DRAFT FOR CONSULTATION

NATIONAL SURFACE AND GROUNDWATER MONITORING PROGRAMMES REPUBLIC OF IRELAND

PREPARED TO MEET THE REQUIREMENTS OF EU WATER FRAMEWORK DIRECTIVE (2000/60/EC)

AND

NATIONAL REGULATIONS IMPLEMENTING THE WFD SI NO 722 OF 2003

AND

NATIONAL REGULATIONS IMPLEMENTING THE NITRATES DIRECTIVE SI NO 788 of 2005

VOLUME 2 – RIVERS

Draft Version 12
22 May 2006

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1. River Monitoring Programme

1.1 Introduction – River Monitoring Programme

This chapter describes the WFD River Monitoring programme for Irish rivers. The Surveillance, Operational and Investigative Monitoring programmes are described. A range of subnets targeted at particular requirements of the WFD are outlined with their rationale and indicative size. Locations and details of the actual monitoring points are listed in separate tables in appendices to the river monitoring programme. Monitoring frequency and the associated precision and confidence for quality elements are described.

1.2 River Surveillance Monitoring Network

The overall objectives of the Surveillance Monitoring are specified in the text of the WFD (Table 1). There are four main objectives for SM and a number of stipulated types of monitoring points that must be included in the SM programme.

Table 1. WFD Text concerning design of Surveillance Monitoring Programme for Surface Waters

1.3.1. Design of surveillance monitoring

Objective

Member States shall establish surveillance monitoring programmes to provide information for:

1. supplementing and validating the impact assessment procedure detailed in Annex II,
2. the efficient and effective design of future monitoring programmes,
3. the assessment of long-term changes in natural conditions, and
4. the assessment of long-term changes resulting from widespread anthropogenic activity.

The results of such monitoring shall be reviewed and used, in combination with the impact assessment procedure described in Annex II, to determine requirements for monitoring programmes in the current and subsequent river basin management plans.

Selection of monitoring points

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 subcatchments within the river basin district. In selecting these bodies Member States shall ensure that, where appropriate, monitoring is carried out at points where:

1. 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 greater than 2500 km2,
2. the volume of water present is significant within the river basin district, including large lakes and reservoirs,
3. significant bodies of water cross a Member State boundary,
4. sites are identified under the Information Exchange Decision 77/795/EEC, and
5. at 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.

Selection of quality elements

Surveillance monitoring shall be carried out for each monitoring site for a period of one year during the period covered by a river basin management plan for:

1. parameters indicative of all biological quality elements,
2. parameters indicative of all hydromorphological quality elements,
3. parameters indicative of all general physico-chemical quality elements,
4. priority list pollutants which are discharged into the river basin or sub-basin, and
5. other pollutants discharged in significant quantities in the river basin or sub-basin,

Unless the previous surveillance monitoring exercise showed that the body concerned reached good status and there is no evidence from the review of impact of human activity in Annex II that the impacts on the body have changed. In these cases, surveillance monitoring shall be carried out once every three river basin management plans.

The design of the Irish Surveillance Monitoring network is based on key sub-networks (or 'subnets') each designed to fulfil one or more of the main objectives of SM. These are described in greater detail below and lists of monitoring sites are given in the appendices to this programme.

Four principal subnetworks or 'subnets' are outlined here together with a number of overlapping minor subnets designed to match other national and international monitoring requirements:

1.2.1 River SM Subnet 1 – 'Representative' Subnet for Status

Aim of subnet: This subnet is designed to be representative of the overall surface water status as per the WFD stated requirement**:** '*surface water bodies to provide an assessment of the overall surface water status within each catchment or subcatchments within the river basin district'.*

Subnet Size: This network has 188 sites nationally (See Appendix 1 for details of monitoring points and breakdown within RBDs and Maps)

Location of Monitoring Points: Representative sites are distributed evenly within the RBDs and selected to be representative of status within RBD. They also give a good representation of different river types and pressures within catchments. The overall proportional breakdown for the status of sites within this subnet is intended to match the overall water status within Irish RBDs.

Quality Elements: All the biological elements are monitored and supporting elements: physico-chemical, hydromorphological, priority substances and other pollutants appropriate to the individual water bodies are monitored in this Surveillance Network subnet.

1.2.2 River SM Subnet 2 – Long-Term Trend Monitoring

Aim of subnet: Detection of long-term trends as per WFD requirement – '*the assessment of long-term changes in natural conditions, and the assessment of long-term changes resulting from widespread anthropogenic activity.'*

Subnet Size: This subnet includes a reduced set of 30 monitoring points that are sampled at higher frequency than other SM sites in order to provide reliable and sensitive detection of long-term trends.

Location of Monitoring Points: This subnet includes 10 high status sites of different types aimed particularly at providing early warning of long-term anthropogenically influenced trends and of natural variation over time. It includes 5 to 10 Flux stations or load monitoring stations located on major riverine tributaries to lakes. It also includes a set of marine flux stations – OSPARCOM sites. It also includes sites aimed at assessing long-term trends in diffuse pollution. (See Appendix 1). It will also include a small number of groundwater surface water flux sites aimed specifically at monitoring interactions between surface and groundwater.
Quality Elements: All the biological elements are monitored and supporting elements: physico-chemical, hydromorphological, priority substances and other pollutants appropriate to the individual water bodies are monitored in this Surveillance Network subnet.

1.2.3 River SM Subnet 3 – Supplementing and Validating the Risk Assessments

Aim of Subnet: Supplementing and validating risk assessments particularly at those sites where the degree of uncertainty is greatest as per the WFD requirement – *"supplementing and validating the impact assessment procedure detailed in Annex II".*

Size of Subnet: This subnet includes a fixed percentage of RWBs in the four major risk categories as identified in the Article 5 Characterisation Report. The number of monitoring points is weighted towards the less certain risk categories i.e. the 'probably at risk' (1b) and 'probably not at risk' (2a). Thus, the subnet includes approximately 6% of RWBs that are 'probably at risk' (1b) and 6% of those that are 'probably not at risk' (2a) – i.e. just over 1 in 20 of these where the risk assessment is less certain will be validated. In addition a smaller number of 1a and 2b sites will be included. As risk assessments are improved, however, with further characterisation and ongoing monitoring, the size of this subnet will decrease. The current sites within this subnet are listed in Appendix 1.

Location of Monitoring Points: Sites within this subnet will be distributed throughout RBDs in proportion to risk categories especially

representing the RWBs where the risk category requires to be validated. The monitoring points also represent a range of different pressures identified in the Article 5 report.

Quality Elements: All the biological elements are monitored and supporting elements: physico-chemical, hydromorphological, priority substances and other pollutants appropriate to the individual water bodies are monitored in this Surveillance Network subnet.

1.2.4 River SM Subnet 4 – Stipulated Rivers

Aim of Subnet: To explicitly include those categories of RWB that are specifically stipulated in the text of the WFD. This includes rivers mentioned in the main text of the WFD as follows for surface waters generally:

> 1. 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 greater than 2500 km2,
>
> 2. the volume of water present is significant within the river basin district, including large lakes and reservoirs,
>
> 3. significant bodies of water cross a Member State boundary,
>
> 4. sites are identified under the Information Exchange Decision 77/795/EEC, and
>
> 5. at 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.

Size of Subnet: The RWB SM programme includes river sites under the following headings:

4 x Large rivers with catchments over 2500km^2 in area
10 x sites representing the large rivers within each RBD
5 x sites for the significant cross border rivers
4 x existing Exchange of Information Sites
20 x sites representing the major OSPARCOM marine flux sites

Location of Monitoring Points: The locations as described above are shown in detail in Appendix 1.

Quality Elements: All the biological elements are monitored and supporting elements: physico-chemical, hydromorphological, priority substances and other pollutants appropriate to the individual water bodies are monitored in this Surveillance Network subnet.

1.2.5 Other Overlapping Subnets

Within the structure of the above subnets the SM programme also includes the following overlapping subnets – overlapping in the sense that they will also be contained in one or more of the four principal subnets above.

- Eurowaternet (EIONET) sites,
- Surface water / groundwater interaction sites,
- River Lake interaction sites - Lake flux sites to measure nutrient loading to some major lakes (5-10 sites) on eg Conn, Derg, Ree, Sheelin, Leane
- Selected reference condition (e.g. RivType Project) sites to ensure that sufficient of the highest status RWBs are included (important for detection of long-term natural trends as per CIS Monitoring Guidance)
- WFD Intercalibration register sites
- Selected NPWS Protected Area sites – see also OM programme

[cross check against TOR]

Individual monitoring points may be included in one or more of the main subnets.

In total the SM network will include approximately 188 sites on Irish rivers.

1.2.6 Design of Future River Monitoring Networks

This is an important objective of the SM programme. It does not require a specific set of sites or subnet, as in the case of other objectives of SM, but is taken here to refer to the network as a whole. As the SM programme proceeds and status is assigned to RWB those which are shown to be of less than good status at any point in the programme may be added to the operational monitoring programme if they are not already included there. This does not mean, however, that they necessarily have to be dropped from the SM programme, as it is essential to maintain continuity in, for example, the long-term trend monitoring subnet. It is obvious too that it is necessary to maintain a representative selection of sites, which mirror the overall surface water status in each RBD.

The results from the SM network will be used at the end of each RBMP cycle to revise the overall network. The document entitled "Reporting Sheets for Reporting Monitoring Requirements" (DGENV and Littlejohn, 2005) states "The Directive allows for monitoring programmes to be amended during the period of the river basin management plan, and between RBMP cycles." Thus, it is not essential to wait until the end of a River Basin Management Plan (RBMP) cycle to change the location of sites or to increase or decrease the number of monitoring points. It is envisaged that, for example, the subnet for supplementing and validating the risk assessment will be reduced as time goes by as the risk factors affecting the status of RWBs becomes clearer on

foot of the monitoring results. If a site is found to be unsuitable for the purpose intended following initial monitoring, it is proposed to replace such a site with a new one, ideally within the same RWB. Similarly, alterations in the range of quality elements or changes to the frequency of monitoring are possible where such a course is dictated by emerging data from the core monitoring programme and in response to other related sources of information such as ongoing risk assessments. All such changes to the Surveillance Monitoring network should, however, be referred to the EPA in order that the central database of WFD monitoring sites can be updated.

The long-term trend subnet is likely to point up potential new threats to water status – e.g. climate change or other as yet unforeseen pressures or impacts and this may suggest revision of the overall network for future RBMP cycles. Similarly, the WFD allows revision of the SM where the monitoring shows that a water body has reached good status.

1.2.7 Quality Elements for Rivers SM Programme

The quality elements for SM are clearly designated in Annex V of the WFD – see Table 2 below.

> "Selection of quality elements
>
> Surveillance monitoring shall be carried out for each monitoring site for a period of one year during the period covered by a River Basin Management Plan for:
>
> – parameters indicative of all biological quality elements
> – parameters indicative of all hydromorphological quality elements
> – parameters indicative of all general physico-chemical quality elements
> priority list pollutants which are discharged into the river basin or sub-basin and
> – other pollutants discharged in significant quantities in the river basin or sub-basin
>
> unless the previous surveillance monitoring exercise showed that the body concerned reached good status and there is no evidence from the review of impact of human activity under Annex II that the impacts on the body have changed. In these cases, surveillance monitoring shall be carried out once every three River Basin Management Plans."

Table 2. Quality elements and *minimum* required frequency of monitoring for individual quality elements in surface waters monitoring.

Quality Element	**Rivers**	Lakes	Transitional	Coastal
Biological				
Phyto-Plankton	**6 months**	6 months	6 months	6 months
Other aquatic flora	**3 years**	3 years	3 year	3 year
Macro invertebrates	**3 years**	3 years	3 years	3 years
Fish	**3 years**	3 years	3 years	
Hydromorphological				
Continuity	**6 years**			
Hydrology	**continuous**	1 month		
Morphology	**6 years**	6 years	6 years	6 years
Physico-Chemical				
Thermal Conditions	**3 months**	3 months	3 months	3 months
Oxygenation	**3 months**	3 months	3 months	3 months
Salinity	**3 months**	3 months	3 months	
Nutrient Status	**3 months**	3 months	3 months	3 months
Acidification Status	**3 months**	3 months		
Other Pollutants	**3 months**	3 months	3 months	3 months
Priority Substances	**1 month**	1 month	1 month	1 month

1.2.8 Biological elements for River Monitoring

The Irish Quality Rating System has been intercalibrated with biological indexes from a wide range of other European countries as part of the Northern Intercalibration Group and the Central/Baltic Intercalibration Group. The Quality Rating system is based primarily on macroinvertebrates but also incorporates phytobenthos and macrophytes in the overall Q-Value. Individual metrics will be applied to each biological quality element before recombining and classifying river sites into one of five status categories.

Biological Classification Systems
Macroinvertebrates
Modified Q-Value – Q-value expressed as an EQR with phytobenthos and macrophytes disaggregated
Phytobenthos
Filamentous algae and diatoms. Q-Value Index of macroalgal abundance. TDI and French diatom index to be assessed.

Macrophytes
In-stream submerged and emergent macrophytes. Q-value index of macrophyte abundance and NSSHARE Dodkins index – metrics still under development

Fish
Fish populations on a river water body basis due to mobility and wider range of fish within rivers it is proposed that representative sites for RWBs as a whole may be more useful than sticking rigidly to sites selected for the purposes of physico-chemical, hydrometric or other biological element monitoring.
Metrics will include e.g. Fame and modelled relationship between fish populations and water quality in Irish rivers (Champ et al).

Phytoplankton
Because most Irish rivers have a residence time too short to allow for a true phytoplankton population to develop phytoplankton sampling will only be carried out on a small number of larger rivers where the residence time is judged to be sufficient. (Phytoplankton populations in rivers downstream of lakes with will be inferred from the lake monitoring programme results

1.2.9 Sediment and biota monitoring for Rivers

PS measurements in selected sites - subnet

1.2.10 Physico-chemical elements for River Monitoring

Standard grab-sampling will continue to be the mainstay of the physico-chemical monitoring network.

Automatic samplers will be used at the major flux sites and core long-term trend sites in order to provide detailed initial understanding of nutrient and sediment loading patterns. Daily sampling may be required - time weighted or in certain cases flow-triggered sampling for flow-weighted sampling to account for high flow periods that yield large sediment or nutrient loads for example.

Continuous electronic monitoring of parameters such as conductivity, turbidity, temperature, and dissolved oxygen with telemetry to public websites will supplement the SM monitoring (although this will be more important in the OM programme)

Results to be judged against EQSs set for the individual determinands.

1.2.11 Priority Substances to be Monitored in Rivers

Annex X substances monthly for one year during the cycle. Other PS identified within the catchments of SM sites will also be included. Future monitoring will depend on the outcome of the initial phase. (The daughter directive on dangerous substances will also influence the ongoing monitoring for PS perhaps requiring revisions in the medium term).

Priority Substances discharge in the river basin or sub basin upstream of water body [initially all Annex X substances will be analysed for at Surveillance Monitoring Sites). As monitoring data and screening data become available it may be possible to determine that certain substances listed in Annex X are not discharged in a particular river basin or sub-basin]

1.2.12 Other Pollutants to be Monitored in Rivers

Other pollutants listed in Annex VIII. See Table C2

1.2.13 Hydromorphological Monitoring in Rivers

Hydrology

High precision, high frequency river discharge monitoring will be required for the long-term trend and flux sites (OSPAR and lakes). Automatic gauges will be essential for these subnets.

Lower precision measurements may be sufficient for other subnets – e.g. well-calibrated staff gauges with good ratings to enable flows to be determined on the day of sampling if the staff gauge is read accurately.

Computer modelling of daily flows may be required in some cases (although more likely to be needed in case of OM and IM below)

Appendix 2 indicates the type of gauge required for individual monitoring points

Hydromorphology and Continuity

Hydromorphology will be monitored on a 6-year cycle combining remote sensing, GIS analysis and field measurements.

National Expert Committee to develop metrics for judging hydromorphological condition of rivers particularly as they support ecological status.

1.3 Rivers Operational Monitoring Network

1.3.1 Introduction to the Rivers OM Programme

The WFD requires Operational Monitoring (OM) primarily in support of measures aimed at achieving the main objectives of the WFD – attainment of at least good status in water bodies that are less than good at present and also to retain high and good status where it exists at present. The success of the WFD depends crucially on the Programmes of Measures (POM) implemented in the RBDs. The Operational Monitoring (OM) Programme outlined here is focussed on support of POM – it is designed to provide highly

targeted information on the success or otherwise of particular measures within catchments.

OM is obviously required where pollution or other impacts on ecological status are apparent. Crucially, however, because the protection of high and good status are such high level objectives of the WFD, OM must also provide information on whether the POMs aimed at maintaining high and good status are effective. Thus, even waterbodies which may not be deemed to be at risk in the Characterisation Report prepared under Article 5 of the WFD may be included in the OM programme because measures are required to maintain them at their current high or good status regardless of existing risk status.

The OM programme for rivers has approximately 1177 joint physico-chemical/ecological monitoring points on Irish RWBs (Appendix 2.1). This programme is designed to be flexible in order to respond to changes within catchments that impact on water status.

The OM programme for rivers incorporates all of the 188 sites contained in the SM programme – the SM network is a subset of the OM network.

The Irish OM has six separate subnets aimed at monitoring particular aspects of POMs and providing feedback for the national EMS system within RBMPs.

1.3.2 Rivers OM Subnet 1: Monitoring of the Effectiveness of Point Source Measures

Aim of Subnet: Monitoring to assess whether the measures aimed at improving the impact of individual and combined point sources are successful. This includes assessment of ambient levels of organic pollution, eutrophication impacts and priority substances.

Subnet Size: Over 600 river water bodies were placed at risk due to point source pressures. Some 800 [tbc] monitoring points will be required for this purpose (Appendix 2)

Location of Monitoring Points: The aim of the POMs for point sources is to achieve good status in rivers downstream of discharges. Thus, in theory at least, one sample point downstream of a point source may be sufficient to tell whether a RWB downstream of a point source is at good status or not and thus, whether measures being implemented are effective. If, however, other impacts either diffuse or point source, located upstream of a point source of interest are also affecting status in the river then control monitoring sites upstream of the original point source may be needed to disentangle the impact of different pressures and the effectiveness of the POMs.

With regard to multiple point sources, for example, in towns or cities, the text of the WFD states clearly that in designing OM programmes representative monitoring points may be used to assess the combined impact of a number of point sources.

1.3.3 Rivers OM Subnet 2: Monitoring of Effectiveness of Diffuse Pollution Measures –

Aim of Subnet: To assess effectiveness of diffuse pollution control measures

Subnet Size: Diffuse pollution risk was the predominant risk to water status identified in the Article 5 Characterisation Report published in December 2004. Some **600** [to be confirmed] RWBs are designated for assessment of diffuse pollution control measures within this subnet. The subnet is further subdivided based on the pressures outlined in the National WFD Article 5 Characterisation Report.

Location of Monitoring Points:
The location of monitoring points within this subnet are shown in Appendix 3. Currently not all Irish RWBs identified in the Article 5 report are monitored and some aggregation is required in order to provide effective monitoring. Aggregation of water bodies by type and pressure is undertaken to gauge the effectiveness of measures that are implemented on a wide scale. The rules for aggregation of waterbodies subject to diffuse pollution are outlined in Appendix 3.

1.3.4 Rivers OM Subnet 3: Monitoring of Effectiveness of Measures to reduce Hydromorphological pressures–

Aim of Subnet: To assess effectiveness of measures to reduce hydromorphological pressures and impacts

Subnet Size: Hydromorphological risk was an important source of risk to water status identified in the Article 5 Characterisation Report published in December 2004. Some **200** [to be confirmed] RWBs are designated for assessment of measures to reduce hydromorphological risk.

Location of Monitoring Points:
As hydromorphology monitoring is a new component of the national monitoring programme, the locations of these sites will be identified in early 2007 by a POM study that is addressing hydromorphological pressures and survey techniques.

1.3.5 Rivers OM Subnet 4: Monitoring of the Effectiveness of Measures aimed at retaining High and Good status RWBs

Aim of Subnet: To monitor high and good status sites currently not deemed to be at risk in order to assess the effectiveness of POMs aimed at maintaining high and good status sites.

Subnet Size: Approximately 1600 monitoring points for biological assessment

Location of Monitoring Points: This subnet will include representative sites of high and good status rivers located on all major RWBs included in the OS River Basin of Ireland map. Sites are given in Appendix 2.

1.3.6 Rivers OM Subnet 7: Species and Habitat Protected Areas

Aim of Subnet: To monitor Species and Habitat Protected Areas that are at risk.

Text from Article 1.3.5 of Annex V

"Habitat and species protection areas

Bodies of water forming these areas shall be included within the operational monitoring programme referred to above where, on the basis of the impact assessment and the surveillance monitoring, they are identified as being at risk of failing to meet their environmental objectives under Article 4. Monitoring shall be carried out to assess the magnitude and impact of all relevant significant pressures on these bodies and, where necessary, to assess changes in the status of such bodies resulting from the programmes of measures. Monitoring shall continue until the areas satisfy the water-related requirements of the legislation under which they are designated and meet their objectives under Article 4."

Size of Subnet: See Appendix 3 for initial river water bodies included in this subnet. (tbc).

Location of Monitoring Points: See Appendix 3 (tbc) for locations of monitoring points.

1.4 Quality Elements for OM Programme

1.4.1 Biological elements

Macroinvertebrates
Phytobenthos
Macrophytes
Fish

1.4.2 Physico-chemical elements

The WFD specifies a range of physico-chemical elements that are required to support the biological elements. It is likely that a core range of determinands will be monitored at each site, with an additional selection inserted where appropriate to be representative of the specific dominant pressure at that sample location. The generic list of physico-chemical determinands includes temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity. It is possible that not all determinands will be monitored at each sample location, and that the selection of determinands will reflect the dominant pressures.

1.4.3 Priority Substances

Some of the sites within the point and diffuse sub-nets may require some priority substances (as listed in Annex X) sampling to be undertaken. These substances will be identified as being specific to activities or pressures identified as being dominant at that sample location. Pressure based sub-net elements that may include some elements of PS monitoring may include pesticides from arable farming, forestry and sheep dip, specific process based substances from IPPC and section 4 activities, as well as those from WWTPs with significant trade effluent inputs. POMS working groups are investigating these factors in more detail and their findings will guide the eventual list of selected determinands. Further screening using biological metrics might also be appropriate in confirming those sites which require further chemical monitoring.

1.4.4 Other Pollutants

A range of other pollutants (as listed in Annex VIII) must be measured if they are discharged in significant quantities within a river basin or sub-basin. It is not always possible to

Suggested determinants for operational monitoring in rivers are listed in the table below.

1.4.5 Hydrometric Monitoring

The hydrometric programme supporting the rivers monitoring programme will deliver the capability of producing daily flows for all monitoring points. This

Table *.* Physico-chemical, priority substances and other pollutants to be analysed for within individual operational monitoring subnets.

	Sub-Net	Generic Determinands	Additional Determinands
Diffuse – Agriculture	*Arable Only*	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, nitrite, suspended solids, ammonia
	Pasture Only	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, nitrite, suspended solids, ammonia Mecoprop/MCPA,
	A+P	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, nitrite, suspended solids, ammonia Mecoprop/MCPA,
	D.S. Arable	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Glyphosate, IPU, propiconazole, pirimicarb, dimethoate
	Sheep Dip		Cypermethrin/OPs
Diffuse – Urban	*Urban Only*	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Total hydrocarbons, copper, zinc, lead, cadmium, mercury, cyanide, COD, TOC, bacteriological
	Roads	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Copper, zinc, total hydrocarbons,
Diffuse – Forestry	*Forest-acid*	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, pH and alkalinity	
	Forest-eutro	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	
	Forest-solids	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Suspended solids
	Forest D.S.	temperature, dissolved oxygen, conductivity, hardness, pH and alkalinity	cypermethrin, biological screening
Diffuse – Mixed	*A+U*	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Selected from above
	P+U	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Selected from above
	A+P+U	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Selected from above
Point	*WWTP*	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, ammonia, suspended solids, (metals/specified substances – if significant trade effluents)
	Section 4	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, ammonia, suspended solids, substances specific to individual processes
	IPPC	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, ammonia, suspended solids, substances specific to individual processes
	CSO	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	COD, suspended solids, ammonia, nitrite, bacteriological (total coliforms, faecal coliforms, faecal strep.) , priority substances, hydrocarbons
	WTP	temperature, dissolved oxygen, BOD, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Aluminium, manganese, residual chlorine, suspended solids
	Mines	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, pH and alkalinity	Total and filtered metals (copper, zinc, cadmium, lead, nickel, chromium, iron) , suspended solids
	Quarries	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, pH and alkalinity	Chromium, suspended solids, visible oils,
	Tips	temperature, dissolved oxygen, BOD, salinity, conductivity, hardness, chloride, phosphorus, nitrogen, silicon, pH and alkalinity	Sulphide, ammonia, priority substances, phenols, COD, sulphate,

may be by direct measurement of the discharge at the monitoring point or alternatively by extrapolation or modelling based on a nearby flow gauging point.

1.4.6 Hydromorphology

1.4.7 Monitoring of Drinking Water Abstraction Points

Additional monitoring is required for drinking water sources as per the text of article 1.3.5 of Annex V of the WFD independently of the SM or OM programmes outlined above:

> *Bodies of surface water designated under Article 7 which provide more than 100 m^3 a day as an average shall be designated as monitoring sites and shall be subject to such additional monitoring as may be necessary to meet the requirements of that Article. Such bodies shall be monitored for all priority substances discharged and all other substances discharged in significant quantities which could affect the status of the body of water and which are controlled under the provisions of the Drinking Water Directive. Monitoring shall be carried out in accordance with the frequencies set out below:*

Community served	**Frequency**
< 10 000	4 per year
10 000 to 30 000	8 per year
> 30 000	12 per year.

Size of Programme: To be completed

Location of Monitoring Points: To be completed

1.5 Investigative Monitoring

Table X: Design of Investigative Monitoring – WFD Quotation

"1.3.3 Design of investigative monitoring
Objective

Investigative monitoring shall be carried out:
– where the reason for any exceedances is unknown;

– where surveillance monitoring indicates that the objectives set under Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, in order to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives; or
– to ascertain the magnitude and impacts of accidental pollution;
and shall inform the establishment of a programme of measures for the achievement of the environmental objectives and specific measures necessary to remedy the effects of accidental pollution."

1.5.1 **Rivers IM Subnet 1: Investigation of unexplained exceedances and** accidental pollution;

Aims of subnet: To understand the reasons for any unexplained exceedances and to ascertain the magnitude and impacts of accidental pollution;
Subnet size: Dependent on particular events or problems being investigated
Location of Monitoring Points: Not applicable

1.5.2 Rivers IM Subnet 2: Geographical/spatial Screening and Risk Assessment Subnet

Aim of subnet: To provide a more detailed geographical picture of catchments by means of rolling programme of snapshot catchment monitoring. This will help to inform the establishment of the programme of measures by enabling POMs to be aimed at the precise location of pollution problems within catchments. Investigative monitoring of this nature allows for ongoing refinement of POMs to ensure that they are targeted effectively. Widespread 'snapshot' sampling within waterbodies will identify the sub-catchments most at risk. Results will also be used to identify new permanent monitoring points within the other subnets of the OM and SM programmes. Wider geographical coverage than is possible with a fixed point monitoring network is essential when it is realised that over 70% of total channel length may not be monitored if first and second order streams are omitted. This may reduced the effectiveness of measures particularly for diffuse pollution. The risk of diffuse pollutants entering a river may be seen as proportional to the total length of the riverbank. Thus additional geographical screening of 1st and 2nd order streams that comprise over 70% of total channel length in Irish rivers can assist in improved location of primary monitoring points and in more effective POMS.

Subnet Size: This is a nation-wide rolling programme covering up to 25,000 individual monitoring points which covers all the 4000+ waterbodies identified in the WFD Article 5 Characterisation Report.

Location of Monitoring Points: All small streams within all identified waterbodies. Snapshot monitoring will be carried out in a small number of water bodies on any given day with the aim of giving an instantaneous picture of the risk of impact on water status associated with individual subcatchments. This is intended as a rolling programme of snapshot monitoring moving from catchment to catchment over time. This will include a large number of sites within a catchment in order to pinpoint potential sources of pollutants within sub-catchments and to verify that existing risk assessments provide a realistic assessment of the true risk.

This risk programme will include separate physico-chemical and biological programmes. The biological programme will use rapid screening techniques such as the 'Small Stream Risk Score' approach developed by the WRBD and EPA for this purpose. This type of investigative screening methods cannot provide true 'status' assessments but rather a risk assessments that can be used to guide the location and interpretation of the status information arising by the primary monitoring points on the surveillance and operational programmes.

In the case of the physico-chemical snapshot programme it is proposed to allocate 25% of the overall sample collection and physico-chemical analysis effort for water chemistry to this risk assessment subnet. In the case of the biological SSRS programme this will be undertaken mainly in Winter and Spring in order to maximise the reliability of the biological risk score in identifying RWBs that are definitely at risk.

1.5.3 Rivers IM Subnet 3: Electronic Alert and Screening Subnet

Aim of Subnet: To identify episodic pollution sources not identified by other subnets. Routine grab sample monitoring does not always coincide with actual pollution events in RWBs. Infrequent discharges of pollutants may be highly damaging to aquatic ecosystems but can be difficult to pinpoint in space and time using standard main channel river monitoring based on standard sample collection routes. Where discharges are constant, grab sampling is effective but many discharges are episodic and unpredictable in nature. Electronic alert networks – providing continuous measurement and telemetry of parameters such as conductivity, turbidity, DO, etc. will be used to provide alerts to potential pollution sources or pollution incidents. These will involve telemetry to a public website. Alerts generated will be used to direct RBD resources to solving problems within catchments

through improved operational monitoring and more focussed programmes of measures.

Size of subnet: This subnet will be introduced on a trial basis in a number of catchments in order to assess the effectiveness of the approach. It is envisaged that a major catchment of 500 km^2 would have up to 100 individual low-cost nodes providing continuous data for a range of parameters. Results will be assessed in conjunction with high resolution spatial data emanating from e.g. chemical snapshot sampling of catchments, the biological small stream risk score and from remote sensing.

Location of Monitoring Points: The alert network should be flexible allowing for ongoing relocation of monitoring nodes depending on the results obtained from the network itself. Typically an alert network will start with a small number nodes located on the main river channel plus nodes on all major tributaries (of 3rd order or greater). Nodes can be relocated to provide greater spatial resolution when sufficient data are available to pinpoint tributaries that appear to have anomalous discharges within their catchments. In this manner an initial picture of both the temporal and spatial pattern of potential discharges can be built up. Such networks will help to modify the OM and SM programmes and the relevant POM for the catchments being monitored. Sufficient resources to enable the ongoing maintenance of such a network is a key to the success of this type of approach.

1.5.4 Rivers IM Subnet 3: Remote Sensing Subnet

Aim of Subnet: In addition to the temporal and geographical coverage provided by the snapshot and electronic alert networks, aerial photography used for hydromorphological assessments can provide additional screening for small point sources of pollution and visual verification of a wide range of catchment pressures. Satellite imagery can provide similar coverage albeit at lower resolution.

Size of subnet: The subnet for aerial photography will coincide with that of the hydromorphological network. Satellite imagery is available for complete RBDs at low resolution and should be used in conjunction with the aerial photography and the snapshot screening subnet.

Location of Monitoring Points: The RWBs surveyed will coincide with those chosen for hydromorphological purposes but additional investigative coverage may be necessary when particular catchments need more detailed surveys to discover the source of a particular problem.

1.6 Frequency of Monitoring

1.6.1 Introduction

Sample frequency will vary depending on the monitoring programme and the individual subnets and the quality element. Basic requirements for quality elements are specified in the WFD (Table 2). Long-term trend monitoring sites will require higher frequency sampling than for example, than those required for supplementing and validating the risk assessment or for general representative monitoring.

The text of the WFD outlines the requirements under frequency of monitoring (Table X) below.

Table X. WFD text concerning monitoring frequency

1.3.4 Frequency of monitoring

"For the surveillance monitoring period, the frequencies for monitoring parameters indicative of physico-chemical quality elements given below should be applied unless greater intervals would be justified on the basis of technical knowledge and expert judgement. For biological or hydromorphological quality elements, monitoring shall be carried out at least once during the surveillance monitoring period."

"For operational monitoring, the frequency of monitoring required for any parameter shall be determined by Member States so as to provide sufficient data for a reliable assessment of the status of the relevant quality element. As a guideline, monitoring should take place at intervals not exceeding those shown in the table below unless greater intervals would be justified on the basis of technical knowledge and expert judgment."

"Frequencies shall be chosen so as to achieve an acceptable level of confidence and precision. Estimates of the confidence and precision attained by the monitoring system used shall be stated in the River Basin Management Plan."

"Monitoring frequencies shall be selected which take account of the variability in parameters resulting from both natural and anthropogenic conditions. The times at which monitoring is undertaken shall be selected so as to minimise the impact of seasonal variation on the results, and thus ensure that the results reflect changes in the water body as a result of changes due to anthropogenic pressure. Additional monitoring during different seasons of the same year shall be carried out, where necessary, to achieve this objective."

Frequency of monitoring will determine the confidence and precision of the results obtained particularly in the physico-chemical monitoring programmes as outlined in Chapter 8. Target sample frequencies for the individual sub-networks of the main monitoring programme are outlined in Appendix 5.

1.6.2 Monitoring Reporting Sheet Table C2 Surveillance and Operational Monitoring Programmes for Irish Rivers

(Table C2 from: EC-DG Environment D.2 and Carla Littlejohn, (2005)

Monitoring Reporting Sheet Table C2 Surveillance and Operational Monitoring Programmes for Irish Rivers

(Table C2 from: EC-DG Environment D.2 and Carla Littlejohn, (2005)

Surveillance Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
Parameters indicative of all biological quality elements		
QE: Benthic invertebrate fauna Modified Irish Quality Rating system (Q-Value-Macroinvertebrates)	188	Once per three years
QE: Macrophytes and Phytobenthos • Q-Value Phytobenthos abundance metric • Diatoms (TDI and other metrics) • Q-Value Macrophyte Abundance metric • NSSHARE Dodkin's Macrophyte Index	188	Once per three years
QE: Fish • Composition and abundance and age structure of population	188	Once per three years
QE: Phytoplankton **Chlorophyll** **Cell Counts/Biomass Metrics** **Taxonomic Metrics**	0 (Not Applicable – Residence time is too short in Irish rivers for the development of true phytoplankton populations.)	-

Surveillance Monitoring Programme River Water Bodies		
QE: Parameters indicative of all general physico-chemical quality elements **Thermal Conditions** **Temperature** **Stratification** **Oxygenation** **Dissolved Oxygen** **Diurnal Oxygen range** **BOD** **Salinity** **Conductivity** **Hardness** **Chloride** **Nutrients** **Phosphorus** **Nitrogen** **Silicon** **Acidification Status** **PH** **Alkalinity** **ANC**	188 (Not all parameters will be measured in all subnets of the Rivers SM Programme)	4 to 12 times per year (But some monitoring subnets will have continuous electronic measurements and automatic composite samplers. See subnet tables for details)
QE: Hydromorphological quality elements		
Continuity	188	6 months
Hydrology		Continuous
Morphology		6 months
		12 times per year for one year in 3-year cycle
1. Alachlor	188 Sites (Note that the precise list of compounds will vary from site to site depending on whether the Annex X	
2. Anthracene		
3. Atrazine		
4. Benzene		
5. Brominated diphenylethers		
6. Cadmium and its compounds		

Surveillance Monitoring Programme River Water Bodies		
7. C_{10-13}-chloroalkanes	substance in question is discharged in the river basin or sub-basin in which the SM monitoring point is located. The initial approach will be conservative in that it will be assumed that all Annex X compounds are likely to be discharged until evidence to the contrary becomes available. The initial list of compounds will be based on the results from an intensive screening programme.)	
8. Chlorfenvinphos		
9. Chlorpyrifos	188	
10. 1,2-Dichloroethane		
11. Dichloromethane		
12. Di(2-ethylhexyl)phthalate		
13. Diuron		
14. Endosulfan, (alpha-endosulfan)		
15. Fluoranthene		
16. Hexachlorobenzene		
17. Hexachlorobutadiene		
18. Hexachlorocyclohexane, (gamma-isomer,Lindane)		
19. Isoproturon		
20. Lead and its compounds		
21. Mercury and its compounds		
22. Naphthalene		
23. Nickel and its compounds		
24. Nonylphenols, (4-(para)-nonylphenol)		
25. Octylphenols, (para-tert-octylphenol)		
26. Pentachlorobenzene		
27. Pentachlorophenol		
28. Polyaromatic hydrocarbons, (Benzo(a)pyrene), (Benzo(b)fluoranthene), (Benzo(g,h,i)perylene), Benzo(k)fluoranthene), (Indeno(1,2,3-cd)pyrene)		
29. Simazine		
30. Tributyltin compounds, (Tributyltin-cation)		
31. Trichlorobenzenes, (1,2,4-Trichlorobenzene)		
32. Trichloromethane (Chloroform)		
33. Trifluralin		

Surveillance Monitoring Programme River Water Bodies		
QE: Other pollutants discharged in significant quantities in the river basin or sub-basin (Annex VIII pollutants) 1. Organohalogen compounds and substances which may form such compounds in the aquatic environment. 2. Organophosphorus compounds. 3. Organotin compounds. 4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment. 5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances. 6. Cyanides. 7. Metals and their compounds. 8. Arsenic and its compounds. 9. Biocides and plant protection products. 10. Materials in suspension. 11. Substances which contribute to eutrophication (in particular, nitrates and phosphates). 12. Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.).	188 Sites (Note that the precise list of substances analysed for at any individual site will vary from site to site depending on whether the pollutant in question is discharged in significant quantities in the river basin or sub-basin in which the SM monitoring point is located.)	4 to 365 times per year (some flux stations continuous electronic measurements and automatic composite samplers) ongoing

Operational Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
Parameters indicative of all biological quality elements		
QE: Benthic invertebrate fauna Modified Irish Quality Rating system (Q-Value-Macroinvertebrates)	3200 (See Appendix 1 for breakdown)	Once per three years
QE: Macrophytes and Phytobenthos • Q-Value Phytobenthos abundance metric • Diatoms (TDI and other metrics) • Q-Value Macrophyte Abundance metric • NSSHARE Dodkins Macrophyte Index	3200 200 (188 overlapping with SM) 3200 1177 (may be extended)	Once per three years
QE: Fish • Composition and abundance and age structure of population	100	Once per three years
QE: Phytoplankton **Chlorophyll** **Cell Counts/Biomass Metrics** **Taxonomic Metrics**	0 (Not Applicable – Residence time is too short in Irish rivers for the development of true phytoplankton populations.)	-

Operational Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
QE: Parameters indicative of all general physico-chemical quality elements **Thermal Conditions** **Temperature** **Stratification** **Oxygenation** **Dissolved Oxygen** **Diurnal Oxygen range** **BOD** **Salinity** **Conductivity** **Hardness** **Chloride** **Nutrients** **Phosphorus** **Nitrogen** **Silicon** **Acidification Status** **PH** **Alkalinity** **ANC**	1177 (Not all parameters will be measured in all subnets of the Rivers SM Programme)	4 to 12 times per year (But some monitoring subnets will have continuous electronic measurements and automatic composite samplers. See subnet tables for details)
QE: Hydromorphological quality elements		
Continuity	500	6 months
Hydrology		Continuous
Morphology		6 months

Operational Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
QE: Priority Substances **Annex X Substances** 1. Alachlor 2. Anthracene 3. Atrazine 4. Benzene 5. Brominated diphenylethers 6. Cadmium and its compounds 7. C_{10-13}-chloroalkanes 8. Chlorfenvinphos 9. Chlorpyrifos 10. 1,2-Dichloroethane 11. Dichloromethane 12. Di(2-ethylhexyl)phthalate 13. Diuron 14. Endosulfan, (alpha-endosulfan) 15. Fluoranthene 16. Hexachlorobenzene 17. Hexachlorobutadiene 18. Hexachlorocyclohexane, (gamma-isomer,Lindane) 19. Isoproturon 20. Lead and its compounds 21. Mercury and its compounds 22. Naphthalene 23. Nickel and its compounds 24. Nonylphenols, (4-(para)-nonylphenol) 25. Octylphenols, (para-tert-octylphenol) 26. Pentachlorobenzene 27. Pentachlorophenol 28. Polyaromatic hydrocarbons, (Benzo(a)pyrene), (Benzo(b)fluoranthene), (Benzo(g,h,i)perylene), Benzo(k)fluoranthene), (Indeno(1,2,3-cd)pyrene) 29. Simazine 30. Tributyltin compounds, (Tributyltin-cation) 31. Trichlorobenzenes, (1,2,4-Trichlorobenzene) 32. Trichloromethane (Chloroform) 33. Trifluralin	188 Sites (overlap with SM) (Note that the precise list of compounds will vary from site to site depending on whether the Annex X substance in question is discharged in significant quantities the river basin or sub-basin in which the OM monitoring point is located.)	12 times per year for one year in 3-year cycle
QE: Other pollutants discharged in significant quantities in the river basin or sub-basin (Annex VIII pollutants)		

Operational Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
1. Organohalogen compounds and substances which may form such compounds in the aquatic environment.	d/s arable areas, d/s WTWs	4 to 365 times per year (some flux stations continuous electronic measurements and automatic composite samplers) ongoing
2. Organophosphorus compounds.	Tillage subnet, sheep dip, d/s any relevant manufacturing facilities	
3. Organotin compounds.	d/s arable areas (potatoes)	
4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment.	D/s STW Septic tank Urban diffuse Manufacturing facilities	
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances.	PCB spillages, D/s power generation sites DDT	
6. Cyanides.	Mining Manufacturing, electroplating	
7. Metals and their compounds.	Mining Risk, Concrete manufacture (Cr), Sawmills, timber processing FFDIR sites Cu & Zn	
8. Arsenic and its compounds.	?	
9. Biocides and plant protection products.	Forestry subnet Tillage subnet	
10. Materials in suspension.	FFDIR SS subnet	

Operational Monitoring Programme River Water Bodies		
Category:	**River**	
	No. sites	**Freq**
11. Substances which contribute to eutrophication (in particular, nitrates and phosphates).	1177 Nitrates subnet P Regs EWN subnet Flux sites to lakes and sea (OSPAR)	
12. Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.).	Point Source Subnet – STW, Some Sxn 4 and IPPC sites	

1.7 Appendices for River Volume

1.7.1 Appendix 2.1. River Water Body Surveillance Monitoring Programme

Table with list of 188 river monitoring points flagged according to their subnetworks and including GIS co-ordinates (where applicable). Data to be compatible with outlined monitoring reporting sheets.

1.7.2 Appendix 2.2. Operational Monitoring Programme for River Water Bodies

Table with list of 1177 river monitoring points flagged according to their subnetworks and including GIS co-ordinates (where applicable). OM sites will also be flagged according to the risk assessment pressures or dominant pollution sources and impacts within the upstream catchment. Data to be compatible with outlined monitoring reporting sheets.

1.7.3 Appendix 2.3. Rules of aggregation of river waterbodies identified as likely to be at risk of diffuse pollution and hydromorphological pressure

Flow chart explaining rules of aggregation process for diffuse and hydromorphology – TBA.

1.7.4 Appendix 2.4. Monitoring Frequency for individual sub-networks of the principal river water body monitoring programmes.

This appendix gives guidance on the expected sampling frequency required for individual subnets of the SM and OM programmes. Where a river site is in two different subnets the higher frequency monitoring programme must be selected as the appropriate one in order to provide adequate confidence and precision for the purposes of the higher-frequency subnet.

Subnet	Frequency	Note
Surveillance Monitoring Physico-chemical elements		
Subnet 1 – Representative Subnet	Basic Table 2	See Table 2 in main text for frequencies required for individual elements
Subnet 2 – Long-term Trend Monitoring	monthly	Monthly sampling required
Subnet 3 – Supplementing and Validating the Risk Assessments	Basic Table 2	See Table 2 in main text for frequencies required for individual elements
Subnet 4 – Stipulated Rivers	Basic Table 2	See Table 2 in main text for frequencies required for individual elements
Biological elements		
All subnets	Basic Table 2	See Table 2 in main text for frequencies required for individual elements
Operational Monitoring		
Subnet 1 – Point Source		
Subnet 2 – Diffuse		
Subnet 3 – Hydromorphological	Basic Table 2 Rolling 6-year programme	
Subnet 4 – High and Good Status POM	Basic Table 2	
Subnet 5 – Electronic Alert	Continuous	