boundary."*

Again the interpretation of the text will be important in determining whether the groundwater information provided for the FWD will meet the needs of EUROWATERNET.

5. BASIC NETWORK

5.1. Selection of river stations

Introduction

The basis of EUROWATERNET is the information derived from existing national and/or regional monitoring networks within each Member Country. Member Countries are asked to select river and river stations according to the criteria described in this section. These will form the **basic network** and are expected to be able to provide a **general overview of the quality of rivers at a European level**. The process of selecting stations is illustrated in Figure 5.1.

A **river** in this context not only means the most downstream point of a river catchment but also its constituent reaches, tributaries and subcatchments. For many rivers a number of stations would be required along its length – from source to mouth – to characterise any spatial differences in quality or quantity. Thus one station monitoring quality at the most downstream point or on the largest reaches of a river would not necessarily characterise the water quality of the whole river.

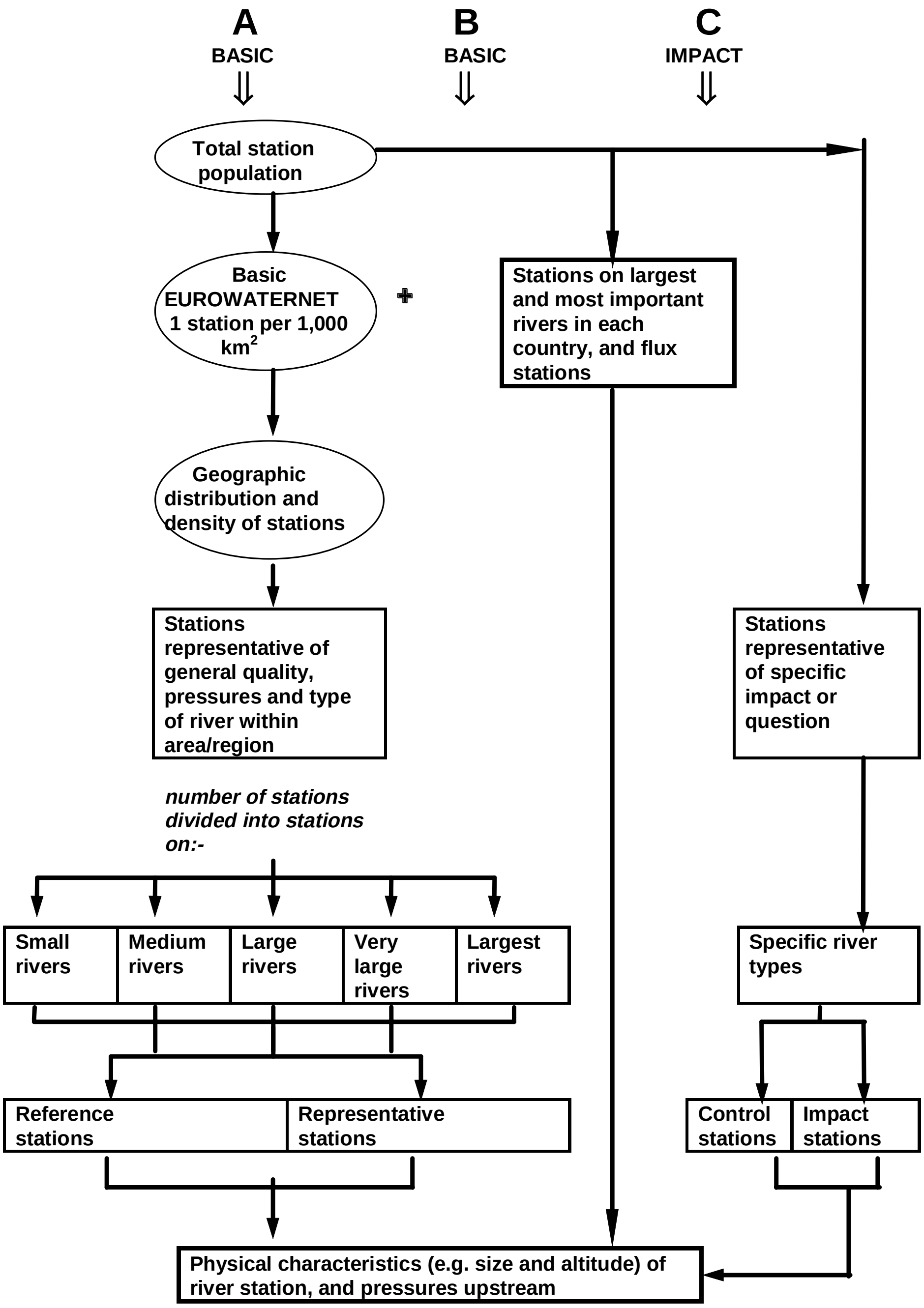
A **river station** is a point on a river where quality, quantity or other aspects of the river are measured. The quality measured at this point will often characterise a defined reach or length of river over which the quality is relatively homogenous or not statistically different. A series of stations along a river will often be used to define the total length or number of reaches within certain quality class ranges within a catchment and/or nationally. The latter often forms the basis of General Quality Classification Schemes. Thus any particular station will be representative of a **length of river** of a certain quality.

To gain an overview of a determinand/indicator over a whole river catchment an assessment would be required of the number of reaches within the catchment, and how the determinand/indicator varied between them. An optimal number of stations could then be located to characterise the river catchment. In practice many of the small rivers (reaches) may not be monitored at a density that would be expected from their occurrence relative to other sized reaches or rivers. Small rivers are, however, ecologically important and because of their relative size might be more at risk from human activities than larger reaches of rivers.

The basic network stations will describe **quality at certain points** along a river. As these may not provide the average, worst or best quality over the whole river, information on smaller (and larger) reaches or rivers is also being asked for. Once aggregated at a European level according to the size and other stratifying criteria given in this section, frequency distributions of quality determinands by **stations** instead of by river lengths will be presented.

Once a fully representative network has been established by consideration of the distribution of quality and quantity determinands/indicators across the different sized rivers and river reaches within catchments and countries then frequency distributions may be able to be expressed as **lengths of river** or **proportions of total resource**.

Figure 5.1 **Illustration of the process of selection of river stations for the basic and impact network of EUROWATERNET**



The different **types** of station (reference, flux, largest rivers) are subsets of the total station population. **Representative** stations are selected to be *representative* of the total station population in a region and nationally. It will, therefore, be expected that some stations will fall into **more than one** type. In a region with very little human activity all stations may meet the 'reference station' criteria. In this case reference stations will be characteristic of the region and will thus also be representative stations. Therefore, if 9 stations are required for the region (and 9 were available) then they would all be reference and representative stations.

Similarly in many parts of Europe there will be **no stations** that meet the 'reference station' criteria in which case the total number of stations required should be made up of **all representative** stations.

Even though once selected these stations might form the basis of the network, and answer 'general' status questions (for example what is the status of organic pollution in rivers) using different indicators, it should be recognised that a more focused selection using the stratified design might be required to answer more specific issues (**an impact network**). This latter issue is discussed further in this note.

Numbers of stations

The required number of stations for the **basic network** should be selected as described in following paragraphs. The process of selection of river stations for the basic network is illustrated in Figure 5.1.

The starting point is the number of river monitoring stations in national and / or regional monitoring networks that is the 'total station population'. The total number of river stations selected by the Member Country from the total station population will initially be based on total land area at a density of **1 river station per 1,000 km^2** (Line A in Figure 5.1). Guidance on how many river stations this equates to for each country is given in Table 5.1.

Member Countries will also be able to report what they consider to be representative of the issue / pressure being assessed, and results from regional surveys will be acceptable. Thus lower (from those recommended in Table 5.1) river station numbers (densities) will be acceptable if representativeness can be demonstrated. In this case an indication of how 'representative' the information is should be given, for example, the removal of bias by weighting factors.

Table 5.1 Approximate number of river stations per country required in the basic network.

Country	Area (km^2)	Total rivers / stations 1 per 1,000 km^2	Reference stations	Represen-tative stations	Stations on largest and most important rivers	Flux stations
EEA Countries						
Austria	83,855	84	8	76	?	?
Belgium	30,519	31	3	28	?	?
Denmark	43,092	43	4	39	?	?
Finland	338,145	338	34	304	?	?
France	547,026	547	55	492	?	?
Germany	357,000	357	36	297	?	?
Greece	131,957	132	13	119	?	?

Table 5.1 continued

Country	Area (km^2)	Total rivers / stations 1 per 1,000 km^2	Reference stations	Represen-tative stations	Stations on largest and most important rivers	Flux stations
Iceland	103,000	103	10	93	?	?
Ireland	70,285	70	7	63	?	?
Italy	301,268	301	30	271	?	?
Luxembourg	2,586	3	-	3	?	?
Netherlands	41,864	42	4	38	?	?
Norway	324,219	324	32	292	?	?
Portugal	91,949	92	9	83	?	?
Spain	504,782	504	50	454	?	?
Sweden	449,964	450	45	405	?	?
United Kingdom	244,103	244	24	220	?	?
EEA 18 Area	3,665,614	3665	364	3301	650	?
PHARE countries						
Albania	28750	29	3	26	?	?
Bosnia and Herzegovina	51129	51	5	46	?	?
Bulgaria	110910	111	11	100	?	?
Czech Republic	78863	79	8	71	?	?
Estonia	45226	45	5	40	?	?
FYROM	9889	10	1	9	?	?
Hungary	93030	93	9	84	?	?
Latvia	64589	65	7	58	?	?
Lithuania	65301	65	7	58	?	?
Poland	312680	313	31	282	?	?
Romania	237500	238	24	214	?	?
Slovak Republic	49014	49	5	44	?	?
Slovenia	20251	20	2	18	?	?

? No information at present

Geographical spread

The required numbers of river stations should be geographically spread across a Member Country. If information is available on the length or numbers of river per catchment, region or area of a Country, then the number of selected rivers or river stations per region / catchment should be weighted according to the density of river length in each catchment, region or area. In this way the catchment / region / area with the longest length has proportionally more stations. An example of this procedure is shown in Table 5.2.

Type of station

The total number of river stations required should be divided into the following types of station based on some key differences in **physical characteristics**, **purpose** of station and **pressures** in the catchment.

Reference river stations should be selected in catchments with little or no human activity and the percentage of natural landscape would be higher than 90%. These stations are likely to be on small rivers with small catchments and would ideally be around 10% of the river stations selected. If the number of stations is less than 10% then select more representative stations.

Table 5.2 Example of geographic spread of river stations in the basic network according to regional density of rivers

	Area (km^2)	Total river stations 1 per 1,000 km^2	
Whole country	138,058	**138**	
		10%	**90%**
Region of country	**Length of river surveyed and/or total length of river in each region (km)**	**Reference Stations (Target 14)**	**Representative stations (Target 124)**
1	14,072	4	34
2	8,674	2	21
3	6,289	2	15
4	3,467	1	8
5	2,789	1	7
6	4,981	1	13
7	10,691	3	26
Total	50,963	14	124

Representative river stations should be selected to reflect the majority of rivers in a region/area with human activities in the catchment consistent with the region's/areas activities. Thus if the region is predominantly agricultural (e.g. 90% of land use) then most stations (e.g. 90%) should reflect the potential impact of agriculture on river quality. On the other hand if water quality in a particular region is mainly impacted by urbanisation and point discharges then the stations selected should reflect this impact.

Equal numbers of representative stations (and reference if possible) should be selected on nationally small, medium, large and very large rivers. The suggested criteria for defining 'small', 'medium', 'large' and 'very large' rivers or river subcatchments are as follows:

- small catchment area upstream of station, <50 km^2;
- medium catchment area upstream of station, 50 km^2 to <250 km^2;
- large catchment area upstream of station, 250 km^2 to <1,000 km^2;
- very large catchment area upstream of station, 1,000 km^2 to <2,500 km^2;
- largest catchment area upstream of station ≥2,500 km^2.

Additional river stations should be selected from the national monitoring networks as separate, discrete strata from the representative and reference station strata. As already described in paragraph 5.7 these additional types of station may also appear within the reference and representative category. The additional river station types are **'the largest and most important rivers'** and **'flux'** stations (Line B in Figure 5.1).

The **largest and most important rivers** in the EEA area comprising approximately 650 in total made up as follows.

- Rivers with a catchment area **greater than 2,500 km^2**: numbering approximately 450 in the EEA area;
- The most important or well-known rivers/canals in each country should be included: these would also likely include those rivers currently monitored for the **Exchange of Information Decisions**.

Flux stations. All monitoring information from those stations currently being used for the assessment of international transboundary loads or loads entering Europe's Seas should be included. Information from these stations will relate to loads of contaminants rather than aggregated data on quality/quantity determinands. However, in the case where any of these stations are also selected in the other 3 station types (reference, representative, largest) quality/quantity data will be required.

The approximate number of reference and representative river stations required for the basic information network is summarised in Table 5.1. National information is not available to the ETC/IW on the number of 'the largest and most important rivers' or 'flux stations'. When submitting information to the EEA a clear indication should be given as to what type of station is being 'allocated' to EUROWATERNET. Thus:

- B = Reference
- R = Representative
- L = Largest and most important
- F = Flux

The transfer of data and information to the ETC/IW and the EEA is discussed further in Section 9.

5.2. Selection of lakes

Introduction

The starting point for EUROWATERNET is the number of lakes and lake monitoring stations in national and/or regional monitoring networks, that is the **'total sampled lake and lake station population'**. Member Countries are asked to select lakes according to the criteria described in this section. These will form the **basic network** and are expected to be able to provide a **general overview** of the quality of lakes at a European level.

A lake in this context may consist of one discrete body of standing water that may contain a number of basins between which there is generally multi-directional exchange and mixing of water at least during part of the year. In some cases lake basins may be interconnected and separated by a relatively shallow channel through which water flows in one direction only. The quality of the interconnected basins or lakes might be different depending on their physical and chemical characteristics, and each basin may be considered, managed and monitored as separate lakes by national authorities.

To gain a **representative view** of any determinand/indicator within a lake it may be adequate to have one sampling station (for example, at the outflow if the lake is well mixed), or a number of stations may be required to take into account horizontal and vertical differences in quality. In the latter case monitoring results may be weighted, according to volume for example, to give an average measure of a determinand. These differences in mixing and physical characteristics are taken into account when national lake sampling programmes are designed. Ideally, therefore, for EUROWATERNET **aggregated data** representative of **each lake** will be made available irrespective whether they are from one or many stations.

To gain a overview of a determinand/indicator within the national or regional total lake population (as opposed to the total **sampled** lake population) an assessment would be required of the numbers and type of lakes, and how water quality varied between them. An optimal or statistically representative number of lakes (perhaps according to lake size distribution, and the 'pressures' on them, for example) could then be sampled to characterise the total lake population. In practise the number of small lakes sampled may not be as high as would be expected from their relative occurrence compared to other sized lakes. However, when considering the cumulative surface area within the total population sampling more large lakes than small lakes might be more representative of the total lake resource in terms of surface area (or perhaps volume). **Small lakes** are, however, also ecologically important and because of their relative size (volume) might be more at risk from human activities than larger lakes. **Small and medium** sized lakes should also, therefore, be included in national selections of lakes for EUROWATERNET.

The different **types** of lake (reference, largest) are subsets of the total lake population. **Representative** lakes are selected to be *representative* of the total lake population in a region and nationally. It will, therefore, be expected that some lakes will fall into **more than one** type. In a region with very little human activity then all lakes may meet the 'reference lake' criteria. In this case reference lakes will be characteristic of the region and will thus also be representative lakes. Thus if 9 lakes are required for the region (and 9 were available) then they would all be reference lakes.

Similarly in many parts of Europe there will be **no lakes** that meet the 'reference' criteria in which case the total number required should be made up of all representative lakes.

Member Countries will also report what they consider to be representative of the issue / pressure being assessed, and results from regional surveys will be acceptable. Thus lower (from those recommended in Table 5.3) lake numbers (densities) will be acceptable if representativeness can be demonstrated. In this case an indications of how 'representative' the information is should be given, for example the removal of bias by weighting factors. Member Countries will also be able to present information for a catchment or region based on monitoring a relatively small portion of the water bodies which have been selected and monitored in a statistically representative manner. The design of lake acidification surveys in the Nordic countries is a good example of monitoring networks providing this type of information.

Initially **reservoirs** should be incorporated as a separate stratum in the lakes network. Thus the following lake selection procedure would also apply to reservoirs (where appropriate). An indication of where reservoirs have been selected instead of lakes should thus be given when submitting information.

Even though once selected these lakes might form the basis of the network, and answer 'general' status questions (for example what is the status of organic pollution in lakes) using different indicators, it should be recognised that a more focused selection using the stratified design might be required to answer more specific issues (**an impact network**). This latter issue is discussed further in this note.

For the basic network lakes are included each of which may be characterised by one or more stations (paragraph 5.25). For the impact network it might also be appropriate to include impact stations within lakes, particularly in the largest lakes, as well as impacted lakes. When lake stations are included then information would also have to be provided on what proportion of the lake the impact stations represent perhaps, for example, in terms of impacted area or volume. Thus in the largest lakes impact stations might occur in lakes that are also considered to be representative or even reference.

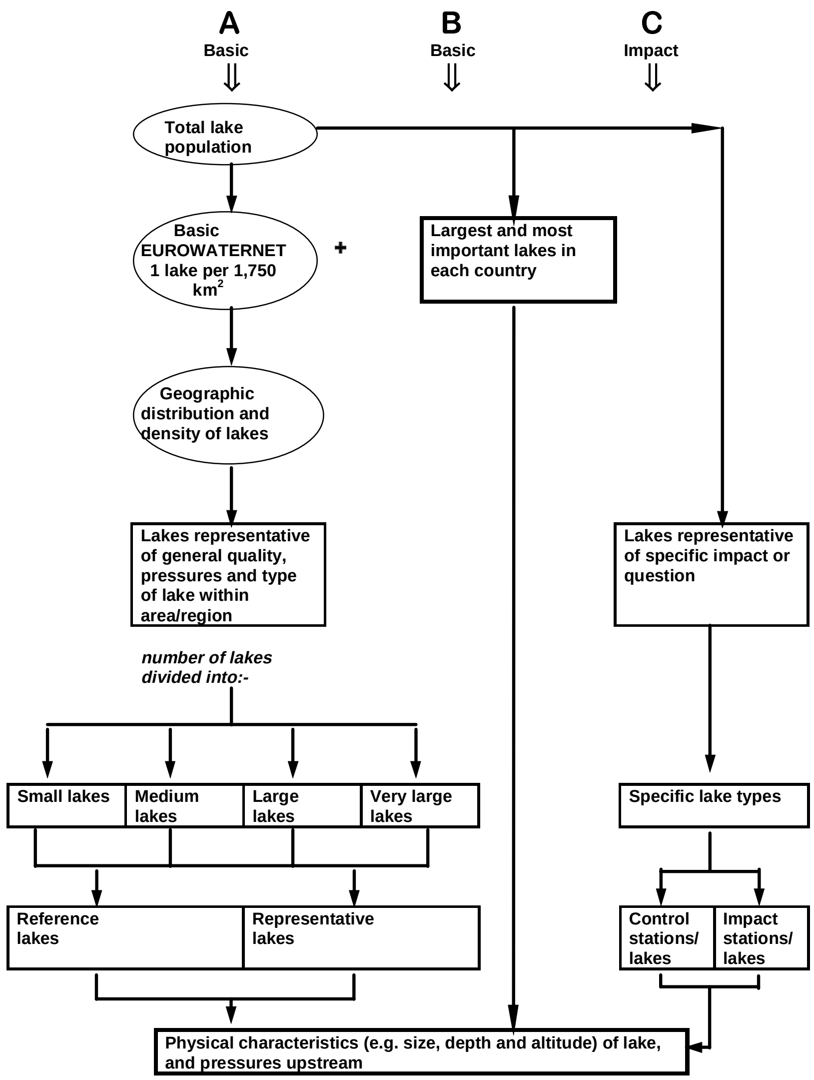
Numbers of lakes

The total number of lakes with a surface area greater than 0.1 km^2 selected by the Member Country from the total lake population will initially be based on total land area and a density of **1 lake per 1,750 km^2** (Line A, Figure 5.2). Guidance on how many lakes this equates to for each country is given in Table 5.3.

Geographical spread

The required number of lakes should be **geographically spread** across a Member Country. At the proposed density there will be for most Countries at least one lake in each of the national administrative regions. National administrative regions typically have a land area between 2,000 km^2 to 35,000 km^2. If information is available, the number of selected lakes per region or area of a Country should be weighted according to the numbers of lakes in each region or area so that the region / area with the largest number of lakes is sampled proportionally more.

Figure 5.2 Illustration of the process of selection of lakes (or reservoirs) for the basic and impact network of EUROWATERNET



Type of lake

The total number of lakes required should be divided into the following types of lakes based on some key differences in **physical characteristics** of the lakes and **pressures** in the upstream catchments.

Reference lakes should be selected in catchments with little or no human activity and the percentage of natural landscape would be higher than 90%. If possible these lakes should be around 10% of the lakes selected.

Representative lakes should be selected to reflect the majority of lakes in a region/area with human activities in the catchment consistent with the region's/area's activities. Thus if any particular region large lakes made up the greatest proportion of the total sum area (or volume) of all lakes in the region, then more large lakes than other sized lakes should be selected. The aim should, however, to have examples of lakes in all size categories in EUROWATERNET where possible. The proposed surface area size criteria are as follows.

- small lakes >0.1 to 1 km^2 surface area
- medium lakes >1 to 10 km^2 surface area;
- large lakes>10 to 100 km^2 surface area;
- very large lakes >100 km^2 surface area.

In **homogenous areas** with little human activity all representative lakes may also be reference lakes, and would ideally include lakes of different surface area.

Additional lakes should be selected from the national monitoring networks as separate, discrete strata from the representative and reference lake strata. As already described in paragraph 5.27 (Line B, Figure 5.3), this additional type of lake may also appear within the reference and representative category. The additional lake type is **'the largest and most important lakes'**.

The **largest and most important lakes** in the EEA area comprising approximately 200 in total made up as follows.

- lakes with a surface area greater than 100 km^2: numbering approximately 100 in the EEA area;
- the most important or well-known lakes/reservoirs in each country should be included.

The approximate number of **lakes (reservoirs)** required for the basic EUROWATERNET is summarised in Table 5.3. A clear indication should also be given as to what type of lake (reservoir) is being 'allocated' to EUROWATERNET. Thus:

- B = Reference
- R = Representative
- L = Largest
- M = Most important
- Where a reservoir is included in the basic network it should be highlighted with the prefix **(RES)** with an indication as to what type it is, 'B', 'R', 'L' or 'M'.

This is discussed further in Section 9 on data and information transfer.

Table 5.3 Approximate number of lakes (reservoirs) per country in the basic network

Country	Area (km^2)	Total number of lakes 1 per 1,750 km^2	Reference lakes	Representative lakes	Lakes with surface area >100 km^2	Most important lakes
EEA Countries						
Austria	83,855	48	5	43	2	?
Belgium	30,519	17	2	15	0	?
Denmark	43,092	25	2	23	0	?
Finland	338,145	193	19	174	47	?
France	547,026	313	31	281	1	?
Germany	357,000	204	20	184	2	?
Greece	131,957	75	8	67	1	?
Iceland	103,000	59	6	53	0	?
Ireland	70,285	40	4	36	3	?
Italy	301,268	172	17	155	5	?
Luxembourg	2,586	1	0	1	0	?
Netherlands	41,864	24	2	22	3	?
Norway	324,219	185	19	166	7	?
Portugal	91,949	53	5	48	?	?
Spain	504,782	288	29	259	?	?
Sweden	449,964	257	26	231	22	?
UK	244,103	139	14	125	1	?
EEA 18 Area	3,665,614	2095	209	1886	94	100?
PHARE countries						
Albania	28,750	16	2	14	?	?
Bosnia and Herzegovina	51,129	29	3	26	?	?
Bulgaria	110,910	63	6	57	?	?
Czech Republic	78,863	45	5	40	?	?
Estonia	45,226	26	3	23	?	?
FYROM	9,889	6	1	5	?	?
Hungary	93,030	53	5	48	?	?
Latvia	64,589	37	4	33	?	?
Lithuania	65,301	37	4	33	?	?
Poland	312,680	179	18	161	?	?
Romania	237,500	136	14	122	?	?
Slovak Republic	49,014	28	3	25	?	?
Slovenia	20,251	12	1	11	?	?

Note: ? No information at present

5.3. Selection of groundwaters

As for rivers and lakes the basic network for groundwater will be based on existing national monitoring networks. Because groundwater networks are generally less well developed or established in Member Countries a different approach has been adopted (see paragraph 1.5). Thus at this stage **volunteer Member Countries** have been asked to provide specific information on at least **3 groundwater bodies**.

The information requested relates to the **general characteristics** of each selected groundwater body and to the concentrations of **specified indicators** (ammonium, nitrite, nitrate and dissolved oxygen) measured at **different types of well** (surveillance wells, drinking water wells, industrial wells and wells used for other purposes) in each body. In addition, **maps** of each groundwater body showing the boundaries, sampling sites and type of sampling sites have been requested.

The information collected for this demonstration project is to be presented at the EEA's workshop for NFPs and experts scheduled for October 1998. It is anticipated that **further guidelines** on the basic network and the design for a fully representative network (see Section 8) will emerge from the workshop.

5.4. Physical characteristics and pressure information

For each selected river station, lake and groundwater body additional physical characteristics and pressure information will be required where available. These are summarised in Table 5.4.

Table 5.4 Examples of physical characteristics and pressure information required for each river station and lake in the basic network, and the groundwater network

	rivers	lakes	groundwater
Physical characteristics			
- stream order at station	✓		
- depth (mean)		✓	
- surface area		✓	
- catchment area upstream of station/lake	✓	✓	
- catchment area recharging/affecting groundwater body			✓
- station/lake altitude	✓	✓	
- longitude/ latitude	✓	✓	✓
- upstream river length to source	✓		
- hydrogeology			✓
- aquifer type			✓
- aquifer area			✓
- soil type/geology of catchment	✓	✓	✓
Pressure information			
- population density in (upstream) catchment	✓	✓	✓
Upstream catchment land use such as:-			
- % agricultural land	✓	✓	✓
- % arable	✓	✓	✓
- % pasture land	✓	✓	✓
- % forest	✓	✓	✓
- % urbanisation	✓	✓	✓
Point source loads entering upstream	✓	✓	✓
Fertiliser usage in catchment upstream	✓	✓	✓

Where detailed information on pressures is not available some indication/judgement of the major activities within the catchment upstream of each river station, lake or above each aquifer should be given. For example statements such as '*the catchment is 50% arable, 20% grassland, 10% forested and 20% urbanised*' could be provided, or the catchment has '*low-population density*' (such as <10 inhabitant per km^2) or '*high population density*' (such as >100 inhabitant per km^2).

5.5. Status indicators

Examples of the status indicators required to answer particular questions are given in Table 3.1. These are further defined for rivers and lakes in Table 5.5 in terms of primary determinands, that is those that are essential, and secondary determinands, that is those which would be useful but not essential, that would provide useful information to answer specific problems or issues.

Table 5.5 List of suggested primary and secondary determinands required for the river and lake monitoring networks

Indicator determinands ↓	Problems/issues →	EQ	AC	NS	TS	OP	WU	RA	PI	FL
	Examples of indicators ↓									
Biological indicators	Macroinvertebrates, Fish Macrophytes, Phytoplankton, Chlorophyll	✓✓	✓✓	✓	✓	✓	✓	✗	✓✓	✗
Descriptive determinands	Dissolved oxygen, pH, Alkalinity, Conductivity, Temperature, suspended solids	✓	✓✓	✓	✓	✓✓	✓✓	✗	✓	✓ (ss)
Flow	Flows, levels	✓✓	✓	✓	✓	✓	✓✓	✗	✓✓	✓✓
Hydromorphology	Habitat features, structure of bed, sinuosity	✓✓	✗	✗	✗	✗	✗	✗	✓✓	✗
Additional determinands	Biochemical oxygen demand Chemical oxygen demand Total organic carbon, Secchi disc, Aluminium fractions	✓	✓✓	✓	✗	✓✓	✓	✗	✗	✗
Nutrients	Total phosphorus, Soluble reactive phosphorus, Nitrate Nitrite, Ammonia, Organic nitrogen, Total nitrogen	✓	✗	✓✓	✗	✓	✗	✗	✗	✓✓
Major ions	Calcium, Sodium, Potassium, Magnesium, Chloride, Sulphate, Bicarbonate	✗	✓✓	✗	✗	✗	✓	✗	✗	✗
Heavy metals	Cadmium, Mercury Based on catchment/land-use	✗	✗	✗	✓✓	✗	✓	✗	✗	✓✓
Pesticides	Based on catchment/land-use	✗	✗	✗	✓✓	✗	✓	✗	✗	✓✓
Other synthetic organic substances	PAH, PCBs Based on catchment/land-use	✗	✗	✗	✓✓	✗	✓	✗	✗	✓✓
Microbes	Total and faecal coliforms, Faecal streptococci, Salmonella, Enteroviruses	✗	✗	✗	✗	✓✓	✓	✗	✗	✗
Radionuclides	Total alpha and beta activity Caesium 137	✗	✗	✗	✗	✗	✗	✓✓	✗	✓

Key to problems/issues
EQ Ecological quality
AC Acidification
NS Nutrient status
TS Toxic substances
OP Organic pollution
WU Water use and availability
RA Radioactivity
PI Physical intervention
FL Fluxes

Key to importance:
✓✓ Key determinands - primary
✓ Important but not key determinands - secondary
✗ Not considered as essential

Other:
ss Suspended solids

The status indicators for groundwater quality can be divided into seven groups (Table 5.6).

Table 5.6 List of suggested status indicators for the groundwater quality monitoring network

Group		Determinands
1	Descriptive determinands	Temperature, pH, DO, Electrical Conductivity
2	Major ions	Ca, Mg, Na, K, HCO_3, Cl, SO_4, $P0_4$, NH_4, NO_3, NO_2, Total organic carbon
3	Additional determinands	Choice depends partly on local pollution source as indicated by land-use framework
4	Heavy metals	Hg, Cd, Pb, Zn, Cu, Cr. Choice depends partly on local pollution source as indicated by land-use framework
5	Organic substances	Aromatic hydrocarbons, halogenated hydrocarbons, phenols, chlorophenols. Choice depends partly on local pollution sources as indicated by land-use framework.
6	Pesticides	Choice depends in part on local usage, land-use framework and existing observed occurrences in groundwater.
7	Microbes	Total coliforms, faecal coliforms

5.6. Summary of approach for basic network

River stations and lakes should be selected from the total station population using the stratification criteria recommended in the original EUROWATERNET design report (Topic Report 10/96). The total station population is the number of stations included in national and/or regional networks This approach is the **easiest** and is **recommended** for countries which have no access, at present, to the necessary information to implement the approach by which a more representative network would be obtained (Section 7).

Because this approach does not ensure the attainment of a representative set of stations in comparison to the overall water body types and range of water quality/quantity in a country, countries are also requested to indicate what the selected stations represent (e.g. impact of acidification, eutrophication....).

In some countries the required number of river stations and lakes for the basic network may be greater than the number of river stations/lakes in existing national and/or available regional networks. In this case countries should include **all river stations/lakes** in the **basic** EUROWATERNET and provide the requested physical characteristic and pressure information for determining the river station/lake type. They should also provide an **assessment/judgement** of how **representative** these stations are of the question being asked, and if possible to account for or remove the ‘bias’ in the information submitted. For example, stations may just be located on the most impacted rivers and reaches. In this case to put the results into perspective information may be provided on the length of river the selected station equate to, and how this relates to the total river length in a country.

6. QUESTIONS TO ANSWER SPECIFIC ISSUES - IMPACT NETWORK

Answering specific **issues** or **questions** will often relate to specific **impacts** which may require the selection of specific stations on specific water bodies subject to that impact, and of specific indicators of status and pressures. This will form the **impact** part of EUROWATERNET. This process is illustrated in Line C in Figures 5.1 and 5.2. The need for a separate impact network will be assessed against the ability of the basic network to quantify specific impacts, spatially and temporally, with the desired level of confidence and precision. The role of an impact network in assessing specific policies will be discussed with the EEA and NFPs at the Budapest workshop.

The following example illustrates how EUROWATERNET might be tailored to answer more specific issues should the EEA's customers so wish. The question selected for this example is:

> ***"What is/will be the impact of the Urban Waste Water Treatment Directive on river and lake quality?"***

Requirements of the Directive

The requirements of the Urban Waste Water Treatment Directive (summarised in Table A.1, in Appendix A) are aimed at controlling and reducing the discharges from point sources. Thus the selection of monitoring stations might be targeted at specific areas receiving these discharges and those which might be more distant, downstream, recipients of water quality improvement. Member States are also required to designate areas (inland, estuaries and coastal waters) 'sensitive' to eutrophication in which a specified level of urban waste water treatment is required. For discharges to areas 'sensitive' to contamination from nitrogen and/or phosphorus, tertiary treatment must be installed.

The Directive defines common standards for treatment focusing on the control of N and/or P inputs from larger discharges to areas more sensitive to pollution. Member States must designate sensitive waters and the impact of the directive will depend to a large extent on the extent of designation within each Member State. For example Denmark, Finland, Luxembourg and the Netherlands have designated the whole of their territory as sensitive and will implement (or have already) nutrient removal on all plants with a capacity above 10 000 Population Equivalent (PE) or reach an overall reduction of 75% for total nitrogen and phosphorus load. In contrast, the UK, most regions in France, Germany, Greece and probably Italy and Portugal will designate a 'patchwork' of sensitive areas, requiring nutrient removal only within these limited areas. The UK, Spain, Portugal and Italy have also designated 'less-sensitive' areas allowing less stringent treatment in areas with high natural dispersion characteristics and where there is low risk of eutrophication effects occurring.

These requirements can be used to formulate the target population of river stations and lake types that must be sampled in order to assess the impact of the Directive on water quality. The structure of such a design, the most appropriate status and pressure indicators to be obtained are described in the next sections.

In many countries with large coastal populations and relatively large urban waste water discharges there should be a major impact on estuary and coastal water quality. There is thus an opportunity to extend this question to cover **estuaries** and **coastal waters** in collaboration with the Topic Centre on Marine and Coastal Environment. A similar stratified design could be applied to national monitoring networks, and estuarine and coastal water stations could be selected accordingly.

Selection of stations

There are both temporal and spatial factors to consider when selecting the strata of river stations and lakes from which information on the indicators would be obtained. The starting point, as for the basic network, is the existing national and regional monitoring networks. The following stratification of monitoring stations is recommended.

Stratification of existing national and regional networks according to:

- size of river/lake;
- size of urban waste water discharge;
- sensitivity of receiving water;
- impact, flux and representative (control) stations.

Table 6.1 Selection of river and lake stations to answer Question 3.

	Water sensitivity							
	Standard				Sensitive			
(population equivalents '000's) →	<2	2 to 10	10 to 15	>15	<2	2 to 10	10 to 15	>15
River/lake size↓								
Small								
Medium								
Large rivers								
Very large								
Largest								

Thus stations from existing networks would be 'placed' in the most appropriate cell of the matrix in Table 6.1. Some of the selection criteria would not apply to some countries because of differences in the approach to the designation of sensitive areas, the size distribution of rivers and of sewage treatment works. Some of the cells would thus remain 'empty'.

River size is defined according to the criteria used in the basic network (paragraph 5.17). **Lake size** is defined according to the criteria given in paragraphs 5.35.

Discharge size: If the Directive has been properly implemented by Member States, by the end of 1998 tertiary treatment should be in place for all discharges greater than 10,000 population equivalents (pe) into sensitive waters. It is, therefore, likely that measures to date will have focused on the larger discharges. However river stations should be selected on other sized rivers/lakes and downstream of other sizes of works because the effects on water quality are likely to be different because of the different treatment levels and differences in dilution capacities of the receiving rivers. Though new treatment may have not yet been applied to these smaller discharges it will be of use now to establish a background level of quality in the receiving waters so that any changes in future water quality can be detected.

Impact stations should be selected to be below the influence of effluents discharged from works affected by the requirements of the Directive, or ones which will be in the future.

The impacts of changes in discharge load should also be accounted for if possible, for example, by also selecting stations **representative** of water quality upstream of the discharge, and/or also by locating the impact stations where there are no other impacts on the water quality in the immediate area. This should enable to impact of the urban waste water discharge to be separated from the impact of any changes to water quality upstream of (or away from) the discharge. These are the **'control'** stations against which the information from the impact stations will be compared.

Flux stations at the seaward end of rivers should also be selected to determine what impact there is/will be on loads discharged to seas.

Time series: Ideally river stations/lakes selected would have long time series available to give an indication of long-term variability in quality and how perhaps it has changed in line with other national and international requirements. Associated with time series information on the status indicators complementary information of pressure indicators would also be required where available (see Table 6.2).

Indicators to answer question 3

Table 6.2 lists the indicators proposed for this assessment. As for Questions 1 and 2 it may be the case that not all indicators will be available for all river stations/lakes. However Member Countries are asked to submit what information they have. This will allow the ETC/IW to optimise the aggregation of data. Information on the present status and pressures is required for the most recent 5 years available. Time-series information will be acceptable for as many years as there is a consistent and comparable datasets.

Table 6.2 Potential status indicators to assess effectiveness of UWWT Directive

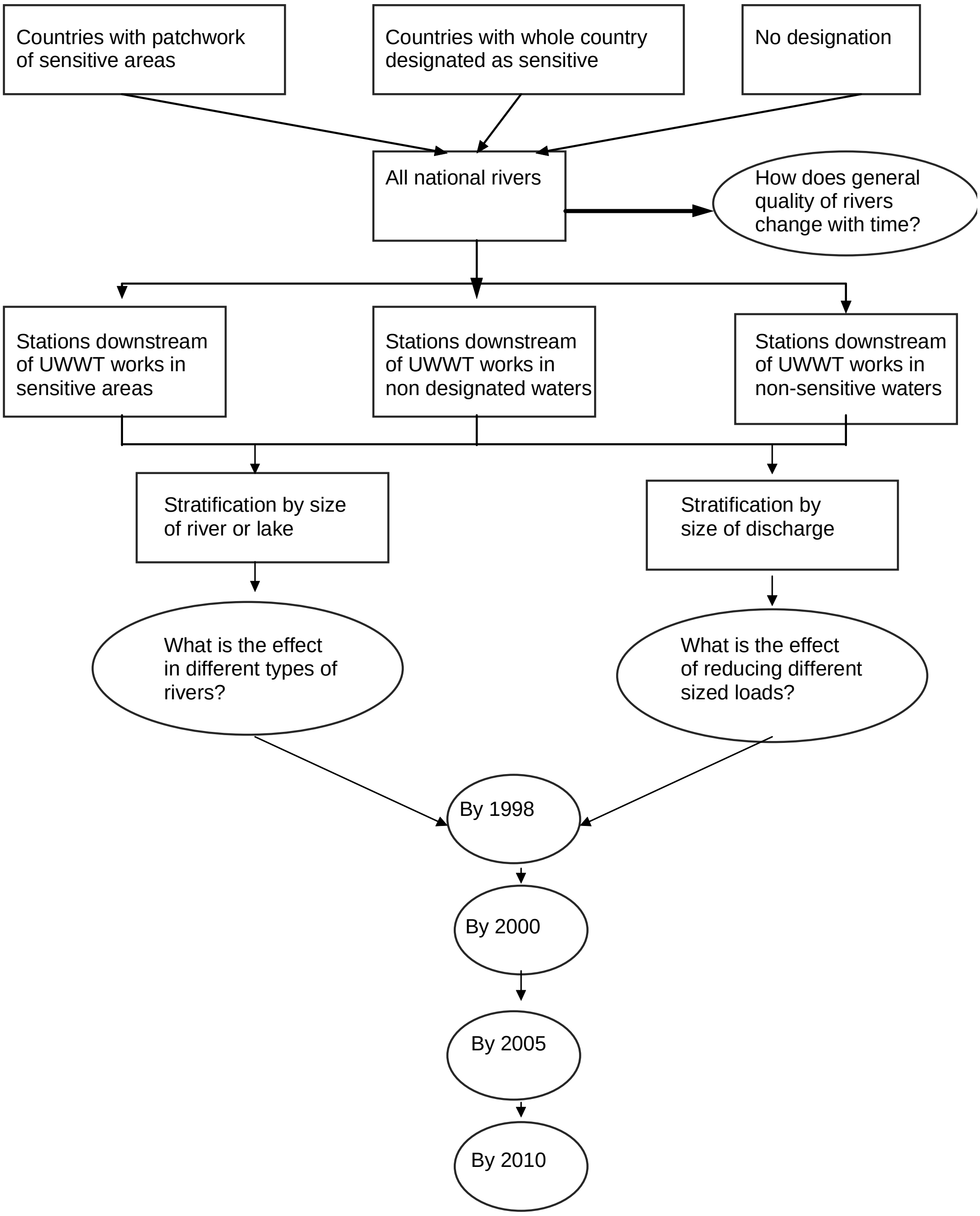
Indicator	Statistical expression
a) Status	
Nitrate Total inorganic nitrogen Ammonium Total nitrogen Soluble reactive phosphorus Total phosphorus	Annual and winter averages [1] " " " Annual and summer averages [1] "
Biochemical/chemical oxygen demand Dissolved oxygen	Annual average [1] "
Chlorophyll a (in large rivers)	Summer average [1]
River discharge and load of P and N species, organic matter at impact, representative and flux stations	Flow weighted annual load [1]
b) Pressure	
Loads of nitrogen, phosphorus and organic matter from UWWT plants entering rivers/catchments upstream of selected impact stations	Annual load
Loads of nitrogen, phosphorus and organic matter from other point sources entering rivers/catchments upstream of selected impact stations	Annual load
Population served by tertiary, secondary, primary and preliminary treatment in catchments above the selected stations	
Numbers of UWWT works in catchments	

1 accompanied by the following descriptive statistics and information for each station:

- standard deviation
- number of samples
- 10 and 90 %iles
- Min, max.
- sampling window (e.g. annual, winter, summer)

Winter December, January, February (if your season is defined differently please give span of months)
Summer June, July August (if your season is defined differently please give span of months)

Figure 6.1 Illustration of how EUROWATERNET might be used to assess impact of UWWT Directive



Supportive information on selected stations

The following **supportive information** (Table 6.3) should be submitted for each of the selected stations. This will facilitate the identification of different types of station so that appropriate comparisons and aggregations can be made.

Table 6.3 **Supportive information on physical characteristics and pressures for each selected station**

	Rivers	Lakes
<u>**Physical characteristics**</u>		
- type of water on which station is located (sensitive, non-sensitive, no designation)	✓	✓
- stream order upstream of station	✓	
- depth (mean)		✓
- surface area		✓
- catchment area upstream	✓	✓
- catchment altitude at station, of lake	✓	✓
- longitude/ latitude	✓	✓
- river length upstream to source	✓	

	Rivers	lakes
<u>**Pressure information**</u>		
- population density in upstream catchment	✓	✓
Catchment land use such as:-		
- % agricultural land	✓	✓
- % arable	✓	✓
- % pasture land	✓	✓
- % forest	✓	✓
- % urbanisation	✓	✓

7. FULLY REPRESENTATIVE NETWORK FOR RIVERS AND LAKES

As described in the introduction to this paper the longer-term aim will be to make **EUROWATERNET fully statistically representative**, building on the experience gained from the basic network particularly in relation to the information required to make Europe-wide and regional comparisons. This will be achieved by developing more homogeneous strata of river and lake types in relation to physical characteristics and pressures. Several possible variables have been suggested including catchment size, altitude, stream order, river flow, catchment gradient for rivers, and surface area and depth for lakes. Which of these variables are used to stratify is less important than the fact that the geo-physical strata should be firstly mutually exclusive, and secondly represent real sub-populations of rivers and lakes in terms of natural (non-anthropogenic) chemistry and biology. Other important factors to take into account are temperature, longitude, geology of catchment, all of which are likely to influence river and lake chemistry and biology.

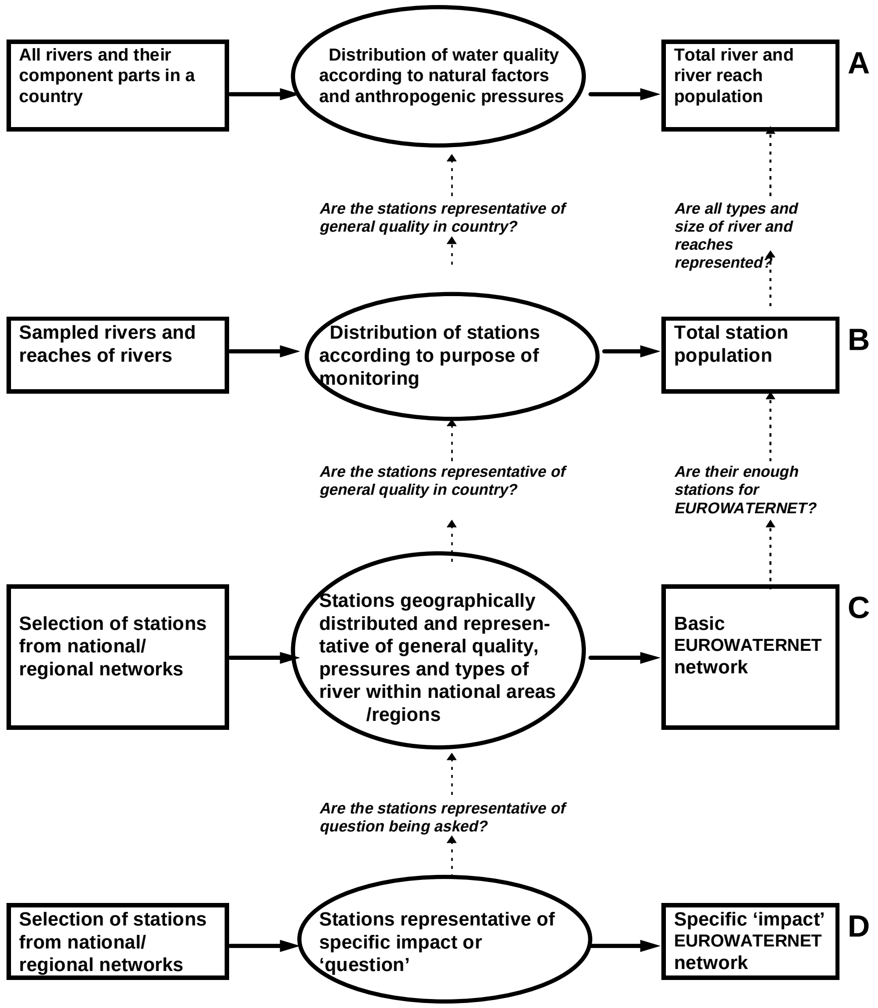
Figure 7.1 illustrates the process by which the representativeness of the basic and impact networks of EUROWATERNET could be assessed with the aim of selecting more river stations and lakes (if necessary), and identifying potential gaps in existing monitoring networks.

The total river[1] and river reach population comprises all the rivers and their component parts in a country (A in Figure 7.1). The water quality within the total river/river reach population will vary according to natural factors and anthropogenic pressures placed upon it. A country may wish to know how quality varies spatially and temporally across its river/lake network for management and control purposes. How the stations are distributed throughout national/regional networks will depend upon factors such as the operational priorities and resource availability (B in Figure 7.1). Thus stations may only be located to monitor the most polluted waters and there may also be a wider distribution of stations to give an overall view of quality. Similarly some countries may concentrate their stations just on their largest and most important rivers rather than on smaller rivers which may have lower priority.

There is, therefore, a wide range of station densities in national networks across Europe. For example, work undertaken by the Topic Centre indicates that the number of sites in the UK's national river monitoring programme is around 10,000 whereas in Germany there are 147 stations and in Denmark 261 stations in the main river monitoring programmes (EEA Topic Report 2, 1996). *[In many countries regional networks may have more river stations and/or lakes than in national networks.]* Questions might then be how well does the national network represent the general quality of rivers in a country, and are all types and size of rivers and reaches represented in the total station population. The same questions will also be asked if a specific impact was being assessed, that is which stations would best represent the scale and extent of the impact. The key is to **understand** what the stations in **national networks represent**. The station selection procedure and associated physical characteristics are intended to aid this understanding.

[1] The descriptions in paragraphs 7.3 to 7.7 would equally apply to lakes

Figure 7.1 Assessment of the representativeness of basic EUROWATERNET and national monitoring networks

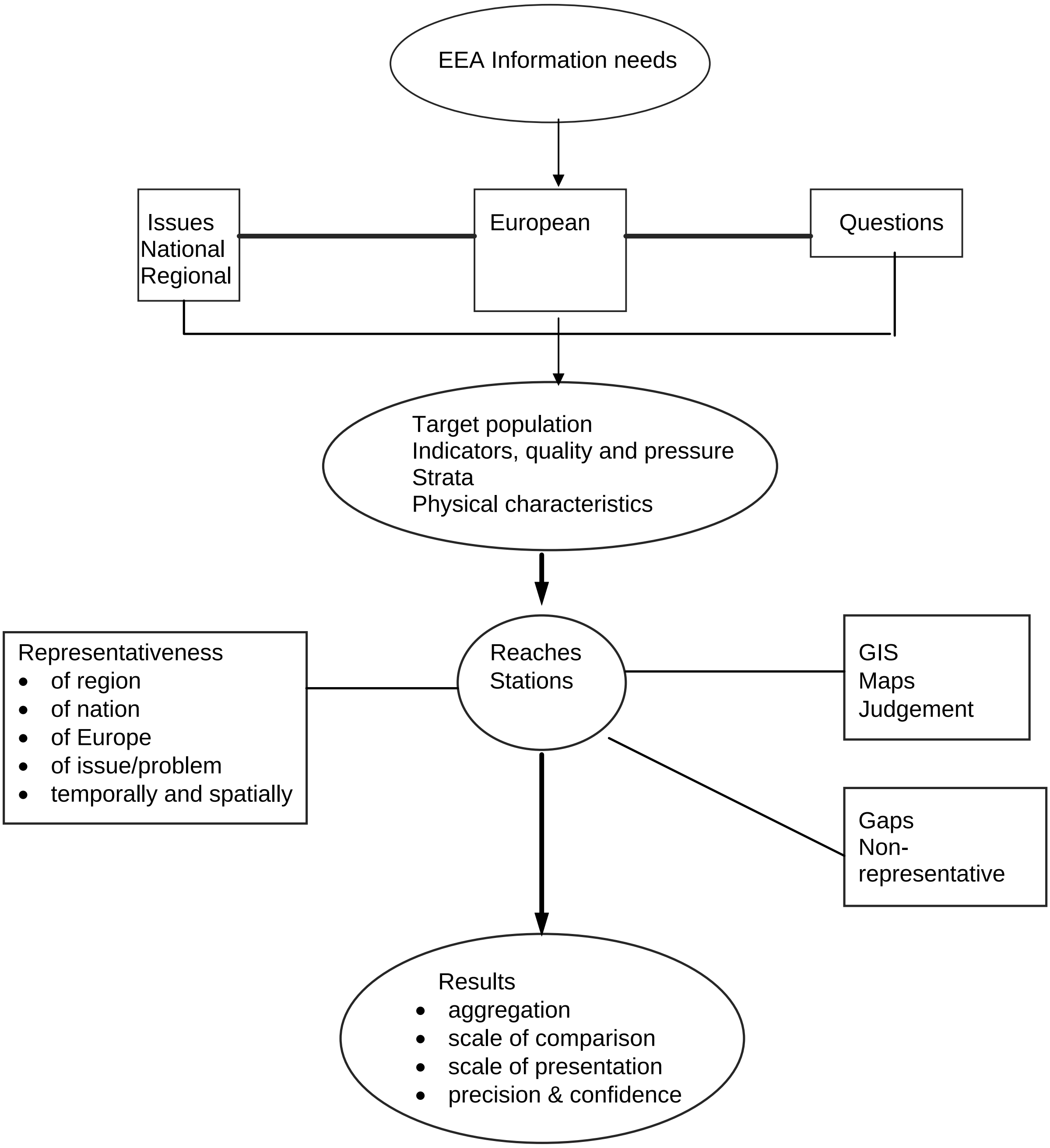


The basic network is based on a selection of river stations and lakes from existing national and/or regional networks. Thus once the basic network has been selected the next phase will be to assess how representative these stations are of general quality within a country and hence across Europe (C in Figure 7.1). Similarly the impact network is selected from the same existing networks and consideration should be given to how representative they are of the impact (question) being assessed.

The stations selected for the basic EUROWATERNET might not always be the same to answer all issues asked of the EEA. This may be particularly so in very heterogeneous countries in terms of impacts and pressures, and types of river lakes and groundwaters.

Figure 7.2 illustrates a possible process for establishing a more representative network. The identification of homogeneous river reaches and selection of stations within each river reaches groups is facilitated by the use of a GIS system. This enables the characterisation of river reaches according to hydrological parameters and/or quality parameters or physical characteristics. It allows the assessment of the representativeness of selected stations in comparison to the overall existing water bodies types in a country. In this way, the comparisons on a like with like basis across Europe is made possible. The application of this method enables to optimise the efficiency of the network by reducing the variability, to make comparisons between similar water body types (strata) and to ensure the representativeness of the reported information/data.

Figure 7.2 Illustration of process for establishing representative network



8. GUIDELINES FOR A EUROPEAN GROUNDWATER MONITORING NETWORK DESIGN - DRAFT PROPOSAL

Scope

The draft monitoring strategy outlined in this section has been based on:

- the information needs of the EEA (objective, reliable and comparable data);
- the results which have been elaborated so far within the ETC/IW work programme as well as on general principles of monitoring network design;
- the spirit of the draft EU Groundwater Action Programme (COM(96) 315 final);
- the current discussion on Annex II, III and V of the draft Framework Water Directive;
- and last but not least on the principles of efficiency and saving costs.

Representative data in this proposal are seen as data which provide an overview of the state of groundwater quality and quantity in the EEA area. Delivered information should allow the status of groundwater bodies ranging from nearly "natural" to "heavily impacted" to be identified. Member Countries should therefore deliver representative data based on their existing national programmes.

Objective of EUROWATERNET for groundwater

The objective of EUROWATERNET for groundwater is to provide:

- objective, reliable and comparable information at the European level;
- a survey of the important groundwater bodies in the EEA area;
- a description of the status of groundwater quantity and quality in the EEA area;
- information about trends in groundwater quantity and quality status;
- a long-term assessment about the impacts of measures.

Which aquifers are covered?

[**Aquifer** means a subsurface layer or layers of rocks or other geological strata of sufficient porosity and permeability to allow a significant flow of groundwater and the abstraction of significant quantities of groundwater.]

[**Groundwater body** means a hydrogeologically distinct volume of groundwater within an aquifer or aquifers.]

Monitoring of all **important groundwater bodies** (groundwater in porous media, karst groundwater and others), both shallow and deep aquifers.

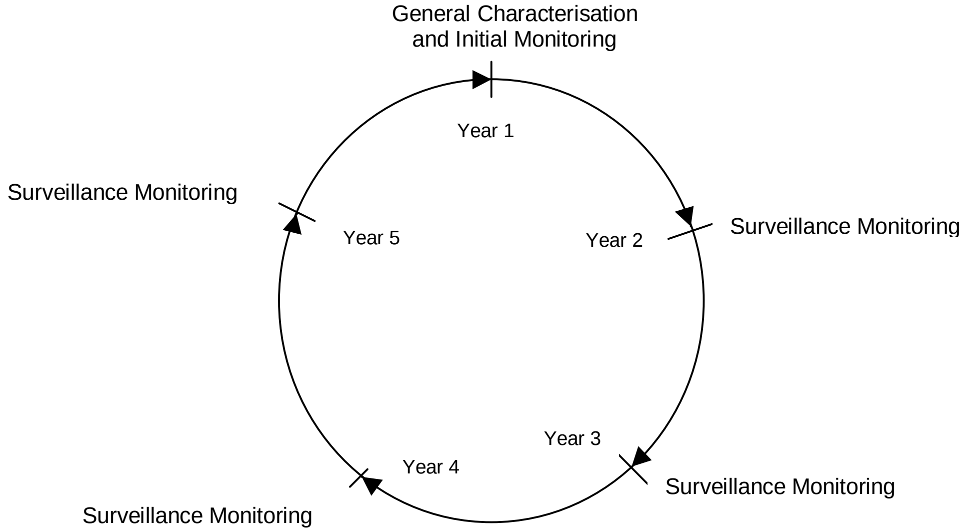
Important groundwater bodies are defined when at least one of the three requirements below are met:

- > 300 km²;
- of regional, socio-economic or environmental importance in terms of quantity and quality;
- exposed to severe or major impacts.

General characteristics of a representative monitoring programme

The proposed monitoring programme is cyclic with a period of five years. The monitoring specifications are illustrated in Figure 8.1 and described below.

Figure 8.1 Illustration of a representative monitoring programme



General Characterisation and Initial Monitoring should provide a more comprehensive description of the groundwater body. Based on the knowledge of this programme, the extent and characteristics of Surveillance Monitoring will be derived. Every five years the general characteristics should be updated (according to Table 8.1) and the initial monitoring – based on the general characterisation – should be carried out. Monitoring results will then be the basis for the development of the new surveillance monitoring. This system should be a tool to adapt the monitoring strategy regularly in accordance with the change of conditions within the monitored region.

Characterisation of groundwater bodies

There should be a two-step approach:

- A general characterisation should be carried out for all important groundwater bodies.
- The general characterisation of the groundwater body should be reviewed and updated (especially the pressure situation) at least every five years.

The general characterisation of the groundwater body shall identify:

Table 8.1 General characterisation

Groundwater Quantity	Groundwater Quality
• the location, area and boundaries of the groundwater body; • geological characterisation of the groundwater body including: extent and type of geological units and the characterisation of the overlying strata in the catchment from which the groundwater body receives its recharge; • hydrogeological characterisation of the groundwater body and the surface layer hydrological characterisation of the groundwater body including: climate (precipitation); • stratification characteristics of the groundwater within the groundwater body; • an inventory of associated surface systems including terrestrial ecosystems and surface water bodies, with which the groundwater body is dynamically linked. • land use in the catchment or catchment from which the groundwater body receives its natural and artificial recharge; land use information shall include the percentage of: agricultural, arable, pasture land, forest, urbanisation or any other impacts of human intervention;	
• Assessment of the pressures to which each groundwater body is liable to be subject incl.: are there water abstractions or artificial recharges, associated aquatic or terrestrial ecosystems?	• Assessment of the pressures to which each groundwater body is liable to be subject incl.: are there diffuse sources or point sources of pollution, associated aquatic or terrestrial ecosystems?

Groundwater quantity monitoring

Two-step approach:

- Periodical characterisation of the groundwater body (according to paragraphs 8.10 to 8.11).
- Initial and continued surveillance monitoring of the groundwater quantity of all important groundwater bodies should be carried out.

Types of Monitoring Stations:

- The monitoring network should be based on a balanced distribution of sampling sites in order to provide representative information on the quantitative aspects of a groundwater body;
- Monitoring stations should be located away from abstraction or recharge stations.

Monitoring Station Density:

The **density** of monitoring stations in a groundwater network shall depend on:

- The size of the groundwater body;
- The geological and hydro(geo)logical characteristic and complexity of the aquifer;
- The intensity of impacts (e.g. land use, population density, abstraction and recharge).

Vulnerability mapping will provide additional basic information for the selection of sampling sites and monitoring station distribution within the monitored area.

Monitoring Frequency

Groundwater quantity shall be monitored according to the following monitoring programme which has been set up for a period of five years:

- In the first year of the monitoring period all important groundwater bodies have to go through an initial monitoring where groundwater bodies should be monitored at least four times in order to detect seasonal variations (depending on the hydrology and the dynamics of the aquifer system). More frequent monitoring may be necessary in more variable systems.
- In the following four years of the monitoring period all important groundwater bodies have to run through a surveillance monitoring where groundwater bodies shall be monitored at least twice a year in order to detect maximum and minimum groundwater levels (depending on their hydrology and dynamics).

Parameter

- Piezometric head of groundwater

No recommendation for karst aquifers can be made at this stage.

Interpretation and Presentation of Groundwater Quantitative Status

- Member Countries should provide a map of all important groundwater bodies including the location of sampling sites.
- For each important groundwater body Member Countries should provide information on the characterisation of the groundwater body.
- The results for one sampling site should be aggregated as an annual mean value or twice-yearly mean value if appropriate. For each groundwater body monitoring these data should be aggregated per year and be compared with or related to the data of a reference year, the mean values for a reference period or to average long term values (e.g. for a 30 years period). The aggregation of yearly data could be done as percentiles, mean values and extremes for the groundwater area. Wherever possible trends should be calculated. Overviews (e.g. figures 8.2 and 8.3) should be provided by tables, figures and maps (further details will be given at a later date subject to the findings of pilot studies carried out by ETC/IW partners).

The following table (Table 8.2) and figures show (by way of example) the difference of the mean groundwater levels of the current year to a reference year (mean value of a reference period).

Table 8.2 Differences of the mean groundwater levels of the current year to a reference year (mean value of a reference period) in cm. (All measured values were derived from one groundwater body). Analysis of the frequencies.

1994	Summary frequency in % and extremes										
Groundwater body	mean	min	10	20	30	40	50	60	70	80	90	max
GW-1	0	-11	-9	-6	-5	-3	-2	-1	1	3	7	52
GW-2	6	-38	-12	-6	-2	2	6	8	12	16	20	74

Figure 8.2 Summary frequency

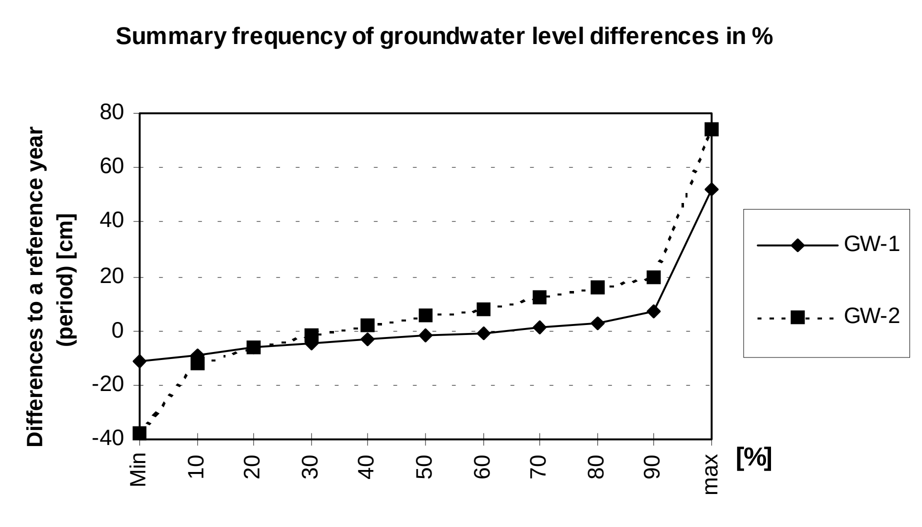
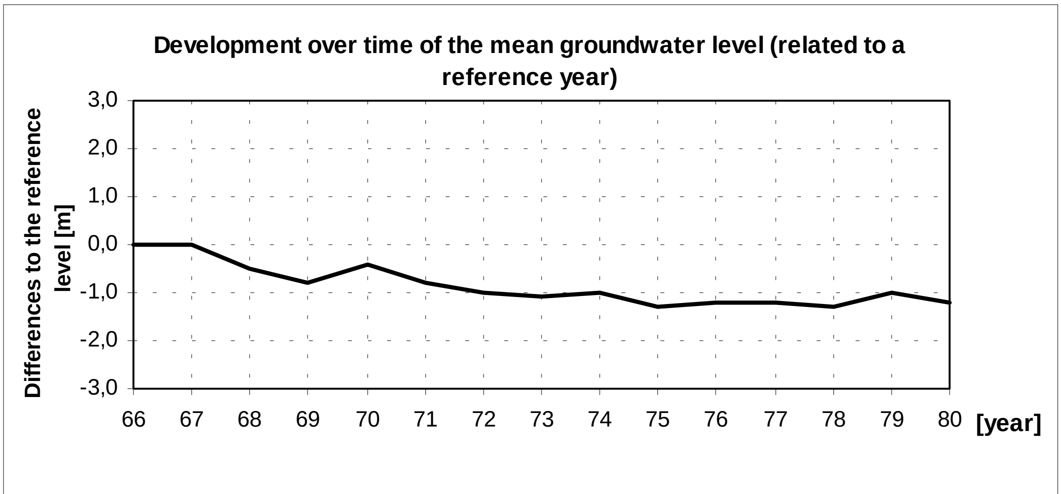


Figure 8.3 Development over time of the mean groundwater level for a groundwater body related to a reference year.



Groundwater quality monitoring

Two-step approach:

- Periodical characterisation of each important groundwater body;
- Initial and surveillance monitoring of the groundwater quality of each important groundwater body should be carried out.

Characteristics of Sampling Sites

The construction characteristics of the monitoring station must be provided when information is submitted (in particular the information on the aquifer (groundwater body being sampled or monitored). This is particularly important in multi-aquifer systems or where quality changes strongly with depth.

The monitoring network should be based on a balanced spatial distribution as well as a balanced mixture of different types of sampling sites in order to give representative information on the mean quality of a groundwater body. A monitoring network dominated by a specific type of sampling sites could provide results which are not representative for the region (e.g. drinking water wells are usually situated in unpolluted areas).

The purpose of a sampling site shall be indicated when information is submitted:

1. Drinking water well;
2. Industrial;
3. Other uses (irrigation,…);
4. Surveillance.

Sampling Site Density

The density of observation wells should depend on:

- The size of the groundwater body;
- The geological and hydro(geo)logical characteristics and complexity of the aquifer;
- Intensity of impacts (e.g. land use, population density, point and diffuse sources).

Comment: A pilot study in heavily impacted area suggested that a sampling density of about 25 km²/site would be appropriate for such an impacted area. For regional surveillance in less--impacted areas a more appropriate sampling density could exceed 100 km²/sampling point. Further experience is essential.

For each important groundwater body for which vulnerability mapping exists monitoring density should be chosen also in accordance with the findings from the vulnerability mapping.

Monitoring frequency

Groundwater quality parameters should be monitored according to the following monitoring programme which has been set up for a period of five years:

- In the first year of the monitoring period all important groundwater bodies have to run through an initial monitoring where groundwater bodies should be monitored at least twice. Seasonal variations and aquifer characteristics should be taken into account and might require higher monitoring frequency.
- during the following four years of the monitoring period all important groundwater bodies have to run through a surveillance monitoring where groundwater bodies should be monitored at least once a year. Seasonal variations and aquifer characteristics should be taken into account and might require higher monitoring frequency.
- All important groundwater bodies for which the general characterisation did not detect significant anthropogenic pressures and the initial monitoring did not detect impacted groundwater quality, do not have to run through the surveillance monitoring.
- After the completion of the monitoring programme it has to be started again with an initial monitoring.

The sampling schedule should relate to the infiltration or recharge regime of the groundwater body and to seasonal variations in the use of pollutants (from land use) causing groundwater pollution.

Parameters

The initial monitoring should give a first overview and characterisation for all important groundwater bodies about the natural content of quality parameters and anthropogenically induced pollution. It shall contain at least bold marked determinants of Group 1 and all other determinants of group 1 and 2 which could be of relevance according to the anthropogenic pressures which were detected in the course of the general characterisation of the groundwater body.

Group		Determinands
1	Descriptive parameters	**pH, EC, DO** Temp.
	Major ions	**Ca, Mg, Na, K, Cl, NH_4, NO_3, NO_2, HCO_3, SO_4** PO_4, TOC
2	Heavy metals	As, Hg, Cd, Pb, Cr, Fe, Mn, Zn, Cu, Al, Ni, Choice depends partly on local pollution source as indicated by land-use framework
	Organic substances	Aromatic hydrocarbons, halogenated hydrocarbons, phenols, chlorophenols. Choice depends partly on local pollution source as indicated by land-use framework
	Pesticides	Choice depends in part on local usage, land-use framework and existing observed occurrences in groundwater.
	Additional parameters	Choice depends partly on results of pressure analysis (according to chapter 5)

The surveillance monitoring follows the initial monitoring and observes all group 1 determinants and all other determinants, where (significant) deviations from the natural background occur.

Interpretation and presentation of groundwater chemical status:

- Member Countries should provide a map of all important groundwater bodies including the location of sampling sites.
- For each important groundwater body Member Countries should provide information on the characterisation of the groundwater body.

The results for one sampling site should be aggregated as an annual mean value. The results of individual monitoring points within a groundwater body should be aggregated for the groundwater body as a whole.

- Sampling sites: Number of sampling sites for each type of sampling site.
- Quality data: For each groundwater body monitoring data should be aggregated per year. The aggregation of yearly data could be in the form of percentiles (10, 25, 50, 75, 90), mean values and extremes for the groundwater area. Wherever possible trends should be calculated. Overviews could be provided by tables, figures and maps.

This information should allow an assessment of groundwater quality with regard to limit values (e.g. Drinking Water), a comparison between unimpacted and impacted groundwater bodies and analysis of time series.

The information provided (maps, table, descriptions, statistical data) should allow the assessment about the status of the groundwater body and extent of the impacted areas.

Table 8.3 to 8.6 and Figures 8.4 to 8.6 show examples for the presentation of quality data:

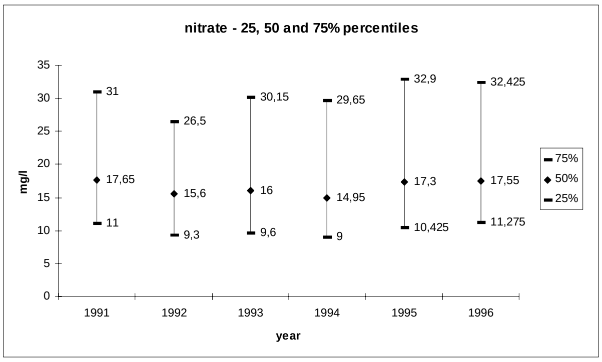
Table 8.3 Example of summary frequency of nitrate (annual mean values in mg/l)

					percentile											
YEAR	sampl. sites	mean value		min	10	20	25	30	40	50	60	70	75	80	90	max
1991	85	27,16194118		0	3,12	9,54	11	12,51	15	17,65	22	28	31	35,04	66,35	137
1992	85	24,95014837		0	3,08	7,9	9,3	10,2	12,9	15,6	19,36	23,6	26,5	31,84	63,68	138
1993	84	26,18678679		0	3,5	7,7	9,6	11	13,36	16	19,42	27,4	30,15	38,02	64,62	142,4
1994	83	25,02109091		0	2,51	7,32	9	10,26	12,5	14,95	18,1	24,8	29,65	34,14	61,92	243
1995	81	28,06574074		0	2,85	7,5	10,425	12,15	14,8	17,3	23,1	30,6	32,9	37,8	68,7	144,9
1996	94	30,5079492		0	2,705	9,61	11,275	12,2	14,6	17,55	22,2	29,1	32,425	42,6	83,1	251

Table 8.4 Example of summary frequency of chloride (annual mean values in mg/l)

					Percentile											
YEAR	sampl. sites	mean value	std. dev.	min	10	20	25	30	40	50	60	70	75	80	90	max
1991	85	30,05635294	40,22328343	1,4	6,03	9	10,275	11,03	14	17,5	22,92	27	32,425	39,84	58,96	266
1992	85	30,96765579	53,20033727	1,4	6,28	7,98	9,2	10,38	14,02	16,6	22,5	27,56	31,6	38,26	54,64	548
1993	84	30,14744745	46,3567404	1,9	6,7	8,58	9,6	11,1	14,42	17,6	22,58	27,52	33,1	40,04	61,42	460
1994	83	38,31424242	92,71338885	1,7	6,41	8,7	9,275	11,03	14,7	17,5	23,18	28,24	33,525	39,32	60,95	947,1
1995	81	39,66234568	91,5225997	1,6	7,35	9,1	10,3	12,35	15,4	19,05	23,6	31,5	35,75	42,4	63,1	962,7
1996	94	35,8197861	46,4115366	1,94	7,57	9,68	10,775	13,3	16,4	21,3	28,3	39,7	44,75	53	71,95	468

Figure 8.4 Example of 25 %, 50 % and 75 % percentiles for nitrate and chloride (1991 - 1996)



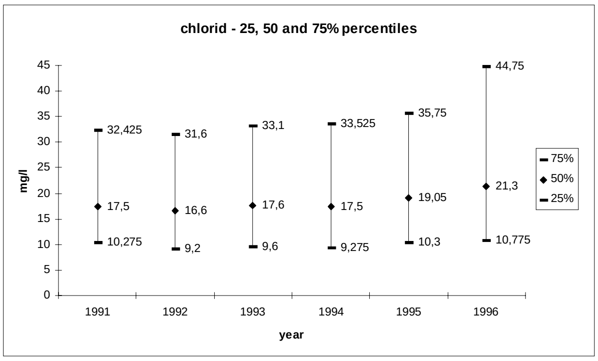
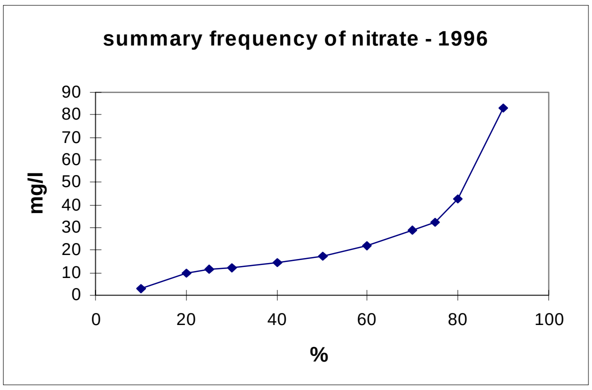


Table 8.5 and Figure 8.5 Example of summary frequency of nitrate and chloride in 1996

1996					Percentile											
para	sampl. sites	mean value		min	10	20	25	30	40	50	60	70	75	80	90	max
nitrate	94	30,5079492		0	2,705	9,61	11,275	12,2	14,6	17,55	22,2	29,1	32,425	42,6	83,1	251
chloride	94	35,8197861		1,94	7,57	9,68	10,775	13,3	16,4	21,3	28,3	39,7	44,75	53	71,95	468



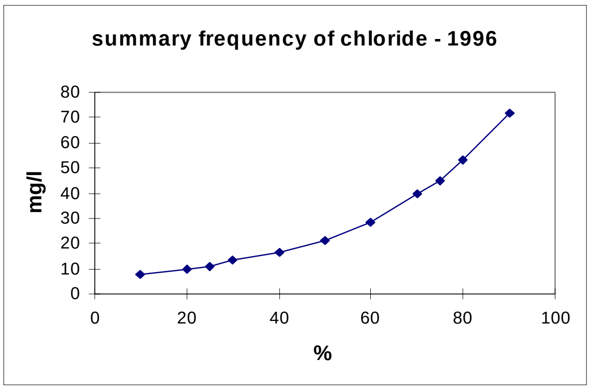
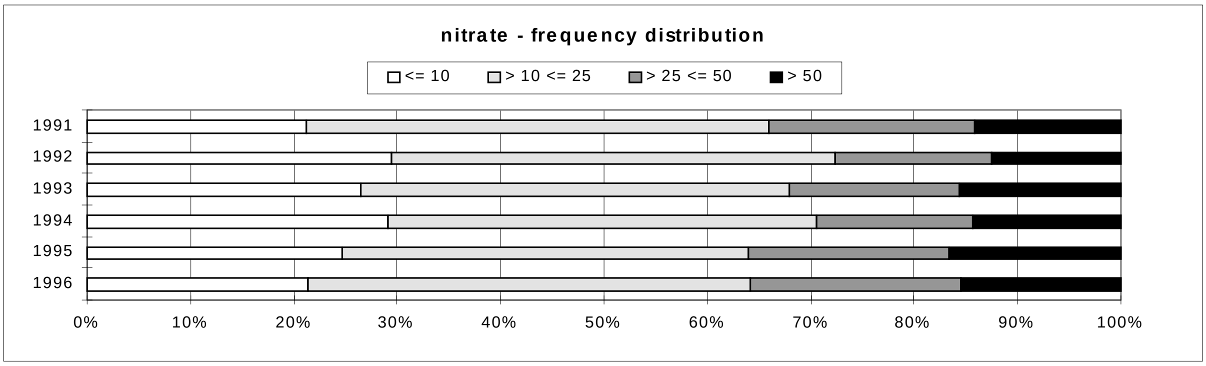
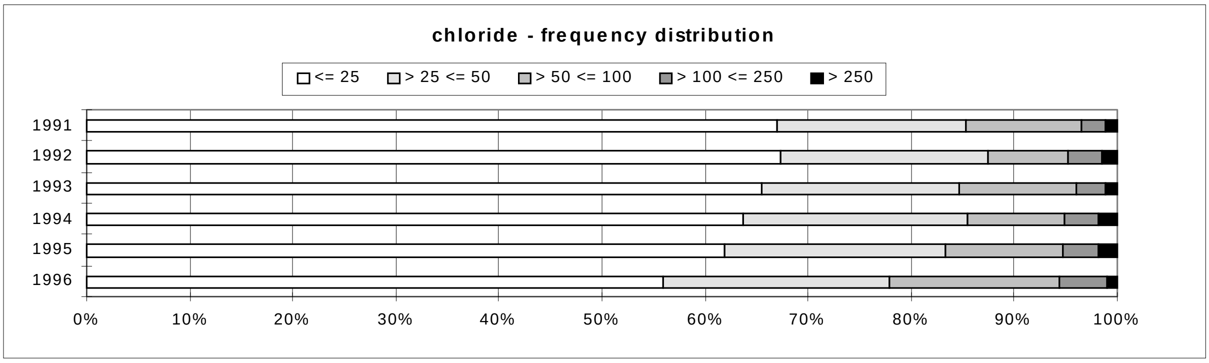


Table 8.6, Figure 8.6 Example of frequency distribution of nitrate and chloride (annual mean values of sampling sites)

	frequency distribution in %				
nitrate	<= 10	> 10 <= 25	> 25 <= 50	> 50	sampling sites
1996	21%	43%	20%	16%	94
1995	25%	39%	19%	17%	81
1994	29%	42%	15%	14%	83
1993	26%	41%	17%	16%	84
1992	29%	43%	15%	12%	85
1991	21%	45%	20%	14%	85

	frequency distribution in %					
chloride	<= 25	> 25 <= 50	> 50 <= 100	> 100 <= 250	> 250	sampling sites
1996	56%	22%	17%	5%	1%	94
1995	62%	22%	11%	3%	2%	81
1994	64%	22%	9%	3%	2%	83
1993	65%	19%	11%	3%	1%	84
1992	67%	20%	8%	3%	1%	85
1991	67%	18%	11%	2%	1%	85





9. FORMAT FOR THE EXCHANGE OF INFORMATION WITH NFPs, NRCs AND ETC/IW

A Data Exchange Module (DEM) is currently being developed under other EEA projects and is not expected to be completed for about a year but until then an interim solution has to be found.

The proposed interim solution is part of an associated ETC/IW project. The proposal is appended to these guidelines (Appendix B). The templates will accompany the electronic distribution of these guidelines in separate files. If necessary diskette copies of the templates will also be made available to NFPs on request.

If participants are unable to submit information in the requested manner then information can be submitted either as EXCEL (version 5) spreadsheets or as ASCII files with each value or information separated by "**;**". Each column or field heading must have a full description of what it is. Tables 9.1 to 9.3 give examples of such a format for information on the river stations' physical characteristics, status and pressure indicators.

For any **further information** on these **guidelines** please contact Steve Nixon at the **ETC/IW Core Team** at Water Research Centre, Medmenham UK.
EUROWATERNET information on **rivers** from participating Countries should be transmitted electronically to the e-mail addresses given below.

tel:	+44 1491 571531
fax:	+44 1491 579094
e-mail	nixon@wrcplc.co.uk or snixon@etc-iw.eionet.eu.int
or	iw@wrcplc.co.uk

EUROWATERNET information on **lakes** from participating Countries should be **transmitted** electronically to Jens Bøgestrand, National Environmental Research Institute, Denmark at the e-mail address given below. Information should also be **copied** to the ETC/IW Core Team at the address given in 9.4.

tel:	+45 89 20 14 00
fax:	+45 89 20 14 14
e-mail	jbo@dmu.dk

EUROWATERNET information on **groundwater** from participating Countries should be **transmitted** electronically to Johannes Grath, Austrian Working Group on Water at the e-mail address given below. Information should also be **copied** to the ETC/IW Core Team at the address given in 9.4.

tel:	+43 1 31304 3510 or 3720
fax:	+43 1 31304 3700
e-mail	grath@uba.ubavie.gv.at

Table 9.1 Structure of physical characteristic information for river stations

River name	Monitoring station (national code or name)	Major basin or catchment name	Station location[1]	Station location [1]	Type of station [2]	Catchment area [3] upstream of station (km²)	Station altitude (m) [3]	Mean long term water discharge. (m^3/s) [4]	Strahler Stream order [4]
1									
2									
3									
4									
5									
etc.									

1 Longitude/latitude
2 Codes: B = reference
R = Representative
L = Largest
F = Flux
3 Priority physical characteristics
4 Please provide if available

Table 9.2 Structure of status information

River name	Monitoring station (national code or name)	Nitrate									Ammonium etc.
		unit (e.g. mg N/l or mg NO_3/l)	annual average	standard deviation	10 per-centile	median	90 per-centile	maximum	minimum	number of samples per year	
1											
2											
3											
4											
5											
etc.											

Table 9.3 Structure of pressure information

River name	Monitoring station (national code or name)	Population density in the catchment (capita/km²)	% agricultural land	-% arable	% pasture land	% forest	% urbanisation	Point source loads	Fertiliser usage in catchment upstream
1									
2									
3									
4									
5									
etc.									

APPENDIX A

Table A.1 Requirements of the Urban Waste Water Treatment Directive

Agglomeration size (1,000's Population equivalent)	Nature of receiving water		Treatment level required		
	Type	Sensitivity	31 Dec. 1998	31 Dec. 2000	31 Dec. 2005
<2	All waters	All	-	-	Appropriate treatment
2-10	Coastal waters	Standard	-	-	Appropriate treatment
	Estuaries	Less sensitive	-	-	Primary treatment
	Freshwater estuaries	Standard	-	-	Secondary treatment
10-15	Coastal waters	Less sensitive	-	-	Primary treatment
	All waters	Standard	-	-	Secondary treatment
	All waters	Sensitive	Tertiary treatment	-	-
>15	Coastal waters	Less sensitive	-	Primary treatment	-
	All waters	Standard	-	Secondary treatment	-
	All waters	Sensitive	Tertiary treatment	-	-

APPENDIX B

Developing the Exchange of Information - A Pilot Project

Data flow

A Data Exchange Module (DEM) is currently being developed under other EEA projects and is not expected to be completed for about a year but until then an interim solution has to be found. Thus the participants in the Pilot Project will be asked to submit information by filling in the templates prepared for this project. The templates are based on EXCEL (version 5) spreadsheets.

The templates

Two Excel files, one for rivers (*river.xls*) and one for lakes (*lake.xls*) are available for this project, and accompany the electronic distribution of these guidelines. Examples of the templates completed with Danish data are also included (*ex_lake.xls* and *ex.river.xls*). Each file consists of 3 templates (spreadsheets).

Definitions

The definition of every column or heading is given for each template.

Rivers

Template: Basic information

Definitions:

Country_ID	Country-code (DK = Denmark, SE = Sweden etc.)
Station_ID	National code for monitoring station (number)
Station_name	National name for monitoring station (text)
Year	Year for last revision (yyyy)
River_name	The Name of monitoring river (text)
Region	Name of geographical area or administrative area (text)
Longitude	Degree of longitude, Greenwich (decimal)
Altitude	Degree of latitude, Greenwich (decimal)
Latitude	Level above sea-level (m)
Type	Type of station, (B = reference, R = Representative, L = Longest and most important, F= Flux)
Stream_order	Stream order after Strahler (number)
Discharge	Mean long term water discharge (m^3/s)(number)
River-length	The length from the river spring to the monitoring station, (km) (number)
Remarks	Comments to figures (text)
Population	Population: the density of the population (people/km^2) (number)
Catch_area	The area of the catchment where the station is situated (km^2)
Urban	Per cent urbanisation area of the catchment area (%), (Urbanisation = 1. artificial surfaces (Land Cover))
Wetland	Per cent wetland area of the catchment area (%), (wetland = 4. wetlands (Land Cover))
Nature	Per cent nature land area of the catchment area (%) (Nature land = 3.2 shrub and/or herbaceous vegetation associations + 3.3 Open spaces with little or no vegetation (Land Cover))
Forest	Per cent forest area of the catchment area (%),(Forest = 3.1 Forest (Land Cover))
Total_agr	Per cent agricultural area of the catchment area (%) (Agricultural areas = 2. Agricultural areas (Land Cover))

Arable	Per cent arable land of the agricultural areas (%) (Arable land = 2.1 Arable land (Land Cover)
Pasture	Per cent pasture land of the agricultural area (%) (Pasture land = 2.3 Pastures (Land Cover))
Other_agr	Per cent land of other agricultural use of the agricultural area (%) (Land of other agricultural use = 2. Agricultural areas minus 2.1 Arable land and 2.3 Pastures (Land Cover)

Template: Indicator-status

Country_ID	Country-code (DK = Denmark, SE = Sweden etc.)
Station_ID	National code for monitoring station (number)
Year	Year for last revision (yyyy)
TN_annual	Average concentration of Total-N during the year (mg/l)
TN_summer	Average concentration of Total-N during the summer (mg/l)
TN_Winter	Average concentration of Total-N during the winter (mg/l)
TN_annual-S	Number of samples during the year (number)
TN_summer_S	Number of samples during the summer (number)
TN_Winter_S	Number of samples during the winter(number)
TN_summer_S	The length of the summer in month (number)
TN_Winter_S	The length of the summer in month (number)
Remarks	Comments to the figures (text)
TP_annual	Average concentration of Total-p during the year (mg/l)
TP_summer	Average concentration of Total-P during the summer (mg/l)
TP_Winter	Average concentration of Total-P during the winter (mg/l)
TP_annual_S	Number of samples during the year (number)
TP_summer_S	Number of samples during the summer (number)
TP_Winter_S	Number of samples during the winter (number)
TP_summer_L	The length of the summer in month (number)
TP_Winter_L	The length of the summer in month (number)
Remarks	Comments to the figures (text)

Template: pressure

Definitions:

Country_ID	Country-code (DK = Denmark, SE = Sweden etc.)
Station_ID	National code for monitoring station (number)
Year	Year for last revision (number)
Equivalents	Population equivalents (number in thousands)
TN_load	The yearly loads from the catchment of Total-N to the lake (tons/years)
TN_waste	Per cent Total-N coming from point-sources of the total loads (N_load) (%)
TN_fishfarm	Per cent Total-N coming from fish farms of the total loads (N_load) (%)
TN_scatter	Per cent Total-N coming from scattered houses of the total loads (N_load) (%)
TN_diffuse	Per cent Total-N coming from diffuse-sources of the total loads (N_load) (%)
TN_atmo	Per cent Total-N coming from atmospheric deposition of the total loads (N_load) (%)
TN-other	Per cent Total-N coming from other sources of the total loads (N_load) (%)
Remarks	Comments to the figures (text)
TP_load	The yearly loads from the catchment of Total-P to the lake (tons/years)
TP_waste	Per cent Total-P coming from point-sources of the total loads (P_load) (%)
TP_fishfarm	Per cent Total-N coming from fish farms of the total loads (N_load) (%)
TP_scatt	Per cent Total-P coming from scattered houses of the total loads (P_load) (%)
TP_diffuse	Per cent Total-P coming from diffuse-sources of the total loads (P_load) (%)

TP_atmo	Per cent Total-P coming from atmospheric deposition of the total loads (P_load) (%)
TP-other	Per cent Total-P coming from other sources of the total loads (P_load) (%)

Lakes

Template: Basic information

Definitions:

Country_ID:	Country-code (DK = Denmark, SE = Sweden etc.)
Lake_ID:	National code for monitoring station (number)
Year:	Year for last revision (yyyy)
Lake_name:	National name for monitoring lake (text)
Region:	Name of geographical area or administrative area (text)
Longitude:	Degree of longitude, Greenwich (decimal)
Latitude:	Degree of latitude, Greenwich (decimal)
Altitude:	Level above sea-level (m)
Type:	Type of station, (B = reference, R = Representative, L= Longest and most important, F= Flux)
Lake_area:	The area of the lake (km^2)
Lake_vol:	The volume of the lake (km^3)
Mean_depth:	The mean depth of the lake (m)
Max_depth:	The maximum depth of the lake (m)
Retention:	Retention-time. the water bodies average residents time in years (lake volume /inflow * year)
Remarks:	Comments to figures (text)
Population:	Population: the density of the population (numbers/km^2)
Catch_area:	The area of the catchment where the lake is situated (km^2)
Urban:	Per cent urbanisation area of the catchment area (%), (Urbanisation = 1. Artificial surfaces (Land Cover))
Wetland:	Per cent wetland area of the catchment area (%), (wetland = 4. wetlands (Land Cover))
Nature:	Per cent nature land area of the catchment area (%) (Nature land = 3.2 shrub and/or herbaceous vegetation associations + 3.3 Open spaces with little or no vegetation (Land Cover))
Forest:	Per cent forest area of the catchment area (%), (Forest = 3.1 Forest (Land Cover))
Total_agr:	Per cent agricultural area of the catchment area (%) (Agricultural areas = 2. Agricultural areas (Land Cover))
Arable:	Per cent arable land of the agricultural areas (%) (Arable land = 2.1 Arable land (Land Cover)
Pasture:	Per cent pasture land of the agricultural area (%) (Pasture land = 2.3 Pastures (Land Cover))
Other_agr:	Per cent land of other agricultural use of the agricultural area (%) (Land of other agricultural use = 2. Agricultural areas minus 2.1 Arable land and 2.3 Pastures (Land Cover)

Template: Indicator-Status

Definition:

Country_ID:	Country-code (DK = Denmark, SE = Sweden etc.)
Lake_ID:	National code for monitoring station (number)
Year:	Year for last revision (yyyy)
TN_annual:	Average concentration of Total-N during the year (mg/l)
TN_summer:	Average concentration of Total-N during the summer (mg/l)
TN_winter:	Average concentration of Total-N during the winter (mg/l)

TN_annual_S:	Number of samples during the year (number)
TN_summer_S:	Number of samples during the summer (number)
TN_winter_S:	Number of samples during the winter (number)
TN_summer_L:	The length of the summer in month (number)
TN_winter_L:	The length of the summer in month (number)
Remarks:	Comments to the figures (text)
TP_annual:	Average concentration of Total-p during the year (mg/l)
TP_summer:	Average concentration of Total-P during the summer (mg/l)
TP_winter:	Average concentration of Total-P during the winter (mg/l)
TP_annual_S:	Number of samples during the year (number)
TP_summer_S:	Number of samples during the summer (number)
TP_winter_S:	Number of samples during the winter(number)
TP_summer_L:	The length of the summer in month (number)
TP_winter_L:	The length of the summer in month (number)
Remarks:	Comments to the figures (text)

Template: Pressure

Definition:

Country_ID:	Country-code (DK = Denmark, SE = Sweden etc.)
Lake_ID:	National code for monitoring station (number)
Year:	Year for last revision (yyyy)
Equivalens:	Population equivalents (number in thousands)
TN_load:	The yearly loads from the catchment of Total-N to the lake (tons/years)
TN_waste:	Per cent Total-N coming from point-sources of the total loads (N_load) (%)
TN_fishfarm:	Per cent Total-N coming from fish farms of the total loads (N_load) (%)
TN_scatter:	Per cent Total-N coming from scattered houses of the total loads (N_load) (%)
TN_diffuse	Per cent Total-N coming from diffuse-sources of the total loads (N_load) (%)
TN_atmo	Per cent Total-N coming from atmospheric deposition of the total loads (N_load) (%)
TN-other	Per cent Total-N coming from other sources of the total loads (N_load) (%)
Remarks:	Comments to the figures (text)
TP_load:	The yearly loads from the catchment of Total-P to the lake (tons/years)
TP_waste:	Per cent Total-P coming from point-sources of the total loads (P_load) (%)
TP_fishfarm:	Per cent Total-N coming from fish farms of the total loads (N_load) (%)
TP_scatter:	Per cent Total-P coming from scattered houses of the total loads (P_load) (%)
TP_diffuse:	Per cent Total-P coming from diffuse-sources of the total loads (P_load) (%)
TP_atmo:	Per cent Total-P coming from atmospheric deposition of the total loads (P_load) (%)
TP-other:	Per cent Total-P coming from other sources of the total loads (P_load) (%)