

DRAFT

**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 4 – TRANSITIONAL AND COASTAL
WATERS**

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TRANSITIONAL AND COASTAL WATERS MONITORING PROGRAMME -
DRAFT

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4. Coastal and Transitional Waters Monitoring Programme

4.1 Introduction

A total of 309 transitional and coastal water bodies were considered for inclusion in the national Coastal and Transitional Waters monitoring programme (the number of water bodies within each River Basin District and each typology is shown in Table 4.1).

In accordance with the Water Framework Directive and guidance provided by the Common Implementation Strategy, a representative number of water bodies were selected that were considered to provide an assessment of the overall status of Ireland's transitional and coastal waters and to meet the other specific requirements of the Directive. As previously noted the programme described here for transitional and coastal waters builds upon national and local knowledge obtained from previous and existing monitoring programmes in Irish tidal waters undertaken since the early 1970s. A number of innovative approaches are included in order to help in targeting programme of measures at the local sub-catchment scale and to begin to provide real-time alert systems for pollution incidents plus remote sensing capability aimed at ensuring that all potential pollution sources are known.

Two primary monitoring programmes are hereby established – the surveillance monitoring (SM) and operational monitoring (OM) programmes. In addition the role of Investigative Monitoring (IM) is outlined.

Table 4.1. Number of water bodies in each type in each RBD

River Basin District	Typolgy						
	TW 2	TW 6	CW 2	CW 5	CW 6	CW 8	CW 10
Eastern RBD	10	3	0	6	1	1	0
South Eastern RBD	16	5	2	4	0	3	0
South Western RBD	29	14	9	9	0	3	6
Shannon IRBD	14	6	4	4	0	1	2
Western RBD	21	47	5	15	0	5	5
North Western IRBD	14	8	4	12	0	6	1
Neagh Bann IRBD	6	3	1	3	0	1	0
Total by Type	110	86	25	53	1	20	14
Total by Category		196					113
Overall Total							309

4.2 Coastal and Transitional Surveillance Monitoring Network

A selection or ‘subnet’ of surveillance monitoring water bodies was chosen to represent the range of significant pressures and typology scenarios present in Ireland’s coastal and transitional waters. Three additional subnets were selected from this ‘representative’ subnet, to fulfil the specific surveillance monitoring requirements of the Directive. These subnets included sites required for assessing long-term anthropogenic and natural change; sites required to supplement and validate the risk assessment process (Annex II); stipulated sites such as significant bodies of water that cross a Member State boundary and sites that are used to assess pollutant loading to the marine environment (e.g., OSPAR Riverine and Direct Discharges Programme).

These are described in greater detail below and lists of monitoring sites are given in the appendices to this programme.

Surveillance Monitoring (SM) Network:

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

4.2.1 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 comprises 37 water bodies of which 25 are transitional and 12 coastal. (See Appendix 4.1 for breakdown within RBDs)

Location of Monitoring Points: Representative sites are distributed evenly within the RBDs and selected to be representative of status within RBD and where possible were selected to give a good representation of different tidal water types, habitats and pressures within catchments. As a result of the outcome of the risk assessment process and given the relatively small number of typologies represented by these two water categories it was not possible to represent all types and risks for each RBD. It was decided, therefore to adopt a regional and national approach to ensure a full representation of types and risk categories.

The overall proportional breakdown for the status of sites within this subnet should match the overall water status within Irish RBDs.

4.2.2 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 all the water bodies in subnet 1 above.

Location of Monitoring Points: This subnet includes 12 water bodies of high status (4 transitional and 8 coastal) and 25 water bodies of lower status (21 transitional and 4 coastal) and is designed to provide early indication of long-term anthropogenically influenced trends and of natural variation over time. The majority of sites included in this subnet possess historical monitoring data hence facilitating the detection of long-term trends. It includes 12 OSPAR marine flux stations located on major riverine tributaries flowing into transitional water bodies. It also includes sites aimed at assessing long-term trends in diffuse and point source pollution. (See Appendix 4.1). Groundwater surface water interaction in the marine environment is also represented by the inclusion of a single water body (e.g. Kinvara Bay).

4.2.3 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: The approach taken to selecting surveillance monitoring sites for this subnet was to represent where possible each of the 4 major risk categories within individual RBDs. The number of sites selected is proportional to the number of water bodies in each risk category. For example, for transitional waters in the Eastern – RBD, the number of sites selected in the 1a risk category is twice the number of sites selected in the 1b category based on the relative proportion of water bodies in that category. Typically, 1 in 5 or 20 % of water bodies were considered for further validation. This initial selection was further reduced by aggregation and resulted in the final selection of 25 transitional water bodies and 12 coastal water bodies.

Location of Monitoring Points: Sites within this subnet will be distributed throughout RBDs in proportion to risk categories (see Appendix 4.1).

4.2.4 SM Subnet 4 – Stipulated Sites

Aim of Subnet: To explicitly include those categories of transitional and coastal waters that are specifically stipulated in the text of the WFD. This includes tidal waters that cross a Member State boundary and other sites, in or upstream of specific water bodies, that 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: This subnet includes 3 transitional and 2 coastal water bodies that cross a Member State boundary and 12 OSPAR marine flux stations. It should be noted that the remaining OSPAR flux stations are included in the operational programme.

Location of Monitoring Points: The locations as described above are shown in detail in Appendix 4.1.

4.2.5 Other Overlapping Subnets

Within the structure of the above subnets the SM programme will also include 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,
- Selected reference condition sites
- WFD Intercalibration register sites
- Selected NPWS Protected Area sites – see also OM programme

4.2.6 Design of Future Monitoring Networks

As the surveillance programme proceeds and status is assigned to transitional and coastal water bodies, those that are shown to be of less than good status will automatically be transferred to the operational monitoring programme. (This does not necessarily mean, however, that they will be dropped from the surveillance programme as it is essential to maintain continuity in, for example, the long-term trend monitoring subnet. It is also necessary to maintain a representative selection of sites that reflect the overall surface water status in each RBD.

As monitoring progresses it is also likely that investigative monitoring will be required to answer questions raised by the results from the surveillance or operational programme, e.g., regarding sources of any priority substances found. Similarly, 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.

The results from the surveillance network will be used at the end of each RBMP cycle to revise the overall network. It is envisaged that, for example, the subnet for supplementing and validating the risk assessment will be reduced as time goes by and the actual risk factors affecting the status of RWBs becomes clear.

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 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.

4.2.7 Quality Element, Site Selection and Sampling Frequency for Surveillance Monitoring Programme

As previously stated the quality elements for surveillance monitoring are clearly designated in Annex V of the WFD – see Table 2 in the section on rivers.

In addition to selecting water bodies that are representative of types and dominant pressures and fulfil specific requirements of the Directive, consideration was given to the selection of quality elements and sufficient monitoring points to assess the status of individual water bodies.

The site selection process within designated water bodies was informed by the United Kingdom – Republic of Ireland Marine Task Team guidelines on site density and coverage required to implement the relevant classification tools. Sites with existing historical monitoring data were also chosen to facilitate the assessment of long-term trends. Expert knowledge on individual biological elements and habitat variation was also used. In addition consideration was also given to clustering sites within adjacent water bodies to provide a mechanism to determine downstream effects of pressures and to improve the overall logistical efficiency of the biological and chemical monitoring programmes. This is extremely important in the marine area given the large size and broad spatial distribution of the water bodies that have to be monitored.

4.2.8 Biological elements for Coastal and Transitional Waters

An overview of each biological element, the particular feature or aspect that is being considered for classification tool development and the required sampling and cycle frequency is given in the sections below.

Benthic Macroinvertebrates

The marine benthic macroinvertebrate biological quality element will be evaluated by the Infaunal Quality Index (IQI) multimetric. This multimetric has been developed by the UK-Ireland Benthic Invertebrate subgroup of the UK-Ireland Marine Task Team. The IQI describes ecological status based on the soft sediment infaunal communities. IQI is composed of three primary metrics combining univariate, functional and diversity indices, AZTI Marine Biotic Index (AMBI), Simpson's Evenness ($1-\lambda'$), number of taxa (S). Individual components (metrics) have been weighted and combined to generate a multimetric classification tool that will be used to describe the changes in the benthic invertebrate community due to anthropogenic pressure. The required criteria listed in the normative definition of the directive for this ecological quality element are all covered by this metric.

$$IQI = (((0.38 \times AMBI^{IQI}) + (0.08 \times (1-\lambda')^{IQI}) + (0.54 \times S^{IQI 0.1})) - 0.4)/0.6$$

where:

$$AMBI^{IQI} = (1-(AMBI BC/7))/(1-(AMBI BC/7))^{max}$$

$$(1-\lambda')^{IQI} = (1-\lambda')/(1-\lambda')^{max}$$

$$S^{IQI} = S/S^{max}$$

The IQI operates over a range from zero (bad status (azoic)) to one (high status (reference)). Each metric is normalised to a maximum value expected for that metric. ^{Max} parameters relate to the reference condition for that metric for a specific habitat.

Reference conditions have for the most part been obtained using a combination of best available historic data, combined with expert judgement, to establish maximum expected values for the individual metrics. Reference conditions (maximum values) are specific for EUNIS habitat sampled, sample size and sample processing (sieve mesh). Maximum values for each individual metric (AMBI, Lambda', S) in the IQI are required. The reference conditions (^{max} values) are for EUNIS levels 3 (habitat complex) and/or 4 (biotope complex). EUNIS is the European Nature Information System and is used to describe different habitat types for biological communities.

Class boundaries are defined using the behaviour of the benthic invertebrate communities over a quantifiable organic enrichment gradient. Deviation from reference condition for each WFD ecological status class, was established by comparing the proportions of the AMBI taxa groups (Group I (sensitive) through to Group V (first order opportunistic taxa)) with the expected proportions of the groups defined in the expanded normative definitions.

Single samples will be collected once per year on a three –year cycle from matched habitats throughout the water body. (Enough samples in total must be taken to ensure the required degree of confidence in WFD assessment is achieved). All samples must be outside any Allowable Zone of Effect (AZE's) that exists for licenced impact areas in the water body. Where possible, it is recommended that samples are taken from stable, depositional sediments within the water body as we currently have the most information regarding these habitats for both the setting of ^{max} values for the metrics and defining the inherent variability of the systems.

Macrophytes (Macroalgae and Angiosperms)

In coastal and transitional waters, the macrophyte biological quality elements include the macroalgal and angiosperm communities. A series of tools have been developed for the monitoring and classification of these elements.

Macroalgae

Reduced Species List

Species richness has been shown to respond to changes in environmental conditions including nutrient enrichment and hydromorphological changes. The tool will include measures of the number of species present on a shore and the ecological status of these species. Changes in the numbers of species present or a shift to more opportunistic algae will indicate changes in the ecological status of the area. Due to the taxonomic complexity of macroalgal communities, a reduced list of taxa has been compiled for shore classification. Three to five sites in each waterbody will be monitored once every 3 years.

Opportunistic Algae

Certain species of algae respond to changes in the nutrient condition of a waterbody by producing large mats of algae overlying soft intertidal sediments. As well as being indicators of changes in the nutrient dynamics of a waterbody, these macroalgal blooms are a source of ecological disturbance themselves.

A tool has been developed to monitor the spatial extent and biomass of these opportunistic algal blooms in transitional and coastal waters, although such events are generally confined to soft-sediment filled transitional WBs. In areas where such events occur, or where suitable conditions for potential blooms exist, the biomass and spatial cover will be assessed annually.

Fucoid Extent

The distribution upstream of low-salinity tolerant marine algae has been shown to respond to certain environmental pressures, in particular stresses from toxic compounds. The geographical limit of Fucoid species towards the freshwater boundary in transitional waters will be used as a measure of ecological status in estuarine waterbodies. An EQR based on changes in the upstream extent for Fucoid algae has been proposed. This biological element will respond slowly to environmental pressures and as such only requires monitoring one year in the RBD cycle.

Angiosperms

Seagrass

Seagrass communities occur as intertidal and subtidal communities around the Irish coasts. For practical purposes only the intertidal beds will be assessed. Seagrass communities are known to respond to environmental pressures such as increased nutrient loading and physical disturbance. Responses are likely to include a reduction in species diversity and habitat extent. An EQR based on the taxonomic composition, spatial extent and bed density has been developed. Due to a paucity of baseline data, initial surveys will be on an annual basis, with surveys undertaken on a three-year cycle once background data has been accumulated.

Saltmarsh

Saltmarshes are a common element of transitional water bodies and coastal lagoons. This biological element is particularly susceptible to habitat loss through erosion. Erosion occurs under natural conditions but can be exacerbated by anthropogenic impacts arising from morphological pressures. Consequently, habitat extent has become a popular means of assessing saltmarsh health. Methods for assessing habitat extent for purposes of the WFD have been based on a simplified version of habitat mapping techniques. An EQR based on changes in habitat extent and biodiversity of beds has been developed. Depending on the size of the saltmarsh habitat in each water body monitoring will be undertaken at 1-3 locations on a three-year cycle.

Fish

Under the Water Framework Directive monitoring of fish communities is only required in transitional waters. The directive requires an assessment of species composition and abundance as well as an indication of the presence of sensitive species.

Development of analysis tools is based on examination of species composition in relation to the status of known pressures. Metrics include those based on such attributes as absolute and relative composition; on proportion of specific species; on contribution of specific functional groups.

In terms of sampling, the rationale will be to assess species composition over as wide a range of habitats and niches as possible. Sampling for fish is based on the multi-method approach developed by the UK's Environment Agency in pilot studies on the Thames estuary. The procedure involves use of a series of netting techniques to develop an appraisal of the fish community over a range of habitats, including littoral and open-water areas.

The mobility of fish, in comparison with the fixed nature of benthic invertebrates and of fucoids and angiosperms, produces additional difficulties in sampling for status assessment. It may be necessary to sample a greater number of stations within a transitional waterbody. It may also be necessary to sample across a broad range of niches in order to more fully establish the community composition. This may create difficulties in developing a 'consistent' site selection procedure.

Sampling frequency will be once per year in autumn and for most water bodies this will take place on a 3-year cycle.

Phytoplankton

The Water Framework Directive states that for phytoplankton the composition, abundance and biomass of phytoplankton taxa **and** the frequency and intensity of phytoplankton blooms needs to be considered when assessing status.

Metrics are based on assessing phytoplankton biomass (as measured using chlorophyll) and frequency, composition and intensity of phytoplankton blooms. The biomass metric works by quantifying the level of chlorophyll present in a water body over a 5-year period. This is achieved by comparing the value of the 90th percentile and median over a 5-year period against reference based classification boundaries. The second metric works by recording the number of events, defined as occasions when values based on individual phytoplankton species cell numbers, exceed a predefined threshold over the period of the monitoring programme.

Sampling frequency is monthly over the entire year and should take place on an annual basis. For operational monitoring monthly sampling can be restricted to the seasonal growth period (March – September).

4.2.9 Physico-chemical elements

Standard bottle-sampling supplemented by vertical profiling CTD (conductivity, temperature, depth) instruments 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 (automatic water samplers may also be used for high frequency (weekly or monthly) phytoplankton sampling). 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 to transitional waters.

Continuous electronic monitoring of parameters such as salinity, turbidity, temperature, chlorophyll fluorescence and dissolved oxygen with telemetry to public

websites will supplement the surveillance monitoring programme (although this will be more important in the operational monitoring programme).

4.2.10 Priority Substances

Priority substances (Annex X) to be sampled 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).

4.2.11 Hydromorphology

The hydromorphology quality element for transitional and coastal waters comprises three components, tidal regime, river flow and morphological conditions.

Tidal regime can be monitored on a national basis by a series of tide gauges located around the coast and overseen by the Marine Institute. Criteria for evaluating status have yet to be determined.

High precision, high frequency river flow 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.

Morphological conditions are described in the directive as the depth variation, structure and substrate of the seabed and condition of the intertidal zones. In light of these assessment criteria, a research project, under the auspices of the Programmes of Measures Working Group, is currently underway in order to establish which morphological indicators might best describe the conditions in coastal and transitional monitoring programmes and respond to the pressures that might act specifically on the morphology of a water body, e.g., dredging (fishing, channelisation), or coastal defenses. In addition, the project will define the relationship between morphology characteristics and biological status and develop a decision support tool for regulators to assess the potential impact of future developments on individual water bodies (i.e. to prioritise activities and establish a tiered assessment system).

4.3 Coastal and Transitional Waters Operational Monitoring Network

For the operational monitoring programme a selection or subnet was made of representative water bodies from those identified as being ‘at risk’ or ‘probably at risk’ of failing to meet their environmental objectives. This selection was further divided into 3 additional subnets for the purposes of assessing the effectiveness of measures to address impacts arising from point, diffuse and hydromorphological pressures, as well as measures to maintain good and high status sites.

These are described in greater detail below and lists of water bodies and number of monitoring sites are given in the appendices to this programme.

Operational Monitoring (OM) Network

The operational programme for transitional and coastal waters has 5 subnets consisting of 80 water bodies. This total is comprised of 57 transitional and 23 coastal water bodies.

4.3.1 OM Subnet 1: Monitoring to establish status of at risk water bodies

Aim of Subnet: Monitoring to establish *the status of those bodies identified as being at risk of failing to meet their environmental objectives.*

Subnet Size: This subnet includes 62 water bodies selected for operational monitoring and is considered to be representative in terms of type and pressures of all the water bodies that have been identified as being ‘at risk’ or ‘probably at risk’. This total is comprised of 49 transitional and 13 coastal water bodies (see Appendix 2).

Location of Monitoring Points: The location of these water bodies is given in Appendix 24.2

4.3.2 OM Subnet 2: Monitoring of Effectiveness of Diffuse and Point Source Pollution Measures –

Aim of Subnet: To assess effectiveness of diffuse and point source pollution control measures.

While the measures needed to reduce diffuse and point source pollution are likely to be different they are combined in this subnet because in most cases the approach in terms of monitoring and assessment will be similar. This is particularly the case in urbanised transitional waters where tidal action and the presence of multiple point sources such as industrial and wastewater treatment plant discharges can make it difficult to identify the most relevant pressures. In

this situation multiple representative sites located less specifically will be used to assess the overall status of the water body.

In some cases, particularly where the source of the pressure/impact is well defined, the approach will be different and will involve monitoring in the vicinity of the pressure but outside the identifiable zone of impact. This approach should be appropriate for activities such as aquaculture, dredging and spoil disposal

Subnet Size: This subnet has 45 water bodies with 40 of those being transitional and the remaining 5 coastal.

Location of Monitoring Points:

The location of water bodies within this subnet are shown in Appendix

2. Currently not all Irish tidal water bodies 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 water bodies subject to diffuse pollution are outlined in Appendix 4.2.

4.3.3 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 the most important source of risk to transitional and coastal water status identified in the Article 5 Characterisation Report published in December 2004. Approximately 1 in 3 transitional water bodies and 1 in 5 coastal water bodies were placed ‘at risk’ or ‘probably at risk’. In total 43 water bodies are included in this subnet, with 33 being transitional and 10 being coastal. This represents over 50% of the total number of water bodies in the operational monitoring network, reflecting the importance of hydromorphological pressures as a source of risk.

Location of Monitoring Points:

The location of monitoring points within this subnet are shown in Appendix

3. As with the diffuse pollution monitoring some aggregation is required in order to provide effective monitoring of measures for hydromorphological pressure. The rules for aggregation of waterbodies subject to hydromorphological pressure are also outlined in Appendix 3.

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

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

Subnet Size: This subnet includes 8 transitional and 10 coastal water bodies.

Location of Monitoring Points: This subnet will include representative water bodies of high and good status transitional and coastal waters. Sites are given in Appendix 4.2.

4.3.5 OM Subnet 5: Electronic Alert and Remote Sensing Subnet

Aim of Subnet: To identify episodic pollution sources and associated impacts not captured by other subnets. Routine spot sampling does not always coincide and therefore capture pollution events that occur over short time-scales. Infrequent discharges of pollutants may be highly damaging to aquatic ecosystems but can be difficult to pinpoint in space and time using traditional spot sampling techniques. Where discharges are constant spot sampling is effective but many discharges are episodic and unpredictable in nature. Electronic alert networks of in-situ monitoring instruments – providing continuous measurement and telemetry of parameters such as salinity, turbidity, DO, etc. will be used to provide alerts to potential pollution sources or pollution incidents.

Size of subnet: This subnet will be introduced on a pilot basis and should link in with what has been suggested for the rivers and lake monitoring programmes.

Location of Monitoring Points: The most obvious advantage of using in situ monitoring devices over traditional methods is their ability to collect high frequency information that can be used to resolve the temporal variability of the parameter(s) being measured. However, it will also be necessary to assess the number of single point locations that will be required to resolve the spatial resolution of the water body or area being monitored. In areas that display high temporal variation but low spatial variation, a single point location may be adequate, whereas in areas that display both high temporal and spatial variability, a number of sites may be required. For example, a small to medium sized shallow lake that remains vertically mixed throughout the year, displaying relatively little spatial variation, may only require a single point location. In an estuary, however, where the level of spatial variation along the salinity gradient is high a number of sites may be needed, whereas in the adjacent coastal water, where the level of spatial variability is low, a single site may be adequate. This is one of the fundamental questions that should be addressed in any pilot programme.

As stated previously sufficient resources to enable the ongoing maintenance of such a network is a key to the success of this type of approach.

4.3.6 OM Subnet 6: Species and Habitat Protected Areas

Aim of Subnet: To monitor Species and Habitat Protected Areas that are at risk of failing to meet their specific environmental objectives.

Size of Subnet: A total of 59 water bodies, or just over 70% of all water bodies in the operational network are included in this subnet. This includes 12 coastal water bodies and 47 transitional water bodies. See Appendix 3 for initial coastal and transitional water bodies included in this subnet. (the numbers given here need to be confirmed).

Location of Monitoring Points: See Appendix 4.2 for location of monitoring points.

4.3.7 Quality Element, Site Selection and Sampling Frequency for the Operational Monitoring Programme

The selection of the most appropriate quality elements for the operational programme was based on expert knowledge, the outcome of classification tool development, and guidance provided by the United Kingdom-Republic of Ireland Marine Task Team. This exercise has helped to identify the elements most sensitive to the relevant pressures (see Table 4.2).

Expert judgement was also used to supplement the risk assessment approach in the selection of site numbers particularly for transitional and coastal lagoons.

It was decided to include most of the biological quality elements in water bodies requiring measures for the protection of high/good status (see subnet 4 above).

4.3.8 Biological elements for Coastal and Transitional Waters

A comprehensive overview of each biological element has been given in section 4.2.8.

4.4.1 Summary of the Operational and Surveillance Monitoring programmes.

A summary of the operational and surveillance monitoring programmes for coastal and transitional waters is shown in Table 4.3. A total of 117 water bodies are included. Of these, 82 are transitional and 35 coastal. Of the transitional water bodies, 57 are included in the operational programme and 25 in the surveillance programme, for coastal water bodies, 23 are operational and 12 are surveillance. The number of monitoring sites and sampling frequency for each quality element in both programmes and water categories is also shown in Table 4.3.

The combined operational and surveillance monitoring programmes, which includes 117 water bodies, represents approximately 40% of the total number of water bodies that were originally considered for inclusion.

Table 4.2 Sensitivity of quality elements (and associated metrics) to pressures

Biological Element	Pressure biological element responds to:
BENTHIC	
MACROINVERTEBRATES	
Soft sediment multi-metric	Hazardous substances, TBT, organic enrichment, dredging, aggregates extraction, spoil disposal
Sensitive species/megafauna tool (To be Developed)	Commercial fishing & shellfish
Hard substrate tool	TBT, disposal
MACROALGAE	
Opportunistic species tool	Nutrient enrichment
Reduced species list	Nutrient enrichment, disposal, hydromorphological change
Fucoid extent (TW only)	Hazardous substances
SEAGRASS	
Intertidal spatial extent, density and diversity	Hydromorphology and nutrient enrichment
SALTMARSH	
Spatial extent	Hydromorphology
PHYTOPLANKTON	
Bloom frequency, composition and biomass	Nutrient enrichment
FISH	
Transitional multi-metric	Ammonia, hazardous substances, catchment abstraction, fishing, shellfish, landclaim, shoreline, barrages (TBD), weirs/sluices (TBD)
Transitional multi-metric with increased summer sampling	Organic enrichment, catchment abstraction
PHYSICO-CHEMICAL	
Nutrients	Nutrient enrichment, Industrial abstraction, catchment abstraction
Dissolved oxygen	Nutrient and organic enrichment
Temperature	Industrial abstraction/discharges
Transparency/Turbidity	Nutrient enrichment
Salinity (monitored with DO & temp)	Catchment abstraction and hydromorphological change
HYDROMORPHOLOGICAL	
Exposure	Landclaim, shoreline
Freshwater flow	Industrial abstraction, catchment abstraction, barrages, weirs/sluices
Currents	Landclaim, shoreline
Depth, substrate, structure & condition of intertidal	Landclaim, shoreline, dredging, aggregate, disposal, barrages, weirs/sluices, fishing, shellfish, alien species (chinese mitten crab only)
Depth, substrate, structure of coastal bed	Landclaim, shoreline, dredging, aggregate, disposal, weirs/sluices, fishing, shellfish
DANGEROUS SUBSTANCES	
Priority Substances	Industrial sites, domestic, transport, run-off, discharges, agricultural, landfill
Relevant Pollutants	Industrial sites, domestic, transport, run-off, discharges, agricultural, landfill

Table 4.3 Summary of Coastal and Transitional Waters Monitoring programme

a) Transitional Waters

Quality Element	Phytoplankton	Macroalgae	Angiosperms	Benthic Invertebrates	Hydromorphology	Physio-chemical	Relevant Pollutants	Priority Substances	Fish
57 Operational Water Bodies									
Total number of Operational Sites	53	42	30	74	38	191	13	13	TBC
Number of sites required:									
On an annual cycle	53 (12)	-	-	-	-	191 (4)	13 (4)	13 (12)	TBC
On a 3-year cycle	-	14 (1)	10 (1)	25 (1)	-	-	4 (4)	4 (12)	TBC
On a 6-year cycle	-	-	-	-	6	-	-	-	TBC
25 Surveillance Water Bodies									
Total number of Surveillance Sites	27	28	45	36	22	61	23	23	TBC
Number of sites required:									
On an annual cycle	27 (12)	-	-	-	-	61 (4)	-	-	TBC
On a 3-year cycle	9 (12)	9 (1)	15 (1)	12 (1)	-	-	-	-	TBC
On a 6-year cycle	-	-	-	-	4	-	4 (4)	4 (12)	TBC

b) Coastal Waters

Quality Element	Phytoplankton	Macroalgae	Angiosperms	Benthic Invertebrates	Hydromorphology	Physio-chemical	Relevant Pollutants	Priority Substances	Fish
23 Operational Water Bodies									
Total number of Operational Sites	16	41	26	96	10	92	1	0	NR
Number of sites required:									
On an annual cycle	16 (12)	-	-	-	-	92 (4)	1 (4)	-	NR
On a 3-year cycle	-	14 (1)	9 (1)	32 (1)	-	-	-	-	NR
On a 6-year cycle	-	-	-	-	2	-	-	-	NR
12 Surveillance Water Bodies									
Total number of Surveillance Sites	21	44	23	53	12	48	12	12	NR
Number of sites required:									
On an annual cycle	21 (12)	-	-	-	-	48 (4)	-	-	NR
On a 3-year cycle	7 (12)	15 (1)	8 (1)	18 (1)	-	-	-	-	NR
On a 6-year cycle	-	-	-	-	2	-	2 (4)	2 (12)	NR

Appendix 4.1

Location and number of water bodies in each of the surveillance monitoring subnets.

(Subnet 1; representative, Subnet 2; long-term trend analysis (a) natural, (b) anthropogenic, Subnet 3; validating and supplemented the risk assessment, and Subnet 4; stipulated sites)

(i) Transitional Water Bodies

Water body	RBD	TYPE	Overall 'Risk' Status	Subnet 1	Subnet 2 (a)	Subnet 2 (b)	Subnet 3	Subnet 4
Boyne Estuary	EARBD	TW2	1a					
Newry Estuary	NBIRBD	TW2	1a					
Erne Estuary	NWIRBD	TW2	1b					
Gweebarra Estuary	NWIRBD	TW2	2b					
Foyle and Faughan Estuaries	NWIRBD	TW2	1a					
Barrow Nore Estuary Upper	SERBD	TW2	1a					
Upper Barrow Estuary	SERBD	TW2	1a					
Nore Estuary	SERBD	TW2	1b					
Lower Suir Estuary	SERBD	TW2	1a					
New Ross Port	SERBD	TW2	1a					
Barrow Suir Nore Estuary	SERBD	TW2	1b					
Lough Gill	SHIRBD	TW6	2a					
Limerick Dock	SHIRBD	TW2	1a					
Upper Shannon Estuary	SHIRBD	TW2	1a					
Fergus Estuary	SHIRBD	TW2	1a					
Lower Shannon Estuary	SHIRBD	TW2	1a					
Drongawn Lough, Sneem	SWRBD	TW6	1b					
Castlemaine Harbour	SWRBD	TW2	1b					
Cromane	SWRBD	TW2	1b					
Loch an tSaile, Mannin Bay	WERBD	TW6	2b					
Murree Lough	WERBD	TW6	2b					
Loch an Aibhinn, Camus Bay	WERBD	TW6	2b					
Kinvarra Bay	WERBD	TW2	1b					
Ballysadare Estuary	WERBD	TW2	1b					
Camus Bay	WERBD	TW2	2a					
Total in each subnet				25	4	21	25	3

(ii) Coastal Water Bodies

Water body	RBD	Type	Overall 'Risk' Status	Subnet 1	Subnet 2 (a)	Subnet 2 (b)	Subnet 3	Subnet 4
Dublin Bay	EARBD	CW5	1a					
Carlingford Lough	NBIRBD	CW8	1b					
Gweebarra Bay	NWIRBD	CW5	2b					
Lough Foyle	NWIRBD	CW8	1b					
NW Atlantic SB (HAs 37;38)	NWIRBD	CW2	2b					
Waterford Harbour	SERBD	CW2	2a					
Cork Harbour	SWRBD	CW8	1a					
Outer Kenmare River	SWRBD	CW2	1b					
Roaring Water Bay	SWRBD	CW2	2b					
Ballysadare Bay	WERBD	CW8	2b					
Sligo Bay	WERBD	CW5	2a					
Kilkieran Bay	WERBD	CW5	2a					
Total in each subnet				12	8	5	12	2

Appendix 4.2

Location and number of water bodies in each of the operational monitoring subnets.

(Subnet 1; at risk or probably at risk, Subnet 2; point and diffuse measures, Subnet 3; hydromorphological measures, Subnet 4; high and good status, Subnet 5; alert and remote sensing (To be decided), and Subnet 6; protected areas.

(i) Transitional Water Bodies

Water body	RBD	Overall TYPE 'Risk'	Overall Status					
			Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 5	Subnet 6
Rogerstown Estuary	EARBD	TW2 1b						
Broadmeadow Water	EARBD	TW6 1a						
Avoca Estuary	EARBD	TW2 1a						
Broad Lough	EARBD	TW2 1a						
Liffey Estuary Lower	EARBD	TW2 1a						
Liffey Estuary Upper	EARBD	TW2 1a						
Tolka Estuary	EARBD	TW2 1a						
Castletown Estuary	NBIRBD	TW2 1a						
Inner Dundalk Bay	NBIRBD	TW2 1a						
Inch Lough	NWIRBD	TW6 1b						
Swilly Estuary	NWIRBD	TW2 1b						
Durnesh Lough	NWIRBD	TW6 2b						
Inner Donegal Bay	NWIRBD	TW2 2a						
North Slob Channels	SERBD	TW6 1b						
Tacumshin Lake	SERBD	TW6 1b						
Bridgetown Estuary	SERBD	TW2 1b						
Lower Slaney Estuary	SERBD	TW2 1a						
Middle Suir Estuary	SERBD	TW2 1a						
Lady's Island Lake	SERBD	TW6 1b						
Colligan Estuary	SERBD	TW2 1b						
Upper Slaney Estuary	SERBD	TW2 1a						
Upper Suir Estuary	SERBD	TW2 1a						
Lee K Estuary	SHIRBD	TW2 1a						
Shannon Airport Lagoon	SHIRBD	TW6 1a						
Cashen	SHIRBD	TW2 1a						
Maigue Estuary	SHIRBD	TW2 1a						
Upper Feale Estuary	SHIRBD	TW2 1a						
Lough Donnell	SHIRBD	TW6 1a						
Deel Estuary	SHIRBD	TW2 1a						
Glashaboy Estuary	SWRBD	TW2 1a						
Lough Mahon	SWRBD	TW2 1a						
(Harper's Island), L.								
Mahon	SWRBD	TW2 1a						
Owenacurra Estuary	SWRBD	TW2 1a						
Lee (Cork) Estuary Lower	SWRBD	TW2 1a						
Lee (Cork) Estuary Upper	SWRBD	TW2 1a						
Lower Bandon Estuary	SWRBD	TW2 1a						
Lower Blackwater Estuary	SWRBD	TW2 1a						
Inner Kenmare River	SWRBD	TW2 2b						
Kilkeran Lake	SWRBD	TW6 2a						
Kilmakilloge Harbour	SWRBD	TW2 2a						
Argideen Estuary	SWRBD	TW2 1b						
Ilen Estuary	SWRBD	TW2 1b						
North Channel	Great							
Island	SWRBD	TW2 1a						

Appendix 4.2 continued

Upper Bandon Estuary	SWRBD	TW2	1a						
Upper Blackwater Estuary	SWRBD	TW2	1a						
Sruwaddacon Bay	WERBD	TW2	1b						
Tullaghan Bay	WERBD	TW2	1b						
Corrib Estuary	WERBD	TW2	1a						
Garavoge Estuary	WERBD	TW2	1a						
Bridge L., Knockakilleen	WERBD	TW6	2b						
Loch Tanai	WERBD	TW6	2b						
Loch an tSaile	WERBD	TW6	2a						
Furnace Lough	WERBD	TW6	1b						
Newport Bay	WERBD	TW2	1b						
Westport Bay	WERBD	TW2	1b						
Erriff Estuary	WERBD	TW2	1a						
Moy Estuary	WERBD	TW2	1a						
Total in each subnet				49	33	33	8	0	47

(ii) Coastal Water Bodies

Water body	RBD	TYPE	Overall 'Risk' Status						
				Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 5	Subnet 6
Boyne Estuary Plume Zone	EARBD	CW5	1a						
Irish Sea - Killiney Bay	EARBD	CW5	1a						
Northwestern Irish Sea	EARBD	CW5	2a						
Malahide Bay	EARBD	CW8	1a						
Outer Dundalk Bay	NBIRBD	CW5	1b						
Killybegs Harbour	NWIRBD	CW8	1a						
Mulroy Bay Broadwater	NWIRBD	CW8	1b						
Lough Swilly	NWIRBD	CW5	1b						
Southwestern Irish Sea	SERBD	CW5	1b						
Wexford Harbour	SERBD	CW8	1b						
Tramore Back Strand	SERBD	CW8	1b						
Dungarvan Harbour	SERBD	CW5	1b						
Inner Tralee Bay	SHIRBD	CW8	1a						
Mouth of Shannon	SHIRBD	CW2	2a						
Youghal Bay	SWRBD	CW5	2b						
Outer Cork Harbour	SWRBD	CW5	2b						
Kinsale Harbour	SWRBD	CW5	2b						
Berehaven	SWRBD	CW5	2b						
Portmagee Channel	SWRBD	CW8	2b						
Sligo Harbour	WERBD	CW8	1a						
Inner Galway Bay North	WERBD	CW5	2a						
Killary Harbour	WERBD	CW5	2a						
Inner Clew Bay	WERBD	CW5	2a						
Total in each subnet				13	1	10	10		12