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**VOLKSGEZONDHEID,
VEILIGHEID VAN DE VOEDSELKETEN
EN LEEFMILIEU**

Directoraat-generaal Leefmilieu
Mariene milieu

MONITORING PROGRAMME FOR THE BELGIAN COASTAL WATERS

REPORTING ACCORDING TO ARTICLE 8
of the Water Framework Directive (2000/60/EC) of 23 October 2000

INTRODUCTION

The monitoring obligations of the Water Framework Directive were summarized in article 8:

1. *Member States shall ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each river basin district.*
    - *for surface waters such programmes shall cover:*
        i. *the volume and level or rate of flow to the extent relevant for ecological and chemical status and ecological potential, and*
        ii. *the ecological and chemical status and ecological potential;*
    - *for ground waters such programmes shall cover monitoring of the chemical and quantitative status,*
    - *for protected areas the above programmes shall be supplemented by those specifications contained in Community legislation under which the individual protected areas have been established.*
2. *These programmes shall be operational at the latest six years after the data of entry into force of this Directive unless otherwise specified in the legislation concerned. Such monitoring shall be in accordance with the requirements of Annex V.*
3. *Technical specifications and standardised methods for analysis and monitoring of water status shall be laid down in accordance with the procedure laid down in Article 21.*

The Water Framework Directive (WFD) requires that the Member States have monitoring programmes for surface and ground waters operational on 22 December 2006. In accordance with article 15 of the WFD, a summary of the monitoring programmes has to be sent to the European Commission.

The WFD distinguishes three types of monitoring. Member States shall establish

- surveillance monitoring programmes to provide information for:
    - supplementing and validating the impact assessment procedure detailed in Annex II,
    - the efficient and effective design of future monitoring programmes,
    - the assessment of long-term changes in natural conditions, and
    - the assessment of long-term changes resulting from widespread anthropogenic activity.
- operational monitoring in order to:
    - establish the status of those bodies identified as being at risk of failing to meet their environmental objectives, and
    - assess any changes in the status of such bodies resulting from the programmes of measures.
- investigative monitoring:
    - where the reason for any exceedances is unknown,
    - where surveillance monitoring indicates that the objectives set out in 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.

In this report, the quality elements and the monitoring programmes for the Belgian coastal waters, defined by the Belgian Federal Government, will be described, which were formulated following the provision of article V of the WFD. The Belgian coastal waters are part of the surface waters.
The first part of the report describes the quality elements (with respect to sampling, analysis, standards, confidence, sampling frequency) that have to be monitored to determine the chemical and ecological status of the Belgian coastal waters. The second part of the report describes the surveillance and operational monitoring programmes and the monitoring sites for the Belgian coastal waters. The reporting structure of this paper version is consistent with the structure of the WFD article 8 digital WISE reporting. Belgium also reported the monitoring programmes using the WISE system.

Reporting level description:
Belgium is governed by various authorities (Federal state, communities, regions, provinces, municipalities), each with their own competences. The competences of the Federal State, the communities and the regions are laid down in the Belgian Constitution and the Special Law of 8 August 1980 on institutional reforms. Pursuant to this constitutional division of competences the three Regions (Flemish region, Walloon region and Brussels capital region) are fully competent for the implementation of the WFD regarding water policy (including drinking water policy), land development, nature conservation and public works and transport on their territory (on land) and the Federal State is fully competent for the implementation of the WFD on their territory (on sea) and for product regulation (and authorisations to put products on the market), protection against ionising radiation, including radioactive waste, the economic aspects of drinking water provision (i.e. the establishment of maximum prices and the approval of price increases) for the entire Belgian territory. The federal and regional competences are exclusive, equivalent material competences, without any hierarchy. A federal or regional legal norm has the same legal value.
The Belgian coastal zone belongs to the international Scheldt river basin district. This river basin district is governed by the Netherlands, France, the three Belgian regions and the Federal State Belgium. This means that there is a need for coordination between the different countries and regions. Coordination takes place in the International Scheldt Commission and is formalised in the Scheldt Treaty of Ghent 03/12/02, concluded by the three countries and the three Belgian regions (the regions are competent to sign and ratify treaties within their material competences).
A second agency for coordination at internal Belgian level (Federal state and regions) is CCIM (Coordination Committee International Environmental Policy). This is established by the "Cooperation agreement of 5 April 1995 between the Federal State, the Flemish Region, the Walloon Region and the Brussels Capital Region regarding international environmental policy". This cooperation agreement is legally binding for these authorities after being ratified by each authority by law, decree or ordinance. The secretary and presidency of the CCIM is being acted by the Federal State. The CCIM has established several technical working groups that are responsible for the coordination of specific environmental issues. Within this framework, the CCIM Steering Group Water (presided by the Flemish Region) is the consultative body that is in charge of the necessary coordination of the implementation of the Water Framework Directive between the different competent authorities in Belgium. Cf. article 1, 3° of the cooperation agreement: "the consultation in order to come to a coordinated execution of recommendations and decisions of international organisations".
The coordination at these two levels makes it possible to compare the used methods, confronting each other with each others actions and strive for coherence and comparability within the Scheldt river basin district.

A. QUALITY ELEMENTS

The biological, hydromorphological, chemical and physico-chemical quality elements relevant for the Belgian coastal waters are listed in table 1.

Quality Element Level 1	Quality Element Level 2	CW	Code
Biological Elements	Biological quality elements (e.g. those indicated in WFD Annex V) are determined	x	QE1
	Composition, abundance and biomass of phytoplankton	x	QE1-1
	Composition, abundance and diversity of benthic invertebrate fauna	x	QE1-3
Hydromorphological Elements	Hydromorphological quality elements (e.g. those indicated in WFD, Annex V) are determined	x	QE2
	Morphological conditions coastal waters – morpho-logical parameters (e.g. those indicated by Annex 5) are determined	x	QE2-6
	- Depth variation	x	QE2-6-1
	- Quantity, structure and substrate of the bed	x	QE2-6-2
	Tidal regime coastal waters – tidal parameters (e.g. those indicated by Annex 5) are determined	x	QE2-8
	- direction of dominant currents	x	QE2-8-1
	- wave exposure	x	QE2-8-2
Chemical and Physico-chemical Elements	Chemical and physico-chemical quality elements (e.g. those indicated in WFD, Annex V) are determined	x	QE3
	General parameters – parameters (e.g. those indicated by Annex 5) are determined	x	QE3-1
	- Transparency	x	QE3-1-1
	- Thermal Conditions	x	QE3-1-2
	- Oxygenation conditions	x	QE3-1-3
	- Salinity	x	QE3-1-4
	- Nutrient conditions	x	QE3-1-6
	Priority Substances (as indicated in Annex 10) are determined	x	QE3-2
	Non-priority specific pollutants (as indicated in Annex 8/9) are determined	x	QE3-3
	Other pollutants (e.g. other pollutants not covered by Annex 8,9 and 10) are determined	x	QE3-4

Table 1: The biological, hydromorphological, chemical and physico-chemical quality elements relevant for the Belgian coastal waters (CW = Coastal Waters).

1. Biological quality elements

1.1. Composition, abundance and biomass of phytoplankton (QE1-1)

The quality element phytoplankton is evaluated based on two metrics, chlorophyll a and *Phaeocystis* cell taxa counts. A third metric is not approved yet by Belgium, but the usefulness of the currently proposed metric Taxa Cell Counts will be evaluated based on the proposed monitoring or another method will be developed.
The metrics to evaluate the ecological status of the quality element phytoplankton are briefly outlined in the following paragraph.
- Metric 1: chlorophyll a concentration (90th Percentile) in order to measure the biomass of the phytoplankton. This metric is based on the location of the 90th percentile of chlorophyll a concentration against boundary thresholds set for the High/Good (10 µg/l) and Good/Moderate (15 µg/l) boundaries.
- Metric 2: Indicator Taxa: Frequency of *Phaeocystis* cell counts exceeding 10^6 cells/litre in order to measure abundance of nuisance species of phytoplankton. Classification of the ecological status is based on the number of sampling times where the *Phaeocystis* cell counts exceed a threshold (10^6 cells/litre) and is calculated as a percentage of the total number of monthly samples collected within one water type for the six-year period.
- Metric 3 (not approved yet): Taxa Cell Counts: Frequency of phytoplankton taxa cells counts above a predefined threshold. The metric is the frequency of blooms of any routinely identifiable phytoplankton taxa (Nanoplankton >2 – 20 µm and Microplankton >20 µm) over a defined threshold from monthly sampling and is calculated as a percentage of the total number of samples collected within one water type over a six-year period.

The sampling and analysis protocol for this quality element and its sub-metrics, the standards, the confidence of the analysis and the frequency methodology will be outlined in the next sections.

1.1.1. Sampling protocol

For metric 1, chlorophyll a concentration (90th percentile), water samples are taken with a Niskin bottle and filtered through glass-fibre filters via a filtration system and subsequently immediately frozen (-65°C). An extraction procedure with 90 % acetone is used to recover the extract to be analysed in the HPLC. The entire procedure for preliminary treatment (filtration and extraction) of the water samples for determination of the cholorophyll pigments is described in the standard operation procedure BMM LAB/SV 010 (a digital version can be asked for by contacting Wendy.Bonne@health.fgov.be).

For metric 2, taxa cell counts of *Phaeocystis*, phytoplankton samples are sampled with a plankton net and preserved with 1 % lugol-glutaraldehyde solution and stored at 4°C in the dark. The sampling protocol is still being developed in more detail in anticipation of a definitive developed standard protocol.

For metric 3, taxa cell counts, sampling protocol idem as for metric 2.

1.1.2. Analysis protocol

For metric 1, chlorophyll a concentration (90th percentile), the chlorophyll concentrations are measured in an extract with aceton with the method HPLC (High-performance liquid chromatography).
The pre-treatment of the water samples for determination of chlorophyll pigments is described in the standard operation procedure BMM LAB/SV 010. Standard instructions for the determination of chlorophyll pigments are given in the standard operation procedure BMM LAB/SV 021, and specific characteristics for the analysis of chlorophyll a in BMM LAB/AK021A. A digital version of these standard operation procedures can be asked for by contacting Wendy.Bonne@health.fgov.be.

For metric 2, taxa cell counts of *Phaeocystis*, the plankton samples are analysed under an inverted microscope according to the Utermöhl method. At least 400 cells are enumerated in each sample. Magnification is chosen according to cell or colony size: 40X or 100X for *Phaeocystis colonies*. This analysis protocol is still subject to changes if monitoring developments would require so.

For metric 3, taxa cell counts, the analysis protocol is the same as for metric 2 (Magnification 100X or 200X for diatoms).

1.1.3. Standards

For metric 1, chlorophyll a concentration (90th percentile): standard operation procedures mentioned above and NBN-EN-ISO/IEC 17025.

For metric 2, taxa cell counts Phaeocystis: prEN 15204 Water Quality – Guidance standard for routine analysis of phytoplankton abundance and composition using inverted microscopy (Utermöhl technique)

For metric 3, taxa cell counts: idem as for metric 2

1.1.4. Confidence

For metric 1; chlorophyll a concentration (90th percentile): The confidence of the method is described in the standard operation procedure BMM LAB/ak-021A (a digital version can be asked for by contacting Wendy.Bonne@health.fgov.be).

For metric 2, taxa cell counts *Phaeocystis*: not yet determined

For metric 3, taxa cell counts: not yet determined

1.1.5. Frequency methodology

The monitoring frequencies for the metrics of this quality element are determined based on the minimal frequency required by the WFD. A joint WFD-OSPAR monitoring programme has been designed.

For metric 1, chlorophyll a concentration (90th percentile): monthly during the growing season (March to October inclusive, length of growing season: 8 months). The definition of this frequency is based on the tool defined in the WFD intercalibration exercise that assumes that 6 years of chlorophyll data are available with monthly sampling.

For metric 2, taxa cell counts *Phaeocystis*: monthly sampling (12 sample events per year) will be performed, but in the growing season a variable amount of additional samples (6 in 2008) will be taken in order to sample as optimal as possible the peak of the bloom and to detect any potential improvement of the situation.

For metric 3, taxa cell counts: monthly sampling (12 sample events per year) will be performed, but in the growing season a variable amount of additional samples (6 in 2008) will be taken in order to try to sample as optimal as possible blooms and any changes.

1.2. Composition, abundance and diversity of benthic invertebrate fauna (QE1-3)

The quality element macrobenthos is evaluated based on the BEQI (Benthic Ecosystem Quality Index) – method that assesses four indicators that are sensitive to different types of stress and that can explain possible deviations. These parameters are density, biomass, number of species and species similarity. Therefore monitoring data are required on these four parameters of the macrobenthos. The method aims at evaluating the water body (ecosystem) as a whole, based on the biological quality of each distinguished habitat (within-habitat level). The overall indicator primarily aims at providing a signal that is capable of showing significant changes/deviations from a certain reference state. More detailed information about the benthos evaluation method can be found in the reports of the Netherlands Institute of Ecology (Van Hoey, G., Ysebaert, T., Herman, P., 2007. Update of the assessment of the Belgian coastal waters with level 3 of the BEQI (Benthic ecosystem quality index)-method. NIOO report 2007-04 and Van Hoey, G., Drent, J., Ysebaert, T., Herman, P., 2007. The Benthic Ecosystem Quality index (BEQI), intercalibration and assessment of Dutch coastal and transitional waters for the Water Framework Directive. NIOO report 2007-02). A digital version can be asked for by contacting Wendy.Bonne@health.fgov.be.

1.2.1. Sampling protocol

The composition, abundance, biomass and diversity of benthic invertebrate fauna are sampled by taking a Van Veen grab (0,1m²) deployed automatically from an oceanographic vessel.

1.2.2. Analysis protocol

The benthic samples are first preserved, then sieved on a 1mm sieve and preserved in a 8 % formaldehyde for analysis in the laboratory. After staining with Rose Bengal or eosine, macrobenthic organisms are picked out in the laboratory. Anthozoa, Oligochaeta and Nemertea are counted as groups and representatives of the Polychaeta, Mollusca, Archiannelida, Crustacea and Echinodermata are identified to species level (where possible) under a stereoscopic microscope.

1.2.3. Standards

A national or international standard is not readily available yet and in development at national level.

1.2.4. Confidence

The parameter results strongly depend on the sampling effort (sediment surface sampled). Therefore, the reference values for the parameters are calculated from permutations (KRW program, developed in FORTRAN) executed over increased sampling surfaces for each habitat and a minimum required total sampling surface is defined for reference values specification and status assessment for each habitat. This is taken into account for each monitoring event of a habitat in order to get enough data to reach a good confidence level for the assessment. Detailed information can be found in the reports of the Netherlands Institute of Ecology (Van Hoey, G., Ysebaert, T., Herman, P., 2007. Update of the assessment of the Belgian coastal waters with level 3 of the BEQI (Benthic ecosystem quality index)-method. NIOO report 2007-04 and Van Hoey, G., Drent, J., Ysebaert, T., Herman, P., 2007. The Benthic Ecosystem Quality index (BEQI), intercalibration and assessment of Dutch coastal and transitional waters for the Water Framework Directive. NIOO report 2007-02). A digital version can be asked for by contacting Wendy.Bonne@health.fgov.be.

1.2.5. Frequency methodology

The monitoring frequency is determined as once every year in autumn (September-October), in order to sample a stable mature population after the recruitment period in summer. This period has been selected as the most appropriate moment for long-term monitoring and has been maintained already since the seventies by several institutes. The intensity of the monitoring (amount of stations per year) depends on the programme (operational or surveillance). Sampling is performed each year in order to cover year-to-year variability and maintain continuity in monitoring experience and know-how.

2. Hydromorphological quality elements as support of the biological elements

2.1. Morphological parameters (QE2-6)

2.1.1. Depth variation (QE2-6-1)

The parameter depth variation is a supporting variable for the biological quality elements and therefore measured at every biological monitoring station at every sampling event (minimal 4 times a year).
Water depth at each sampling station is recorded *in situ* and standardized to the mean low water spring level (MLWS) using the M2 reduction model.
A national or international standard and confidence level for this quality element is not readily available.

2.1.2. Quantity, structure and substrate of the bed; structure of the intertidal zone (QE2-6-2)

The parameter structure and substrate of the sea bottom is measured at every biological monitoring station for macrobenthos at every sampling event and surveyed by determining the sediment composition of the sea bottom. Therefore, at each macrobenthos sampling event a sediment sample is gathered by taking a sub-sample with a small corer out of the Van Veen grab. This sample is dried at 60°C and sieved on a 1.6 mm sieve, the residu is analysed with a

laser diffraction particle size analyzer. Median grain-size, mud content and sorting are determined as the most important parameters. Sediment classification is defined according to the Wenthworth scale.

A national or international standard and confidence level for this quality element is not readily available and in discussion at national level.

The monitoring frequency of this element depends on the frequency defined for the macrobenthos quality element, because it is a supporting variable for this parameter.

2.2. Tidal regime (QE2-8)

2.2.1. Direction of dominant currents (QE2-8-1) and wave exposure (QE2-8-2)

The parameters direction of the dominant currents and wave exposure are continuously monitored by the 'Meetnet Vlaamse banken' (Monitoring Network Flemish Banks of Afdeling Kust (Division Coast) of the Agentschap voor Maritieme Dienstverlening en Kust (Agency for maritime services and coast), Flemish Government). This information will be used to evaluate these hydrological quality elements.
An additional tool for a description of the dominant currents and waves are the models developed by MUMM (Management Unit of the North Sea Mathematical Models). For the estimation of sediment transport and for the validation of these models (in addition to the data of the 'Meetnet Vlaamse Banken') current velocity and direction is monitored by current meters and an ADCP (Acoustic Doppler Current Profiler) about 6 times a year during a tide and about 4 deployments on the sea bottom are realised with a tripode equipped with measuring devices.

A national or international standard and confidence level for this quality element is not readily available.

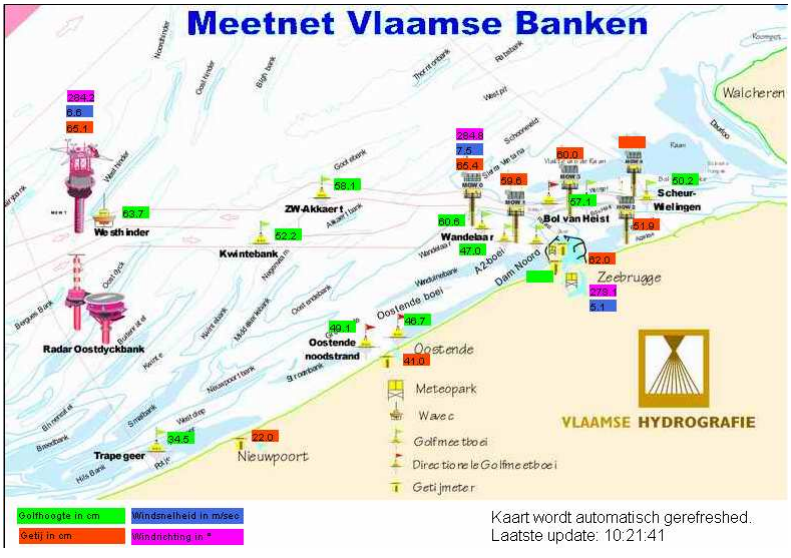

Figure 1: Measurement locations of the monitoring network 'Meetnet Vlaamse Banken' in the Belgian part of the North Sea

3. Chemical and physico-chemical quality elements as support of the biological elements

3.1. General parameters (QE3-1)

Oceanographic, meteorological, navigation and other relevant data are collected on a continuous basis by the measurement devices onboard the oceanographic vessel and linked to an oceanographic data acquisition system.

3.1.1. Turbidity (QE3-1-1)

The turbidity is measured upon arrival at the sampling location at a water depth of 3 m and by means of a CTD-cast (conductivity, temperature and depth cast) as a vertical profile with an optical backscatter sensor connected to a Seacat. The measurement at 3 m water depth registers the oceanographic parameters of the water mass at 3 m water depth, where chemical and biological water samples are taken. The vertical profile gives an overview of the vertical situation in the water column at the sample location as background information.

A national or international standard and confidence level for this quality element is not readily available.

This parameter is a supporting variable for the biological quality elements and therefore measured at every biological monitoring station at every sampling event in the case a SeaCat CTD-cast can be performed (minimal 4 times a year).

3.1.2. Thermal conditions (QE3-1-2)

The temperature is measured at a water depth of 3 m and by means of a CTD-cast (conductivity, temperature and depth cast) as a vertical profile with a Seacat upon arrival at the sampling location. The measurement at 3 m water depth registers the temperature of the water mass where the chemical and biological samples are taken. The vertical profile gives an overview of the vertical situation in the water column at the sample location as background information.

A national or international standard and confidence level for this quality element is not readily available.

Temperature is a supporting variable for the biological quality elements and therefore measured at every monitoring station at every sampling event. The measurement is performed by a CTD-cast in the case a SeaCat is available (minimal 4 times a year). In addition to and in case no CTD profiles are performed, temperature data are collected on a continuous basis by the onboard measurement devices (Thermosalinograph) linked to an oceanographic data acquisition system.

3.1.3. Oxygenation conditions (QE3-1-3)

The oxygen concentration is measured at a depth of 3 m and by means of a CTD-cast (conductivity, temperature and depth cast) as a vertical profile with a Seacat upon arrival at the sampling location. The measurement at 3 m water depth registers the oceanographic parameters of the water mass where chemical and biological water samples are taken. The vertical profile gives an overview of the vertical situation in the water column at the sample location as background information.

A national or international standard and confidence level for this quality element is not readily available.

Oxygenation condition is a supporting variable for the biological quality elements and therefore measured at every monitoring station at every sampling event in the case a SeaCat CTD-cast can be performed (minimal 4 times a year).

3.1.4. Salinity (QE3-1-4)

3.1.4.1. Sampling protocol

The salinity is measured at a depth of 3 m and by means of a CTD-cast (as a vertical profile) with a Seacat upon arrival at the sampling location. The measurement at 3 m water depth registers the salinity of the water mass where chemical and biological water samples are taken. The vertical profile gives an overview of the vertical situation in the water column at the sample location as background information. Upon arrival at the sampling location, a water sampling is taken for determination of salinity in seawater by means of conductivity measurements in the laboratory. This sample serves for the calibration of salinity measurements by the Seacat and the onboard measurement devices (Thermosalinograph) during every sampling event at every sampling campaign.

3.1.4.2. Analysis protocol

The sample for the calibration of salinity measurements is analysed in the laboratory. The document BMM LAB/SV018 describes the procedure for the determination of salinity in seawater by means of conductivity measurements in the laboratory using a Salinometer. The salinity is calculated from conductivity and temperature of the sample by means of an algorithm according to the Practical Salinity Scale 1978 (PSS78). The document BMM LAB/AK018 further describes the characteristics of the analysis. A digital version of the documents BMM LAB/SV018 and BMM LAB/AK018 can be asked for by contacting Wendy.Bonne@health.fgov.be.

3.1.4.3. Standards and confidence

The standard NBN-EN-ISO/IEC 17025 is followed. A confidence level for this quality element is described in the standard operation procedure BMM LAB/AK018.
A handbook on safety is also used in the laboratory. Standard instructions for sampling, rinsing of recipients, pre-treatment of samples, inscription and preservation of samples are also described in standard instruction documents (SI BMM LAB/IO23, SI BMM LAB/IO24.A, SI BMM LAB/IO24.B and SI BMM LAB/IO24.C).

3.1.4.4. Frequency methodology

As a supporting variable for the biological quality elements salinity is measured at every monitoring station at every sampling event. The measurement is performed by a CTD-cast in the case a SeaCat is available (minimal 4 times a year). In addition to and in case no CTD profiles are performed, salinity data are collected on a continuous basis by the onboard measurement devices (Thermosalinograph) linked to an oceanographic data acquisition system.

3.1.5. Nutrient conditions (QE3-1-6)

3.1.5.1. Sampling protocol

For the determination of the nutrient conditions total nitrogen (TN), total phosphorus (TP), dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) in seawater, water samples are taken with a 5l Niskin bottle at a standard water depth of 3 m.

3.1.5.2. Analysis protocol

The filtered water sample for determining the nutrient concentrations is analysed with a continuous flow system. The analysis is based on a chemical reaction, which leads to a specific colouring for the different nutrients. The colour depth gives an estimate of the amount of nutrient in the sample. The concentration of dissolved inorganic nitrogen is the sum of nitrite, nitrate and ammonium in seawater. Details of the methodology are given in the following standard operation procedures:

- Laboratory analysis of nitrite and nitrate in seawater: BMM LAB/SV011 (standard instructions) and BMM LAB/AK011 (characteristics of the analysis)
- Laboratory analysis of ammonium in seawater: BMM LAB/SV014 (standard instructions)
- BMM LAB/AK014 (characteristics of the analysis)
- Laboratory analysis of total nitrogen in seawater: BMM LAB/SV 035 (standard instructions) and BMM LAB/AK035 (characteristics of the analysis)
- Laboratory analysis of phosphate (P-o-PO4) in seawater: BMM LAB/SV013 (standard instructions) and BMM LAB/AK013 (characteristics of the analysis)
- Laboratory analysis of total phosphate in seawater: BMM LAB/SV 036 (standard instructions) and BMM LAB/AK036 (characteristics of the analysis)

A digital version of these documents can be asked for by contacting Wendy.Bonne@health.fgov.be.

3.1.5.3. Standards + Confidence

Details about the standards and confidence can be found in the standard operation procedures listed in the section analysis protocol. All these standards follow the standard NBN-EN-IS0/IEC 17025. A handbook on safety is also used in the laboratory. Standard instructions for sampling, rinsing of recipients, pre-treatment of samples, inscription and preservation of samples are also described in standard instruction documents (SI BMM LAB/IO23, SI BMM LAB/IO24.A, SI BMM LAB/IO24.B and SI BMM LAB/IO24.C).

3.1.5.4. Frequency methodology

The nutrient conditions in the Belgian marine waters are monitored in the context of the OSPAR-CEMP monitoring (2 times in winter per year) in the Belgian part of the North Sea and extended to 4 times a year in the coastal zone (<1 mile).

3.2. Priority Substances (QE3-2)

3.2.1. Sampling protocol

An overview of the priority substances taken into account for the measurements of the chemical status within the Water Framework Directive is given in table 2. Hydrofobic substances are also measured in the sediment, according to the monitoring of hazardous substances in OSPAR.

N°	Name of substance	CAS number	Group	Matrix			Remarks
				Water	Sediment	Biota	
PART A Proposal							
1	Alachlor	15972-60-8	OCP	X	X		from 2008 onwards also in sediment
2	Anthracene	120-12-7	PAH	X			
3	Atrazine	1912-24-9	POL PEST	X			
4	Benzene	71-43-2	VOC	X			
5	Penta Brominated diphenylether	32534-81-9	PBDE	X	X		
6	Cadmium and its compounds (often hardness related)	7440-43-9	H MET	X			
7	Chloroalkanes, C10-13	85535-84-8	CL ALK	X			
8	Chlorfenvinphos	470-90-6	OPP	X			
9	Chlorpyrifos	2921-88-2	OPP	X			
10	1,2-Dichloroethane	107-06-2	VOC	X			
11	Dichloromethane	75-09-2	VOC	X			
12	Di(2-ethylhexyl)phthalate (DEHP)	117-81-7	PHTAL	X			
13	Diuron	330-54-1	POL PEST	X			
14	Endosulfan	115-29-7	OCP	X	X		from 2008 onwards also in sediment
15	Fluoranthene	206-44-0	PAH	X	X		
16	Hexachlorobenzene	118-74-1	OCP		X	X	
17	Hexachlorobutadiene	87-68-3	VOC		X	X	from 2008 onwards also in sediment
18	(γ)Hexachlorocyclohexane (lindane)	608-73-1	OCP	X	X		
19	Isoproturon	34123-59-6	POL PEST	X			
20	Lead and its compounds	7439-92-1	H MET	X			
21	Mercury and its compounds	7439-97-6	H MET			X	
22	Naphthalene	91-20-3	PAH	X	X		
23	Nickel and its compounds	7440-02-0	H MET	X			
24	Nonylphenol (4-Nonylphenol)	25154-52-3	PHENOL	X			
25	Octylphenol ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	1806-26-4	PHENOL	X			
26	Pentachlorobenzene	608-93-5	OCP	X	X		from 2008 onwards also in sediment
27	Pentachlorophenol	87-86-5	PHENOL	X			

N°	Name of substance	CAS number	Group	Matrix			Remarks
				Water	Sediment	Biota	
PART A Proposal							
28	Polyaromatic hydrocarbons		PAH	X	X		
	(Benzo(a)pyrene)	50-32-8	PAH	X			
	(Benzo(b)fluoranthene)	205-99-2	PAH	X			
	(Benzo(k)fluoranthene)	207-08-9	PAH	X			
	(Benzo(g,h,i)perylene)	191-24-2	PAH	X			
	(Indeno(1,2,3-cd)pyrene)	193-39-5	PAH	X			
29	Simazine	122-34-9	POL PEST	X			
30	Tributyltin compounds	688-73-3	OTIN	X	X		
31	Trichlorobenzenes	12002-48-1	VOC	X			
32	Trichloromethane (chloroform)	67-66-3	VOC	X			
33	Trifluralin	1582-09-8	POL PEST	X			
PART B Proposal							
1	DDT total			X	X		
2	para-para-DDT	50-29-3	OCP	X	X		
3	Aldrin	309-00-2	OCP	X	X		
4	Dieldrin	60-57-1	OCP	X	X		
5	Endrin	72-20-8	OCP	X	X		
6	Isodrin	465-73-6	OCP	X			
7	Carbontetrachloride	56-23-5	OCP	X			
8	Tetrachloroethylene	127-18-4	VOC	X			
9	Trichloroethylene	79-01-6	VOC	X			

Table 2: Priority substances from the proposal for a Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC

The priority substances are sampled on a standardised way.
Water samples for chemical analysis are taken with Teflon-coated Go-Flo bottles (10L) at a water depth of 3 m. Samples for supporting inorganic parameters are taken with a 5l Niskin bottle at the same water depth. Water sampling is followed by sediment sampling with a Van Veen Grab. Apart from the STD profiles, oceanographic, meteorological, navigation and other relevant data is collected on a continuous basis by the onboard measurement devices linked to an oceanographic data acquisition system.

3.2.2. Analysis protocol

The extraction method and analytical approach depend on the chemical characteristics of a specific group of organic compounds, to which a specific substance belongs, mentioned in table 2. An overview of the extraction method and analytical approach per group of organic compounds is given in table 3. Most analyses for seawater samples need further method optimisation to achieve the proposed required limits of quantification and are not ready yet for routine use. Methods for organophosphor pesticides, phenols and most of the polar pesticides are not tested yet in seawater, or only very preliminary (as for phtalates).

Group	Description	EXTRACTION METHOD	ANALYSIS
OCP	Organochlorine pesticide	W: Liquid-Liquid Extraction Solid Phase Extraction S: Soxhlet extraction B: Lipid extraction	GC-ECD GC-MS GC-ECD GC-ECD
PAH	Polyaromatic hydrocarbon	W: Solid Phase Extraction S: Pressurized liquid extraction B: Pressurized liquid extraction	GC-MS GC-MS GC-MS
OTIN	Organotin	W & S: Derivatisation	GC-MS
OPP	Organophosphor pesticide	W: Solid Phase Extraction	GC-MS
PHENOL	Phenol	W: Solid Phase Extraction + Derivatisation	GC-MS
PBDE	Polybrominated diphenylether	W & S: Solid Phase Extraction	GC-MS
CL ALK	Chlorinated Alkane	Solid Phase Extraction	GC-MS
VOC	Volatile organic compound	W: Stir Bar Sorptive Extraction	GC-MS LC-MS
PHTAL	Phtalate	W: Stir Bar Sorptive Extraction	GC-MS
POL PEST	Polar pesticide	W: Solid Phase Extraction	GC-MS

GC-MS: Gas Chromatography – Mass Spectrometry
LC-MS: Liquid Chromatography – Mass Spectrometry
GC-ECD: Gas Chromatography with an Electron Capture Detector
W: Water samples
S: Sediment samples
B: samples from Biota

Table 3: Extraction methods and analytical approaches for different organic compounds

Preparation of samples of sediment, suspended solids and biota in the laboratory:
Before analysis sediment samples are sieved to obtain the clay fraction (< 63 µm) using a flow-through centrifuge. The solid material is then freeze dried and milled and homogenized. The samples are stored at –20°C upon further analysis. Biota samples are mixed by a disperion tool and frozen.

An overview of currently used or potential methods for analysis of organic compounds and heavy metals in seawater is given underneath.

Organochlorine pesticides (OCPs)

WATER SAMPLES OF ENDOSULFAN
The method for the water samples is based on a method from the Flemish Environment Agency (Laboratory Organic Micropollutants, E. De Wulf). Water samples (1 l) are shaken for 10 min. with 100 ml petroleumether. Afterwards, the organic layer is dried with sodiumsulphate and concentrated to 1 ml after addition of 1 ml of iso-octane as keeper.

Extracts are analysed with a GC-ECD (Electron Capture Detector). A volume of 2 µl is injected on-column in a fused-silica precolumn coupled to two chromatographic columns (HT-8, 50m, 0.22 mm i.d., 0,25 µm film thickness and CP-Sil, 50m, 0.25 mm i.d.). Helium is used as carrier gas and the ECD make-up gas is argon/methane.

WATER SAMPLES OF SOME OTHER OCPS (OCPs and PCBs together)

Water samples are extracted on board of the research vessel using solid-phase extraction with C18 extraction cartridges. Extracts are stored at –20°C until further analysis. Before GC-analysis the extracts are concentrated to 1 ml.

PCBs and OCPs are determined in one run with a GC coupled to an ion-trap MS operated in EI-MS-MS mode. The separation is carried out on a 50 m x 0.22 mm ID HT-8 column with a film thickness of 0.25 µm. The sample extract (3µl) is injected on-column in a PTV (Programmed Temperature Vaporizing) injector through a silicosteel liner for simulated on-column injection. In essence, compounds are injected directly into a siltek deactivated guard column (10 m x 0.53 mm ID) coupled to the analytical column. Helium is used as damping gas and as carrier gas. Further details about the used EI-MS-MS conditions are available in MUMM Ostend, Belgium.

SEDIMENT SAMPLES (OCPs and PCBs together)

Extraction is based on a soxhlet extraction using a mixture of an apolar and a polar solvent. One to 5 g of material is transferred to the extraction cells, filled with the solvent 25 % acetone in hexane. Inorganic sulphur is removed in a Na_2SO_3 solution in the presence of tetrabutylammonium and iso-propanol. At the end of the extraction, the cells are rinsed with solvent and purged with nitrogen. The extracts of SPM and sediment are washed with water to remove the acetone and polar co-extracts. Prior to GC-ECD analysis other co-extracted material is removed by adsorption chromatography on 5% deactivated basic Al_2O_3. For this a 500mm x 9mm ID glass column is filled with 4 g of 5% deactivated basic Al_2O_3 and the compounds are eluted with 40 ml of hexane. Finally, this extract is concentrated to 2 ml. In order to separate PCBs from OCPs, a second purification is performed. The 500mm x 9mm ID glass column is filled with 3 g of 5% deactivated SiO_2 and the compounds are eluted with 17 ml of hexane. PCBs pass the column without retention. The OCP fraction is eluted with 20 ml of 10 % diethylether in hexane. The extracts are concentrated to 1 ml. Extracts are analysed with a GC equipped with an Electron Capture Detector (ECD).

SAMPLES FROM BIOTA (OCPs and PCBs together)

PCBs and OCPs are extracted through lipid extraction with chloroform methanol. Extraction is based on the total extractable lipid extraction of Bligh and Dyer (Bligh, E.G. and Dyer, W.J., 1959. A rapid method of total lipid extraction and purification for organic compounds. *Can. J. Biochem. Physiol*. **37**, 911-917). The lipid material that is used for the determination of the fat content is redissolved in hexane and cleaned on a Al_2O_3 column (5 % deactivated). The rest of the operation is identical to the sediment analysis.

Poly-aromatic hydrocarbons (PAHs) and Polybrominated diphenylether (PBDE)

WATER SAMPLES: SAMPLE PREPARATION

PAHs are extracted on board of the research vessel using solid-phase extraction with C18 extraction cartridges. Up to 10 l of water is forced through the disk under vacuum. Extracts are stored at –20°C until further analysis. Before GC-analysis, the extract is concentrated to a suitable volume for injection into the GC-MS under a stream of nitrogen gas.

SEDIMENT SAMPLES: SAMPLE PREPARATION

SPM and sediment are extracted by PLE (Pressurized liquid extraction) equipped with a solvent controller. One to 5 g of material is transferred to extraction cells, filled with the solvent 3:1 (v/v) hexane/acetone. At the end of the extraction, the cells are rinsed with solvent and purged with nitrogen. The extracts of SPM and sediment are washed with water to remove the acetone and polar co-extracts and concentrated to 3-5 ml. Prior to GC-MS analysis other co-extracted material is removed by adsorption chromatography on alumina. For this a 200mm x 9mm ID glass column is filled with 2 g of 5% deactivated basic Al_2O_3 and the compounds are eluted with 15 ml of hexane. Finally, this extract is concentrated to 1 ml.

SAMPLES FROM BIOTA: SAMPLE PREPARATION

For biota, extraction and clean-up steps are done simultaneously. About 1 to 5 g of biological material is transferred to the extraction cells, filled with basic Al_2O_3 (5% deactivated). The ASE (accelerated solvent extractor) is used with 100% of hexane as solvent and operated with the same conditions as described for SPM and sediment. All solvents used are of purity for organic residue analysis.

ANALYSIS

PAHs: Aliquots (3 µl) of the extracts are injected in a GC-MS with a 30 m x 0.25 mm ID RTx-5SILMS cross-linked fused silica capillary (0.25 µm film thickness). The carrier gas is helium at a linear flow rate of 1.5 ml/min. Injection is done via a PTV injector in splitless mode. Via a transfer line, the GC column is directly coupled to the ion source of a mass spectrometer. This is interfaced to and controlled by a data system that controls the GC-MS instrument as well as data the acquisition, storage and reduction. The mass spectrometer is operated in the selected ion monitoring (SIM) electron-ionisation mode (EI). Quantification is carried out from mass fragmentograms of the molecular ion for different compounds.
Characteristics of the analysis of poly-aromatic hydrocarbons in sediment are described in BMM LAB/AK026 (a digital version can be asked for by contacting Wendy.Bonne@health.fgov.be).

PBDEs are analysed with the same system as above operated in NCI-mode (negative chemical ionization mode) with ammonia as reagent gas. Helium is used as carrier gas, reagent gas flow is 3 ml min^{-1}. Further details about the used NCI conditions are available at MUMM Ostend, Belgium.

Organo-tins (OTIN)

WATER SAMPLES

Water samples (about 200 ml) are transferred to amber glass 250 ml water bottles.

SEDIMENT SAMPLES

About 1 g of sediment or suspended matter is transferred to an amber 40 ml screw cap vial.
Standard instructions for the analysis of Butyl and Fenyl Tin compounds in sediment are given in the standard operation procedure BMM LAB/SV030. Characteristics of the analysis of organotin compounds in sediment are described in BMM LAB/AK030. A digital version of these documents can be asked for by contacting Wendy.Bonne@health.fgov.be.

ANALYSIS

The procedure for extracting organo-tins from the samples is based on the use of acid reagents in methanolic media (15 ml) by stirring with hexane (7 ml). Samples are buffered (pH 5) by adding sodium acetate. A recovery standard, tributyltin, to control the ethylation process is added prior to derivatisation. Ethylation is done with sodium tetraethylborate. A continuous desorption process is created by adding 4 ml of reagent dropwise to vigorously stirred samples. For degradation of boroxin, formed due to the intensive derivatisation, an aliquot of 5 ml of sodium hydroxide is added to the samples. Finally, internal standards, tetrapropyltin and triphentyltinpentyl, are added to the samples and samples are centrifuged to separate the phases. All solvents used are of purity for organic residue analysis. Chlorinated and ethylated organotins are obtained from Quasimeme. Internal standard and recovery standard tetrabutyltin and tripropyltin chloride are used.

Custom-made chromatography columns (200mm x 9mm ID) are used as low-density adsorption clean-up columns. For clean-up of water, sediment or SPM the column is filled with 4 g of neutral AlOx and 18ml of hexane is used for elution. Compounds are eluted for the columns with 25 ml of hexane. The extracts are stored at 4 °C until GC-analysis.

A large-volume injection (LVI) technique is developed for this analysis, which consists of injecting a volume of 50 µl with an autosampler through a Programmed Temperature Vaporizing (PTV) injector with a glass-sintered liner at a rate of 10 µl min^{-1}. The analytic system consists of a GC coupled to a MS. The analytical column is a 20m x 0.25mm ID Rtx®-5 SILMS with a film thickness of 0.25 µm. Helium is used as carrier gas at a flow rate of 1.5 $ml.min^{-1}$. The mass spectrometer is operated in the selected ion-monitoring (SIM) mode with electron impact ionization at 70eV.

Chlorinated Alkanes (CL ALKs)

Short chain chlorinated parafins (SCCPs) are extracted using solid-phase extraction with C18 extraction cartridges. Five liters of water are forced through the disk under vacuum. The extract is concentrated to a suitable volume for injection into the GC-MS under a stream of nitrogen gas.

Aliquots (1 µl) of the extracts are injected in a GC-MS with a 5 m x 0.18 mm ID RTx-5SILMS cross-linked fused silica capillary (0.25 µm film thickness). The carrier gas is helium at a linear flow rate of 1.5 ml/min. Injection is done via a splitless injector. Via a transfer line, the GC column is directly coupled to the ion source of a mass spectrometer. This is interfaced to and controlled by a data system. The software controls the GC-MS instrument as well as the data acquisition, storage and reduction. The mass spectrometer is operated in the electron- ionisation mode (EI) with both total ion monitoring (50-650 amu) and MS/MS. Quantification is carried out from mass fragmentograms of the daughter ions.

Organophosphor pesticide (OPP)

WATER SAMPLES

No method is currently tested for analysis in seawater but comparable procedures as for OCPs will be tested.

Phenol (FENOL)

WATER SAMPLES

The analysis of phenols in seawater still has to be tested because a currently tested method in seawater does not exist. Derivatisation directly in the water sample is a possibility but not tested for seawater. Preconcentration on SPE (as for OCPs and OPPs) might be necessary, followed by derivatisation.

Volatile organic compounds (VOCs)

WATER SAMPLES

Volatile organic compounds have been measured repeatedly (during 4-6 years) and do not pose a problem in the Belgian coastal waters. Concentrations were always below EQS. A surveillance analysis of volatile organic compounds in seawater will be performed at a later stage.

Phthalates (FTAL)

WATER SAMPLES

An extraction method for water samples has been developed in cooperation with the FEA (Laboratory Organic micropollutants, E. De Wulf). Water samples are extracted by placing a stir bar in a 10 ml sample, followed by stirring it during 60 min at room temperature. Afterwards, the stir bars are introduced in a glass thermal desorption tube and desorbed in a thermal desorption unit. The desorbed compounds are cryofocused in a programmable temperature vaporization inlet at -50°C. After desorption the compounds are injected into the analytical column of a GC-MS by increasing the temperature of the programmable temperature vaporization inlet. Separation is performed on a 30 m HP-5MS column with an ID of 0.25 mm i.d and a film thickness of 0.5 µm. Helium is used as carrier gas at a flow rate of 1.2 $ml.min^{-1}$. The mass spectrometer is operated in the selected ion-monitoring (SIM) mode with electron impact ionization at 70eV.

Polar pesticide (POL PEST)

Chlorotriazine herbicides (atrazine, simazine)

WATER SAMPLES

The method for water samples is based on a method developed by the National Institute for Coastal and Marine Management (RIKZ) in the Netherlands. After filtration, water samples are extracted using SPE cartridges packed with 200 mg styrene divinyl-benzene copolymer (SDB). The analytes are eluted with ethyl-acetate (2x6 ml) and the extract is further concentrated prior to injection in the GC-MS.

The final extracts are analysed by GC-MS. The separations are performed on a 25m BPX-35 fused-silica capillary column with an ID of 0,22 µm and a film thickness of 0,25 µm. For this, 1 µl of sample is injected into a split-splitless injector (split flow 20 ml/min). Helium is used as carrier gas at a flow rate of 1 ml/min. The MS is operated in Electron Impact Mode at 70 eV.

For other substances such as diuron and isoproturon an analysis method is not readily available for seawater and still has to be tested.

For the remaining polar pesticides methods still have to be tested as well and can be comparable to the methods for OCPs.

Heavy metals (H MET)

WATER SAMPLES: SAMPLE PREPARATION
Extraction is performed with a strong organic chelating agent (vb. APDDDC) and with an organic solvent. The destruction of the chelating agent is realised with strong nitric acid and back extraction in aqueous phase.

SEDIMENT SAMPLES: SAMPLE PREPARATION
Extraction of the heavy metals from sediment samples is performed with aqua regia (HNO3/HCl 1:3).

SAMPLES FROM BIOTA: SAMPLE PREPARATION
Extraction of the heavy metals from biota is performed with aqua regia (HNO3/HCl 1:3) or with nitric acid and hydrogen peroxide.

ANALYSIS
The extract is analysed with ICP-MS (Inductively coupled plasm mass spectroscopy).

Mercury and its compounds

SAMPLES FROM BIOTA
Analysis is performed by Atomic Fluorescence Spectrometry of CV-AAS (Cold vapour - atomic absorption spectrometry). For organic mercury compounds such as monomethyl mercury and dimethyl mercury, after derivatisation a separation by Headspace Gas Chromatography is necessary.

3.2.3. Standards

Continuous participation in proficiency tests exists for the analyses of OCPs and PCBs in sediments and biota in the QUASIMEME inter-laboratory performance studies that were initiated by the EU project "Quality Assurance of Information for Marine Environmental Monitoring in Europe".
Analyses of organo-tin compounds and poly-aromatic hydrocarbons in the sediment are accredited. The standards are defined in the standard operation procedures of the MUMM.
Characteristics of the analysis of poly-aromatic hydrocarbons in sediment are described in BMM LAB/AK026.
Standard instructions for the analysis of Butyl and Fenyl Tin compounds in sediment are given in the standard operation procedure BMM LAB/SV030. Characteristics of the analysis of organo-tin compounds in sediment are described in BMM LAB/AK030.
A digital version of these documents can be asked for by contacting Wendy.Bonne@health.fgov.be.
Standard instructions for sampling, rinsing of recipients, pre-treatment of samples, inscription and preservation of samples are also described in standard instruction documents (SI BMM LAB/IO23, SI BMM LAB/IO24.A, SI BMM LAB/IO24.B and SI BMM LAB/IO24.C).

3.2.4. Confidence

The confidence of the analysis is defined in the standard operation procedures of the MUMM: document BMM LAB/AK030 for organo-tin compounds in sediment and in the document BMM LAB/AK026 for analyses of poly-aromatic hydrocarbons in sediments.

3.2.5. Frequency methodology

The monitoring frequencies for the compounds of this quality element are determined based on the minimal required frequency for water sampling by the WFD (monthly every year for operational monitoring and monthly during one year every 6 years for surveillance monitoring) and the integration with other existing monitoring programmes (e.g. OSPAR) for sediment and biota samples. A minimum frequency of one analysis per year from sediment and biota samples is defined. However, for sediment sampling two monitoring campaigns are planned per year in order to have at least once per year successful measurements. When both sampling campaigns are successful, two measurements per year are available. Measurements in biota occur once per year in the OSPAR monitoring framework.

3.3. Non-priority Substances (QE3-3)

3.3.1. Sampling protocol

The non-priority substances (as indicated in Annex 8/9) are sampled on a standardised way in the sediment and in biota. Sediment samples are taken with a Van Veen grab.

3.3.2. Analysis protocol

Heavy metals (especially Cu and Zn for the Scheldt river basin district)

SEDIMENT SAMPLES: SAMPLE PREPARATION
Extraction of the heavy metals from sediment samples is performed with aqua regia (HNO3/HCl 1:3).

SAMPLES FROM BIOTA: SAMPLE PREPARATION
Extraction of the heavy metals from biota is performed with aqua regia (HNO3/HCl 1:3) or with nitric acid and hydrogen peroxide.

ANALYSIS
The extract is analysed with ICP-MS (Inductively coupled plasm mass spectroscopy).

Polychlorinated biphenyls (PCBs)

Extraction and analyses from sediment and biota samples is explained jointly with the extraction and analysis of OCPs in sediment and biota in the section on priority substances.

3.3.3. Standards and Confidence

A national or international standard and confidence level for this quality element is not readily available and in development at national level. Continuous participation in proficiency tests exists for the concerned analyses in the QUASIMEME inter-laboratory performance studies that were initiated by the EU project "Quality Assurance of Information for Marine Environmental Monitoring in Europe".

3.3.4. Frequency methodology

The monitoring frequencies for this quality element are determined based on the minimal required frequency by the OSPAR monitoring programmes. A minimum frequency of one analysis per year from sediment and biota samples is defined. However, for sediment sampling two monitoring campaigns are planned per year in order to have at least once per year successful measurements. When both sampling campaigns are successful, two measurements per year are available. Measurements in biota occur once per year in the OSPAR monitoring framework.

B. PROGRAMMES

1. Surveillance monitoring programme (BEFED_Schelde_SWP_SUP)

In this part, the surveillance monitoring programme for the Belgian coastal waters (< 1 nautical mile) will be outlined. It is a programme defined at national level. Within the Belgian coastal area (< 1 nautical mile), parts of three protected areas under the Bird Directive and one protected area under the Habitat Directive are situated. In each Bird Directive area, one monitoring site is situated and among these three sites also two sites are located in the Habitat Directive area.

1.1. Sub-programme for coastal water (BEFED_Schelde_SWP_SUP_C)

1.1.1. Info on sub-programme

Four monitoring sites are defined for the surveillance monitoring programme for the coastal waters. At three sites all biological quality elements are measured. Priority and non-priority substances are measured at one station.

1.1.1.1. Brief summary of the methodology or criteria used to select sites for this sub-programme

The coastal monitoring stations of Belgium, used in previous years for the OSPAR monitoring, are re-organized to fulfil the monitoring requirements of the WFD and OSPAR at the same time. This means that the 3 monitoring sites for biological quality elements under the WFD are located in such a way that:

- they are located within the zone of 1 nautical mile (only site WO3 had to be adjusted a little bit further in order to make it possible to navigate to this place with an oceanographic vessel).
- their location is representative to follow up the impacts of possible pressures in the coastal zone. Each of the stations is located in the neighbourhood of a harbour, from east to west Zeebrugge, Oostende and Nieuwpoort. By comparing the three sites from east to west, a frequent assessment can also be made of the impact of the effluents from the Scheldt in the coastal waters.
- the use of sub-sites and area sampling for the macrobenthos allows detecting impacts of a series of pressures such as eutrophication, fisheries and hazardous substances near the harbours.

1.1.1.2. Sub-sites: To what extent, and how, has the concept of sub-sites been applied

The coastal area is split up in 3 sub-areas or zones (each represented by a monitoring site) to reflect the anthropogenic gradient in the coastal area caused by the estuary of the Scheldt and to improve the quantitative follow-up of the ecological status.

For the quality element macrobenthos, sub-sites have been defined within the three coastal zones, because of the variation in soft-bottom habitats within the zones. Macrobenthos assessment and classification of the Belgian coastal zone, based on habitat types within the coastal zones, is ecologically more meaningful than a classification of the whole zone as one type. The reported coordinates of the monitoring site per coastal zone is used as the centroid

for the macrobenthos monitoring sub-sites, for the sake of simplicity. At every sub-site several stations are sampled, which are selected by a randomly stratified sampling design at every campaign.

1.1.1.3. Drinking water: Additional monitoring requirements for waters used in the abstraction of drinking water in relation to Article 7

Not applicable for the coastal marine waters.

1.1.1.4. Deviations: Extent to which monitoring deviates from that outlined

There are a few deviations in frequency or the start of the currently defined monitoring programme:
- The frequency for the metric chlorophyll a of the quality element phytoplankton is 4 times a year in 2007 and will be every month in the growing season (March-October) from 2008 onwards.
- The metrics *Phaeocystis* and taxa cell counts of the quality element phytoplankton are not yet monitored in 2007, but will start at the end of 2007.
- Surveillance monitoring of some priority substances in the sediment is performed one to two times per year at 6 sites in the territorial waters within the framework of the OSPAR monitoring, including the three sites for biological quality elements under the WFD, the sites for operational monitoring of priority substances under the WFD and an additional station near the area "Vlakte van de Raan" closer to the mouth of the Scheldt.

1.1.2. Monitoring stations, quality elements, frequency and cycle

Table 4 gives an overview of the quality elements measured at every station and the monitoring frequency and cycle. For the quality element macrobenthos (QE1-3) an area sampling design is used.

	sites	QE	sub-sites	parameter	frequency	cycle	Ass_WB	start
BEFED_Schelde_SWP_SUP_C	BEFED_WO1	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	3	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	3	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
	BEFED_WO2	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	3	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	3	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
	BEFED_WO3	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	3	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	3	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
	BEFED_WO5	QE3-2	no	priority substances	12	6	BENZ	2007
		QE3-3	no	non-priority substances	1	1	BENZ	2007

Tabel 4: Locations, frequency and cycle of monitoring of the different quality elements in surveillance monitoring.

2. Operational monitoring programme (BEFED_Schelde_SWP_OPP)

In this part, the operational monitoring programme for the Belgian coastal waters (< 1 nautical mile) will be outlined. It is a programme defined at national level. Within the Belgian coastal area (< 1 nautical mile), parts of three protected areas under the Bird Directive and a part of one protected area under the Habitat Directive are situated. In each Bird Directive area, one monitoring site is situated and among these three sites also two sites are located in the Habitat Directive area.

2.1. Sub-programme for coastal water (BEFED_Schelde_SWP_OPP_C)

2.1.1. Info on sub-programme

Five monitoring sites are defined for the operational monitoring programme for the coastal waters. At three sites all biological quality elements are measured. Priority substances are measured at three sites, one in common with the biological quality elements and two other sites. Non-priority substances are measured in the sediment at 6 sites in the territorial waters within the framework of the OSPAR monitoring, including the three sites for biological quality elements under the WFD, the sites for operational monitoring of priority substances under the WFD and an additional station near the area "Vlakte van de Raan" closer to the mouth of the Scheldt.

2.1.1.1. Brief summary of the methodology or criteria used to select sites for this sub-programme

The coastal monitoring stations of Belgium, used in previous years for the OSPAR monitoring, are re-organized to fulfil the monitoring requirements of the WFD and OSPAR at the same time. This means that the 3 monitoring sites for biological quality elements under the WFD are located in such a way that:

- they are located within the zone of 1 nautical mile (only site WO3 had to be adjusted a little bit further in order to make it possible to navigate to this place with an oceanographic vessel).
- their location is representative to follow up the impacts of possible pressures in the coastal zone. Each of the stations is located in the neighbourhood of a harbour, from east to west Zeebrugge, Oostende and Nieuwpoort. By comparing the three sites from east to west, a frequent assessment can also be made of the impact of the effluents from the Scheldt in the coastal waters.
- the use of sub-sites and area sampling for the macrobenthos allows detecting impacts of a series of pressures such as eutrophication, fisheries and hazardous substances near the harbours. Sampling west and east from harbours is also evaluated.

2.1.1.2. Sub-sites: To what extent, and how, has the concept of sub-sites been applied

The coastal area is split up in 3 sub-areas or zones (each represented by a monitoring site) to reflect the anthropogenic gradient in the coastal area caused by the estuary of the Scheldt and to improve the quantitative follow-up of the ecological status.

For the quality element macrobenthos, sub-sites have been defined within the three coastal zones, because of the variation in soft-bottom habitats within the zones. Macrobenthos assessment and classification of the Belgian coastal zone, based on habitat types within the coastal zones, is ecologically more meaningful than a classification of the whole zone as one type. The reported coordinates of the monitoring site per coastal zone is used as the centroid for the macrobenthos monitoring sub-sites, for the sake of simplicity. At every sub-site several stations are sampled, which are selected by a randomly stratified sampling design at every campaign.

2.1.1.3. Drinking water: Additional monitoring requirements for waters used in the abstraction of drinking water in relation to Article 7

Not applicable for the coastal marine waters.

2.1.1.4. Deviations: Extent to which monitoring deviates from that outlined

There are a few deviations in frequency or the start of the currently defined monitoring programme:
- The frequency for the metric chlorophyll a of the quality element phytoplankton is 4 times a year in 2007 and will be every month in the growing season (March-October) from 2008 onwards.
- The metrics *Phaeocystis* and taxa cell counts of the quality element phytoplankton are not yet monitored in 2007, but will start at the end of 2007.
- During the growing period the metrics *Phaeocystis* and taxa cell counts will be sampled more intensively than once a month. The amount of extra samples is defined as 6 for the year 2008 but this can be changed according to monitoring requirements to detect any improvement in the situation.
- Operational monitoring of some priority substances in the sediment is performed at the same 6 sites and at the same frequency (one to two times per year) as the surveillance monitoring for some priority substances in the sediment within the framework of the OSPAR monitoring.

2.1.2. Monitoring stations, quality elements, frequency and cycle

Table 5 gives an overview of the quality elements measured at each station and the monitoring frequency and cycle. For the quality element macrobenthos (QE1-3) an area sampling design is used.

	sites	QE	sub-sites	parameter	frequency	cycle	Ass_WB	start
BEFED_Schelde_SWP_OPP_C	BEFED_WO1	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	1	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	1	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
		QE3-2	no	priority substances	12	1	BENZ	2007
		QE3-3	no	non-priority substances	1	1	BENZ	2007
	BEFED_WO2	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	1	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	1	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
	BEFED_WO3	QE1-1	no	phytoplankton	12	1	BENZ	end 2007
		QE1-3	area	benthos	1	1	BENZ	2007
		QE2-6-1	no	depth variation	4	1	BENZ	2007
		QE2-6-2	area	structure substrate	1	1	BENZ	2007
		QE2-8-1	no	direction currents	4	1	BENZ	2007
		QE2-8-2	no	wave exposure	4	1	BENZ	2007
		QE3-1-1	no	transparancy	4	1	BENZ	2007
		QE3-1-2	no	thermal conditions	4	1	BENZ	2007
		QE3-1-3	no	oxygenation	4	1	BENZ	2007
		QE3-1-4	no	salinity	4	1	BENZ	2007
		QE3-1-6	no	nutrient conditions	4	1	BENZ	2007
	BEFED_WO5	QE3-2	no	priority substances	12	1	BENZ	2007
		QE3-3	no	non-priority substances	1	1	BENZ	2007
	BEFED_WO6	QE3-2	no	priority substances	12	1	BENZ	2007
		QE3-3	no	non-priority substances	1	1	BENZ	2007

Tabel 5: Locations, frequency and cycle of monitoring of the different quality elements in operational monitoring.

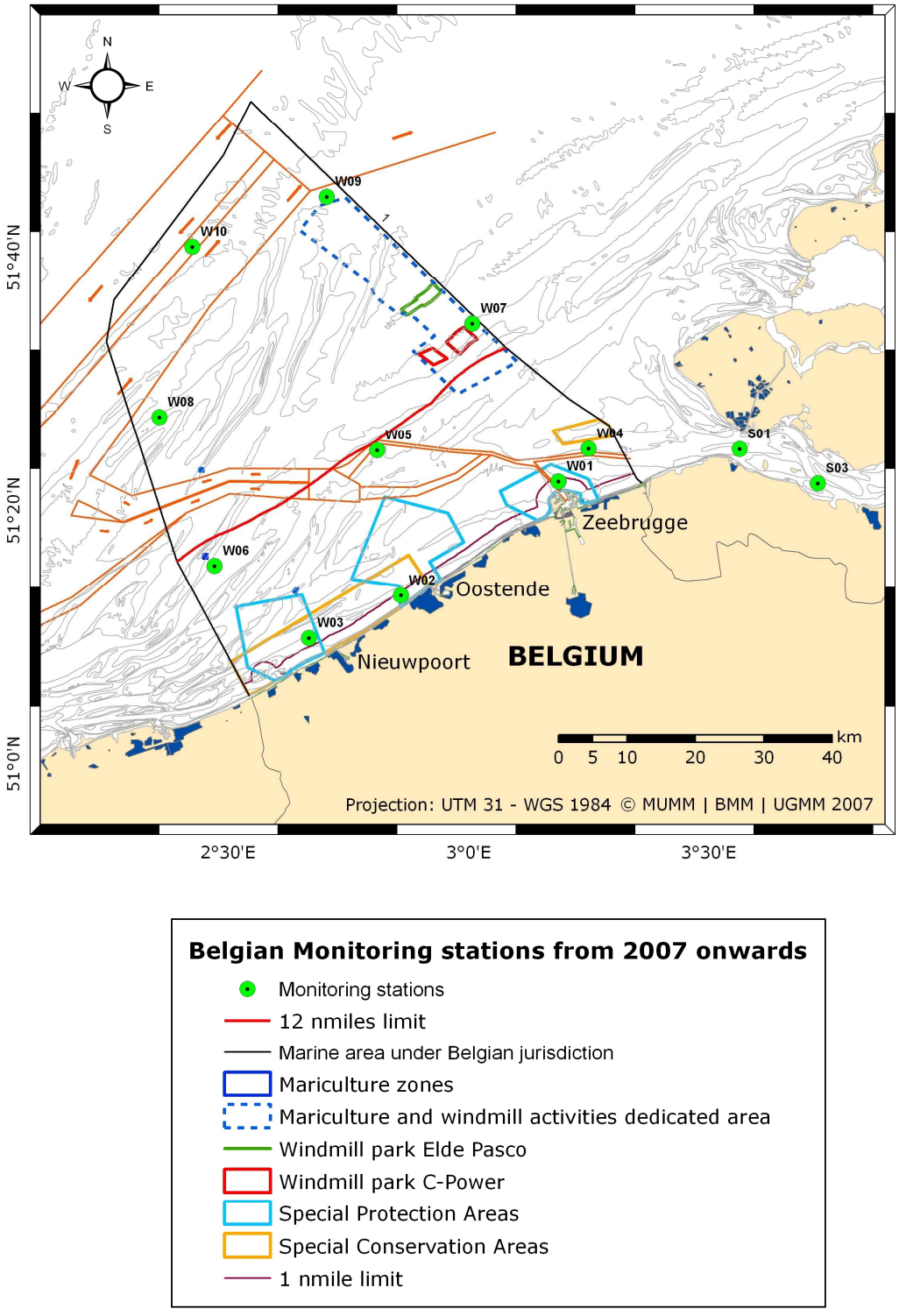

Figure 2: Monitoring sites for the Water Framework Directive and OSPAR monitoring from 2007 onwards