Ministry of Transport, Public Works and Water Management

Directorate-General of Public Works and Water Management

RIZA Institute for Inland Water Management and Waste Water Treatment

Revision of the European Bathing Water Quality Directive

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A preliminary assessment of compliance, sources of pollution, management measures and their cost-effectiveness in the Netherlands

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Preface

This study was conducted by RIZA under the authority of the Dutch Directorate-General Water of the Ministry of Transport, Public Works and Water Management. The reason for the study is the revision of the present Bathing Water Quality Directive 76/160/EEC by the European Commission. In July 2001, the Commission issued a draft of the revised Directive. The study was carried out in the beginning of 2002 as a first step to assess the *implications of more stringent bathing water quality standards in the* Netherlands as foreseen in the revised Directive. Although the report is written primarily for the Dutch DG Water, we hope that the study appeals to a wider international readership concerned with the revision of the EU Bathing Water Quality Directive.

Roy Brouwer and Ivonne van Pelt

Summary

In this study, an overview is given of the data and information presently available to assess the implications of a revised European Bathing Water Quality Directive in the Netherlands in terms of:

- Compliance.
- Sources of pollution in case of non-compliance.
- Management measures.
- Cost-effectiveness of these measures.

The available information about bathing sites, historical bathing water quality at these sites, compliance and potential sources of pollution is included in a Geographical Information System (GIS). A comparison of this information system with an in-depth study carried out in 2000 about bathing water quality and sources of pollution shows that the GIS module helps to provide useful preliminary information about potential sources of pollution. However, currently available information to define and assess relevant management actions in case of a more strict bathing water quality regime, as foreseen in the revised European Bathing Water Quality Directive, and their cost-effectiveness is very limited. Moreover, the costs and effectiveness of different but often complementary management actions largely depend upon the specific circumstances at bathing water locations.

Hence, more detailed information is needed, at least at the level of representative clusters of bathing water locations in different management areas, in order to better understand the consequences of more stringent bathing water quality standards in the Netherlands in terms of appropriate management actions, their costs and effectiveness at a national level.

In order to be able to carry out a cost-effectiveness analysis of relevant management actions, more specific information has to become available about (1) the extent to which each source of pollution contributes to the specific bathing water quality problem, (2) the extent to which each management action contributes to solving this problem, and (3) the associated (unit) costs. Contrary to existing data bases for specific nutrient emission abatement measures, no up-to-date data base exists which contains detailed information about unit costs and effectiveness of various micro-biological management measures. The demand for this type of information, for both nutrient and micro-biological pollution abatement measures, is expected to increase further in the near future in view of the information requirements following from the national implementation of the EU Water Framework Directive.

1 Introduction

The European Commission (EC) is currently looking at the possibilities to revise the present Bathing Water Quality (BWQ) Directive 76/160/EEC, which dates from 1976. In July 2001, the Commission issued a draft of the revised Directive, which is set up in much the same way as the original Directive 76/160/EEC. The original and revised draft BWQ Directive are included in the Appendix to this report. Some of the relevant articles in the draft of the revised Directive are shown in Box 1.

Article 2	List of bathing waters MS have to establish a list of identified bathing waters.
Article 3	Managerial measures for bathing waters A management structure should be established for each identified bathing water or a group of adjacent bathing areas.
Article 5	Assessment of water quality data and sources of pollution Bathing waters are subject to a thorough study and analysis of all (significant) sources and circumstances likely to cause or contribute to pollution or contamination.
Article 7	Compliance The studies and analysis mentioned in article 5 are needed to acquire sufficient confidence that all sources and risks and potentialities are understood in order to commit aimed preventive and remedial actions and ensure compliance.

Box 1: Selection of articles from the revised draft Bathing Water Quality Directive

Important differences between the original BWQ Directive and the revised draft are:

1) The standards for BWQ are expected to be more strict in the revised Directive. However, the standards and the accompanying compliance are still under discussion. So far, they have been elaborated in various preliminary scenarios.

2) There is more emphasis on different types of management measures in the revised Directive to meet BWQ standards.

3) There is a shift in emphasis in the revised Directive from BWQ monitoring to BWQ management.

The last two points are in line with the principles laid down in the Water Framework Directive (WFD). In its 2000 Communication, the EC states that the revised BWQ Directive should have a greater emphasis on the application of suitable, prompt management actions, without forgetting the fact that water quality objectives also have to be met. Under the new scheme, there will be requirements for both compliance with the quality standards and for reaction when these standards are breached.

As part of the revision process, the EC investigates the value added of a new Directive. In a European wide study, the UK based Water Research Centre (WRC) has been asked by the EC to estimate the associated costs and benefits in the EU Member States (MS). In the Netherlands, the Directorate General Water has asked RIZA to carry out a separate assessment, investigating the possible consequences of a revised BWQ Directive. As a first step, a quick scan is carried out to assess current and future compliance with the BWQ Directive in the Netherlands if BWQ standards will become more strict.

The main objectives of the quick scan presented here are to assess:

- Current and future compliance in the Netherlands based on current and possible future BWQ standards.
- Currently available knowledge, data and information enabling the identification of possible sources of pollution causing non-compliance.
- Currently available knowledge, data and information enabling the identification of management measures to ensure compliance in the future.
- Currently available knowledge, data and information enabling the selection of cost-effective measures to ensure future compliance.

The main findings of this preliminary investigation (quick scan) are presented in this report. The results have to be interpreted with the necessary care in view of the short period of time during which the assessment was carried out and the global scale at which the assessment was carried out. The BWQ standards are still under discussion and information collected with respect to potential sources, measures and cost-effectiveness is very general in nature. This means that the results are still surrounded by many uncertainties. Conclusions with regard to specific locations or regions or specific consequences in terms of management actions, their effectiveness *and associated costs can not yet be drawn. One of the most important* conclusions from this assessment is that context specific factors have to be taken into account in order to be able to give a more reliable and accurate answer to the question which cost-effective measures have to be taken in order to guarantee future compliance.

The remainder of this report is set up in the following way. Section 2 briefly outlines the general framework underlying the assessment. Section 3 presents the results when looking at compliance under various compliance regimes. Section 4 discusses the potential sources for non-compliance. Section 5 identifies possible measures to ensure compliance in the future and section 6 their effectiveness and associated costs. Finally, section 7 concludes and gives a number of recommendations for future work.

2 Framework

The steps followed in this preliminary assessment are outlined in Box 2.

1.	Compliance under various compliance regimes
2.	Identification of potential sources
3.	Identification of possible management measures
4.	Assessment of their effectiveness and associated costs

Box 2: Steps followed in the preliminary assessment

Obviously, an important first step is to assess current and future compliance under various compliance regimes. As the standards and compliance regimes under the revised Directive are still under discussion, various scenarios have been introduced. The location of complying and non-complying bathing sites under these scenarios have been included in maps using Geographical Information Systems (GIS).

Once the compliance under various regimes has been assessed and insight has been gained into the relative share of non-complying bathing sites compared to complying sites, the next step is to determine why these sites do not comply. This means that the sources of non-compliance have to be investigated. First, the various sources of pollution and contamination of bathing water in general are identified. Secondly, an attempt is made to pinpoint their exact location. Finally, these location specific sources are linked spatially through GIS maps with the (non-complying) bathing water sites in the Netherlands.

This relationship is established in a very preliminary descriptive way. Linking sources via pathways to bathing water quality and receptors (bathers) in a quantitative way is impossible at present. Scientific knowledge and quantitative information, for instance through models, to underpin these cause-effect relationships are limited and in some cases non-existent. Hence, sources of pollution at non-complying bathing water sites are identified in a very preliminary way with the help of GIS maps. Local and regional expert judgement is needed to assess the relevance of a specific source for a specific (non-complying) bathing site in a more reliable way. In view of the limited amount of time and the predicted number of non-complying sites, this essential step was not part of the preliminary assessment presented here.

A similar argument applies to the identification of possible measures to take away the source for non-compliance. Ideally, this assessment is carried out together with local or regional experts. In this report, a range of possible measures is identified based on existing literature. Solutions proposed in general are linked to the potential sources identified in the previous step.

Finally, in the last step, the effectiveness of these general management measures is assessed, together with the associated costs, again based on existing research and literature.

The preliminary assessment presented here is basically a first step to complete the table below (Table 1). Table 1 is simply an extension of the so-called WHO-matrix or Annapolis Protocol (WHO, 2001), which confronts BWQ classes and potential sources.

Table 1
Basic information sheet needed to be able to assess the extent of compliance and consequences on non-compliance in terms of management actions and associated costs

Bathing site	Historical bathing water quality[1]	Compliance with new standard	Potential polluting source(s)	Management actions	Effectiveness (kill-off rate)	Costs (1000 €)
1						
2						
3						
4						
5						
.....						
.....						
.....						

[1] Complying with guide (CG) or imperative value (CI) or non-complying with mandatory value (NC) for faecal coliforms.

3 Compliance under different compliance regimes

In response to the request of the Bathing Water Expert meeting on the 25th of July 2001, the EC has proposed to test a number of bathing water locations based on compliance regimes under different microbiological thresholds. These tests should improve current understanding of the practical consequences of a number of compliance regimes and hence inform the debate about appropriate protocol formulation, standards and thresholds.

For this purpose, the EC has provided the member states with a protocol. This protocol describes the information needed for an European overview of the feasibility of different compliance regimes and thresholds. However, the EC's suggestion to test these compliance regimes with the help of data referring to the most recent year (2000) provides only limited information about the real extent of the problems at bathing water sites. In the Netherlands, the longer term annual effects of various thresholds and compliance regimes were studied based on five year pooled data (1996-2000). In this way, more data are available, producing statistically more sound results. Most importantly, incidental failures significantly influencing compliance can be accounted for. More insight is gained into the structural nature of potential problems and hence the extent to which more structural measures have to be taken in case the bathing water locations do not comply with a certain compliance regime.

In the draft of the revised BWQ Directive, the EC introduces furthermore two new parameters in the testing protocol: Intestinal Enterococci (IE) and Escherichia Coliforms (EC). Where data are unavailable for these parameters conversion of Faecal Streptococci (FS) and Faecal Coliforms (FC) may be necessary. In this report, a one to one relationship is assumed between IE and EC and the parameters measured under the current Directive[1]. The calculations were furthermore carried out for a 80, 90 and 95 percentage of the samples complying with the standard.

The EC also wishes to test the use of single (IE or EC) and combined (IE and EC) parameters in marine and freshwaters. The value added of using EC for compliance testing in coastal waters is unclear in view of the fact that EC dies off fast in salt water. On the other hand, using EC as well as IE may be helpful in the case of fresh waters. Unfortunately, under the current directive the parameter FS is optional and subsequently not measured for all freshwater locations. In this study, the parameter FS is used to test compliance of coastal waters and FC of fresh waters.

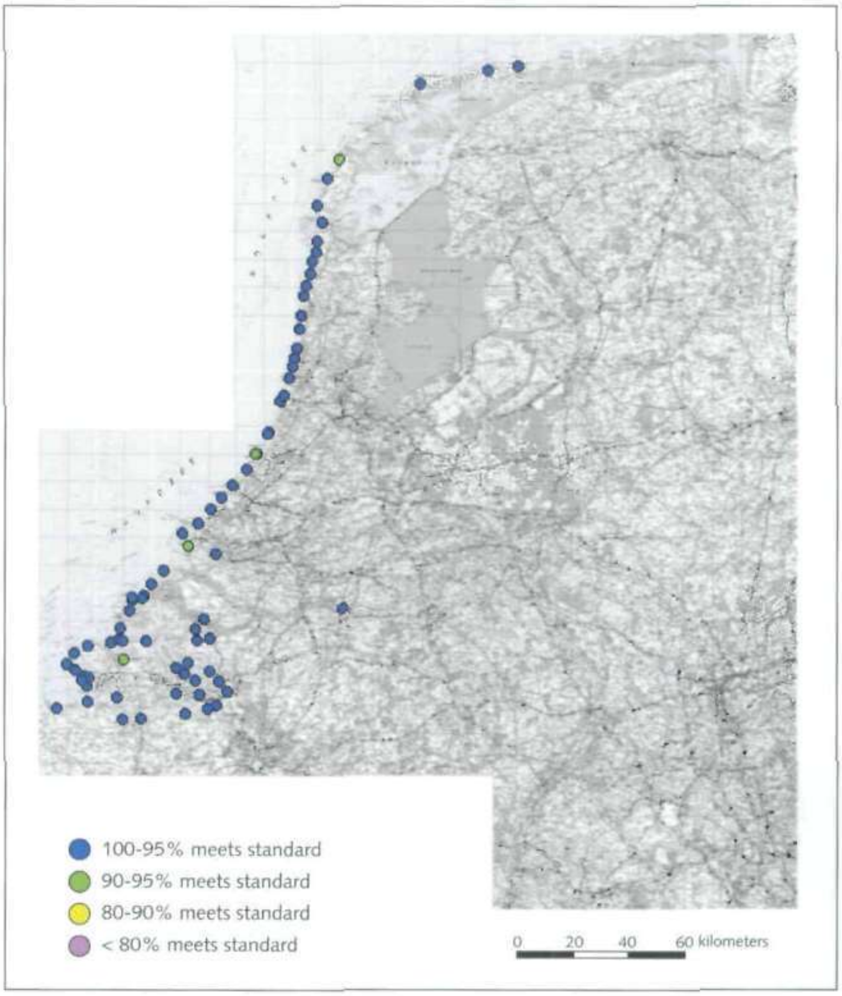
Note

1 In order to convert FC to EC and FS to IE, membrane filtration was used in the Netherlands during trials in 2000. A 1:1 conversion appeared to be appropriate for both parameters.

3.1 Coastal waters

The compliance of coastal bathing waters is calculated based on FS data covering the period 1996-2000. Figures 1 to 3 show the coastal locations which comply with standards ranging from 200 to 50 cfu[2]/100ml for FS for a 80, 90 and 95 percentage compliance regime. Over the period 1996-2000 these coastal locations had an average sampling frequency of 41 samples and each location has a minimum of 20 samples.

Figure 1
Compliance of coastal bathing water locations when 200 FS/100ml is the standard

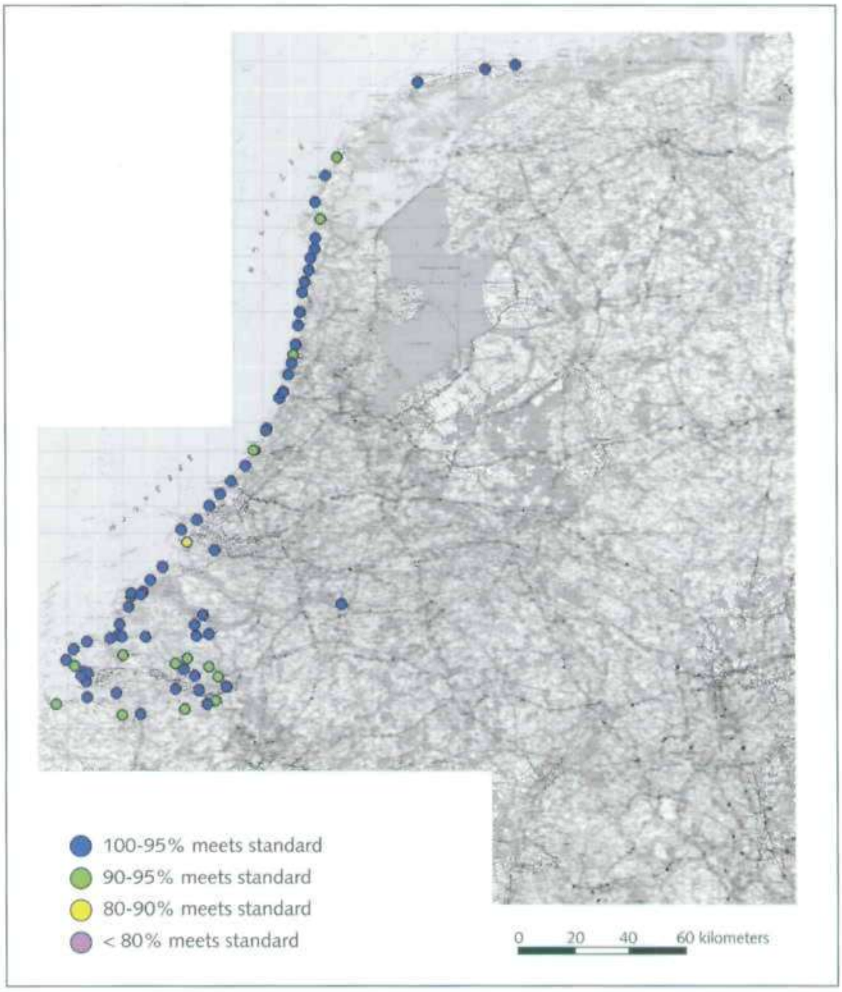


The color of the dots in Figures 1 to 3 gives an indication of the number of complying and non-complying bathing water locations along the Dutch coast, and hence where in-season actions may be necessary to protect the bathers. Blue and green dots (more than 90 percent of the samples taken comply) in the figures can be seen as locations which will have almost no problems during the bathing season (2 failures or less out of 20 samples taken) and can therefore be labeled as 'good' bathing water quality. On the other hand, the yellow and pink dots (less than 90 percent of the samples comply) are locations which require more in-season actions (3 or more failures out of 20 samples) and are therefore labeled as 'poor' bathing water quality[3]. Obviously, the number of yellow and pink dots increases when standards are increased from the current 200 FS/100 ml to 100 and 50 FS/100 ml.

When 200 FS/100 ml is chosen as the standard, 95 percent of the 95 bathing water locations (90 locations) along the coast meet a 95 percent compliance rate. Hence, most dots are blue (some green) at this current bathing water quality standard (Figure 1).

When applying a standard of 100 FS/100 ml, 78 percent of the 95 bathing water locations still meet the 95 percent rate. Changing the standard from 200 to 100 FS/100 ml, most dots in Figure 2 remain blue (some green and one yellow). However, a clustering of poor quality bathing water locations (yellow and one or two pink dots) shows up in the south-west of the Netherlands when increasing the standard further from 100 to 50 FS/100 ml (Figure 3). In the case of a standard of 50 FS/100 ml, less than half (43%) of the 95 locations meet the 95 percent rate.

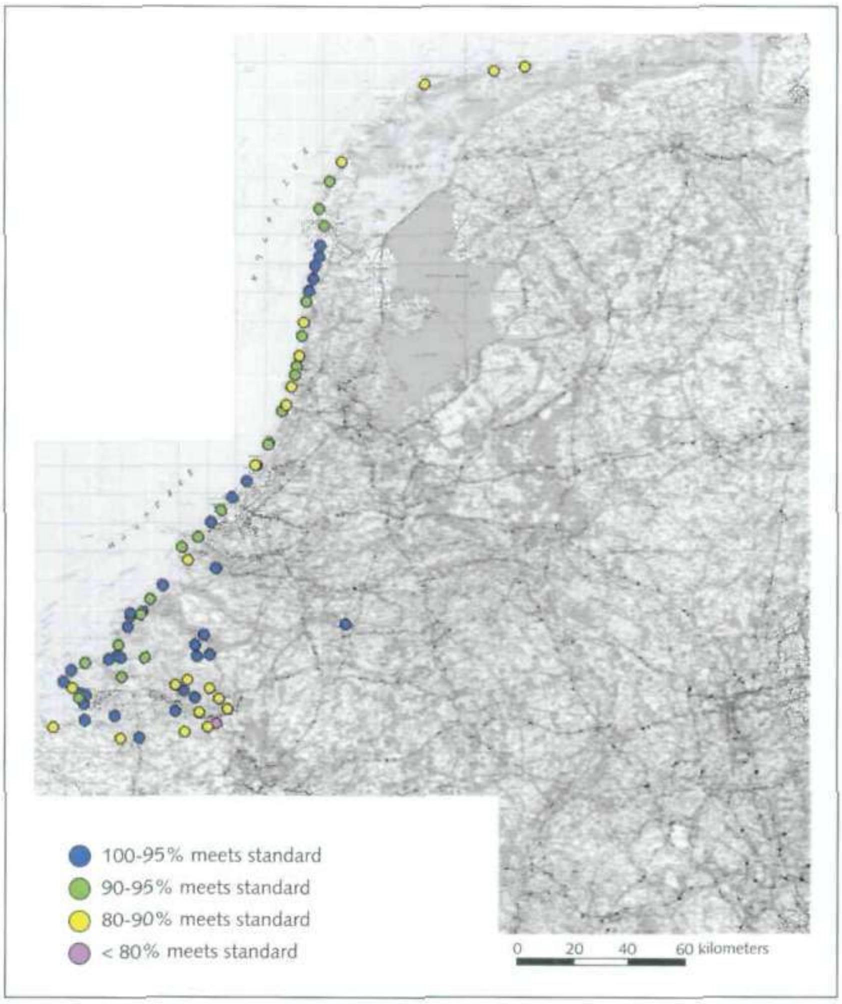
Figure 2
Compliance of coastal bathing water locations when 100 FS/100ml is the standard



Note
2 cfu = colony forming units.

3 See also van Pelt (2000). Although the results presented here are based on pooled data sets over the period 1996-2000, they still have to be interpreted with the necessary care. In order to be able to assess whether non-compliance is structural or incidental, more statistical tests have to be carried out. Most importantly, average water quality during various bathing seasons has to be estimated, including the corresponding standard deviation.

Figure 3
Compliance of coastal bathing water locations when 50 FS/100ml is the standard



3.2. Fresh waters

In the case of fresh waters, compliance is estimated based on a pooled FC dataset covering again the period 1996-2000. In Figures 4 to 6 the compliance of the 561 inland fresh bathing water locations is shown, using standards ranging from 2000 to 100 cfu of FC/100ml for a 80, 90 and 95 percentage compliance regime. These fresh water locations have an average sampling frequency of 48 over the period 1996-2000 and each location again has a minimum of 20 samples.

As for coastal bathing waters, the number of yellow and pink dots (labelled poor bathing water quality) in Figures 4 to 6 increases if the standard is tightened from the current 2000 FC/100 ml to 250 FC/100 ml. Under the current standard of 2000 FC/100 ml, 97 percent of the 561 inland fresh water locations meets the 95 percent compliance rate. In other words, in 97 percent of the cases (i.e. at 544 locations) less than 5 percent of the samples do not meet this standard. Hence, no significant bathing water quality problem seems to exist under the current standard. Most dots in Figure 4 are therefore blue. Only two yellow dots can be detected in the western part of the Netherlands, one at the western shore of Lake IJsselmeer and one in the south-western part of the Netherlands.

However, increasing the standard to 400 FC/100 ml, the number of yellow and pink dots emerging in Figure 5 is substantial, especially in the western part of the Netherlands. Some clustering of yellow and a few pink dots can be detected in the lake district in the south-western part of the northern province of Friesland and a few yellow and pink dots in the south of the Netherlands. At a standard of 400 FC/100 ml, three quarters (74%) of the bathing water locations meet the 95 percent rate.

Finally, applying a standard of 250 FC/100 ml 57 percent of the locations still meet the 95 percent rate. Overall, the number of yellow and pink dots increases, but their spatial distribution remains skewed to the western part of the Netherlands.

Figure 4
Compliance of fresh bathing water locations when 2000 FC/100ml is the standard

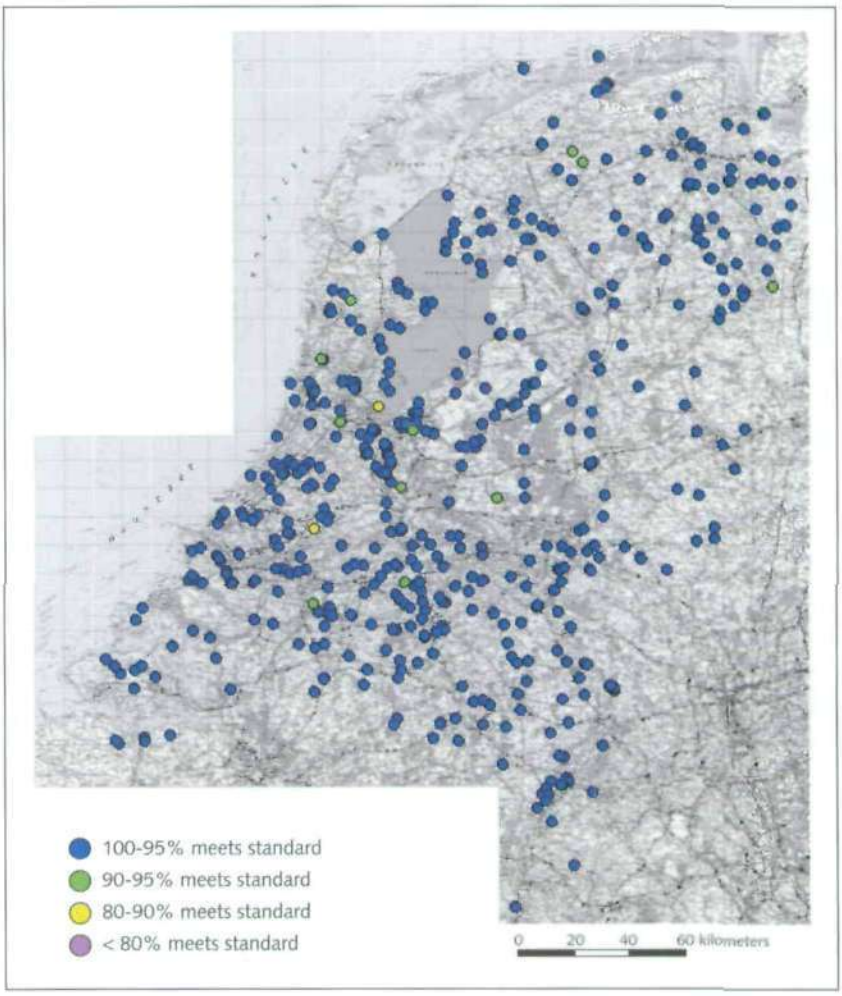


Figure 5
Compliance of fresh bathing water locations when 400 FC/100ml is the standard

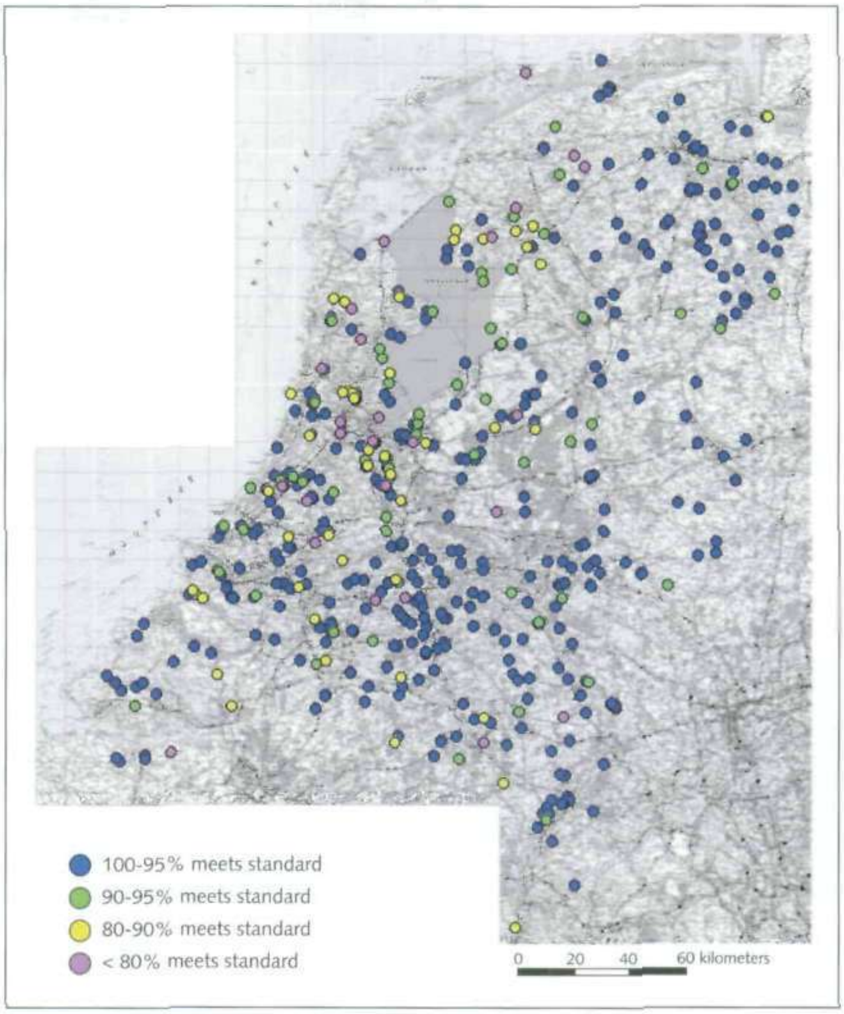
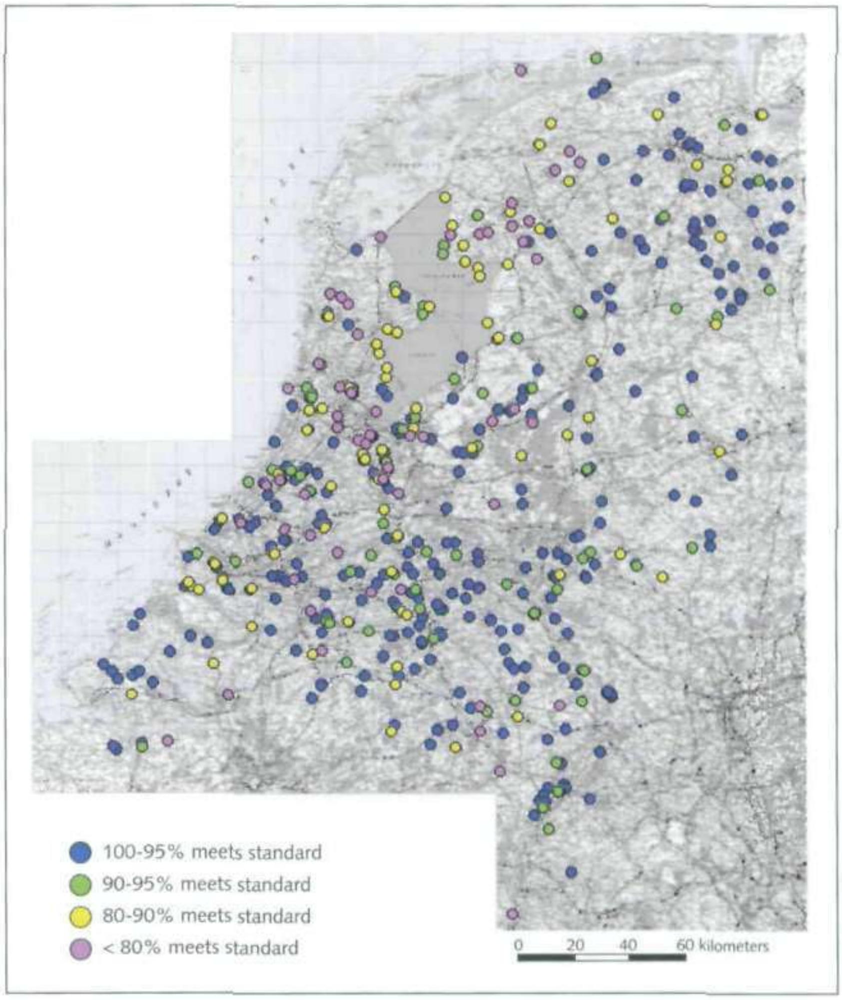


Figure 6
Compliance of fresh bathing water locations when 250 FC/100ml is the standard



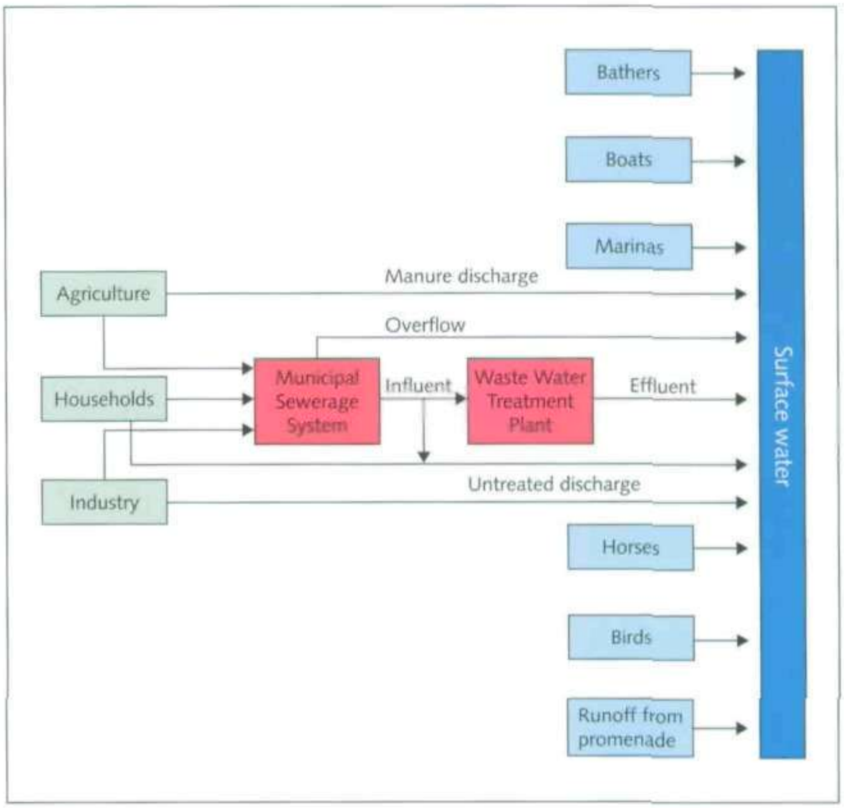
4 Potential sources causing non-compliance

The most important sources of biological organisms which have an impact on BWQ and about which information could be found are (in no particular order):

- Contamination from bathers.
- Toilet discharge from boats.
- Untreated discharge from households not connected to sewerage system.
- Overflow from combined sewerage systems to surface water.
- Untreated or unsatisfactory treated discharge from waste water treatment plants.
- Manure discharge from livestock.

Other potential sources are runoff from streets or promenades at or near the beach, horses or dogs on the beach, bird colonies at waste sites near bathing locations, and discharge from food processing industries into surface water. However, no information is collected systematically about these potential sources. An assessment of the extent to which these potential sources cause the problem will have to be carried out together with local experts who are informed about the specific details at each bathing water site. They will therefore not be discussed any further in this section. The available information collected about the five sources mentioned above and their location will be briefly discussed in the following sub-sections. The potential sources are displayed in Figure 7.

Figure 7
Potential sources of bathing water quality deterioration in the Netherlands

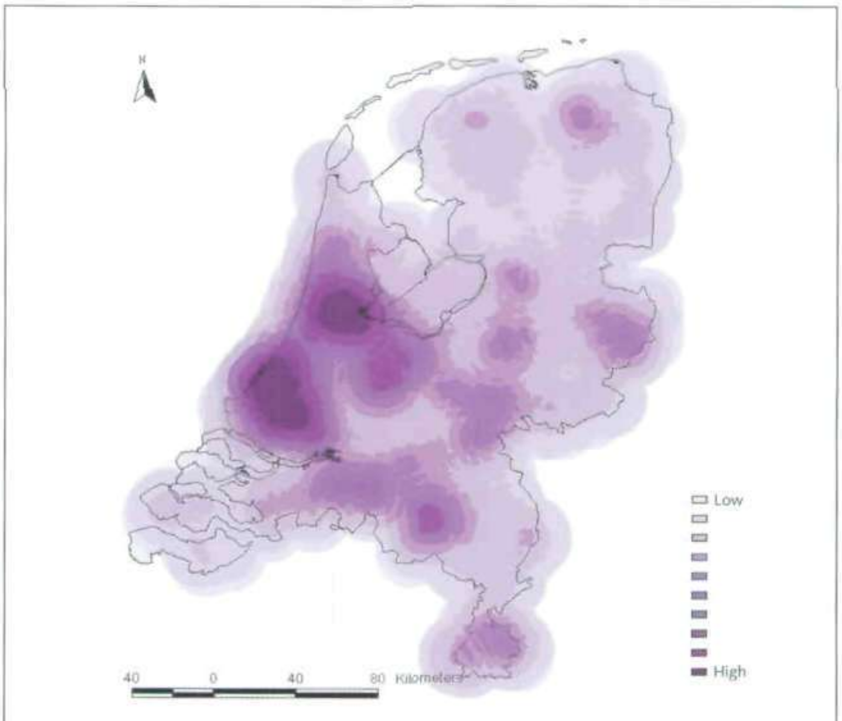


4.1 Water pollution from bathers

One potential source of pollution are bathers themselves. Depending on the number of visitors frequenting the bathing site at one point in time or over a period of time in the summer, the temperature of the water and whether the water at the bathing site is flowing or standing still, bathers themselves may contribute to a deterioration of the BWQ. The number of visitors at the various bathing sites across the Netherlands is currently not monitored systematically. Occasionally one or two municipalities (for instance Den Helder) monitor the number of visitors during summer periods. Sometimes the police or beach rescue teams roughly estimate the number of visitors during a specific day.

The only information currently available is the potential recreation pressure index from the Ministry of Agriculture, Nature and Fisheries (see Figure 8). However, this information is too general to be able to adequately assess the extent to which bathers themselves cause (part of) the problem. More information will be needed from experts, who know the specific location. From Figure 8 it can be seen that the highest recreation pressure is found in the western part of the Netherlands (inland and along the coast).

Figure 8
Recreational pressure index for the Netherlands (water and non-water based)

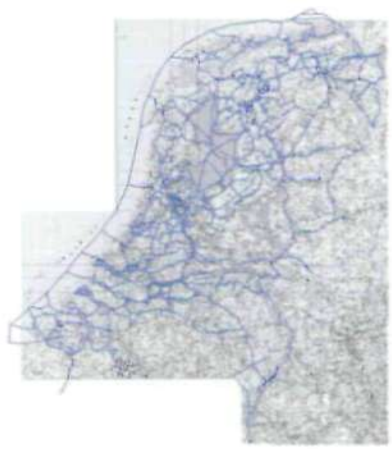


4.2 Toilet discharge from boats

Boats discharging the content of their toilets at mooring places or whilst sailing the Dutch waterways may also be a potential source of pollution of bathing sites. The total number of recreation boats in the Netherlands is about 150 thousand, of which 90 thousand motor boats and 60 thousand sailing boats (SRN, 1999). Part of the recreation fleet is owned by foreigners, in particular Germans and Belgians. In certain recreation areas the amount of foreign boats can be as high as 70 to 80 percent (for instance in the south of the Netherlands in the Limburgse Maasplassen). The recreation fleet is expected to grow at a rate of 1 percent per annum. This means that in the year 2025 the fleet will consist of approximately 190 thousand boats. Another trend is that recreation boats become bigger and more luxurious.

Most of the existing fleet does not have a chemical toilet or a dirty water tank. Only new boats are usually equipped with these attributes. A related problem is the scarcity of dirty water pumps at harbours, marinas or mooring sites. In this study, information has been collected about the location of the waterways in the Netherlands (Figure 9), mooring places, marinas and harbours and the facilities found at these places.

Figure 9
Waterways in the Netherlands



The main recreational navigation structure in the Netherlands consists of three axes ((SRN, 1999, p.15), of which the largest one runs from north-east to south-west. At first sight, a vague resemblance of this latter axis with the spatial track of poor bathing water quality locations detected earlier in *Figure 6 is perhaps noticeable (clustering of yellow and pink dots* in the south-west of the province Friesland, across Lake IJsselmeer to the south-western part of the Netherlands).

In order to illustrate the type of data included in GIS, marinas and mooring places around Lake IJsselmeer are shown in Figure 10. In the IJsselmeer and the Veluwerandmeren over 5500 mooring places are found (25% of the total number of mooring places in the Netherlands) and almost 25 thousand marinas (16% of the total number of marinas in the Netherlands). Less than half of the waterways found in this area have facilities for chemical toilet disposal. The number of marinas and mooring sites and the facilities found at the Dutch waterways are shown in Table 2.

It is important to point out that the percentages Table 2 referring to chemical toilet disposal facilities are based on the number of waterways found in each recreation area, not the number of marinas or mooring sites. In general, the percentage of marinas and mooring sites where facilities for chemical toilet disposal are found is much lower. In 1993, 65% of the total number of marinas and mooring sites in the Netherlands had a toilet, while only 27% had a dumping site for chemical toilets (Oranjewoud, 1993). Updated information about marinas and mooring places in the Netherlands is available from HISWA, the Dutch sector association for water recreation.

However, systematically collected information about on-site facilities, including dumping sites for dirty water, is lacking so far.

Figure 10
Waterways, marinas and mooring sites around Lake IJsselmeer

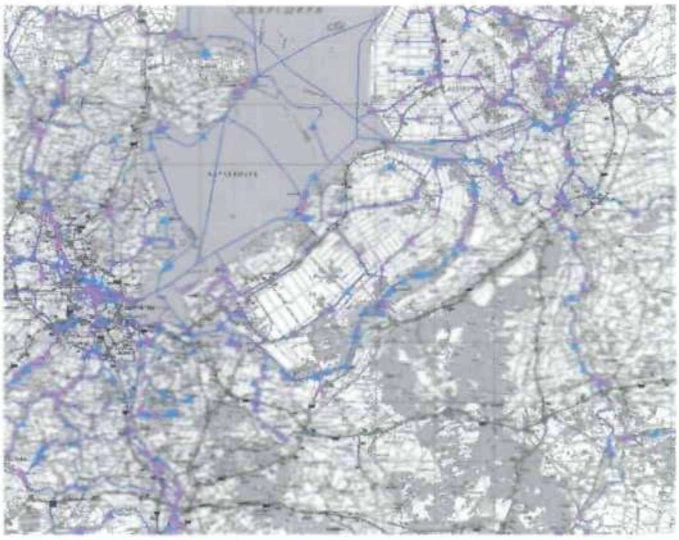


Table 2
Marinas and mooring places found in the main water recreation areas in the Netherland

Water recreation area	Number of waterways	Mooring areas	Marinas	% with toilet	% with chemical toilet disposal
Waddenzee	23	1560	1745	87	39
Lauwersmeer	7	95	1060	57	43
Fries-Groningse kanalen	83	1380	7315	61	36
Fries merengebied	110	1835	15645	61	36
Drents-Overijsselse kanalen	51	550	1695	51	27
Noordwest Overijssel	40	840	4115	50	43
Flevoland	19	20	180	32	21
Randmeren	54	3040	13445	72	46
IJsselmeer en Markermeer	50	2525	11345	82	48
Noordzeekust	14	280	1400	79	29
Noordhollandse kanalen	75	1375	12420	71	37
Noord-, Zuidhollands en Utrechtsplassengebied	88	1895	25270	52	32
Zuidhollandse vaarwegen	62	715	9515	69	31
Deltagebied	85	2305	17115	71	40
Rivierengebied	114	1830	13055	61	35
Biesboschgebied	34	610	5990	71	38
Brabantse kanalen	24	240	1110	50	13
Maas en Maasplassen	49	480	8960	67	43

Source: Oranjewoud, 1993.

4.3 Untreated discharge from households not connected to the sewerage system

The number of households not connected to the sewage system is very low in the Netherlands (2%) (Rioned, 2000). The number of premises not connected in the Netherlands is approximately 160 thousand (Table 3). Most of these premises are found in remote rural areas in the north and east of the Netherlands (water board districts of Friesland, Regge en Dinkel, Rijn en IJssel, Uitwaterende sluizen). Twenty percent of these premises is classified as 'very vulnerable', meaning that the discharge entails risks for human health.

In 2000, just over 300 premises had some kind of individual waste water treatment system[4], such as helophyte filters and submerged beds. Plans exist to increase this number to about 67 thousand by the year 2005. Half (53%) of these premises discharge at present directly into surface water (Rioned, 2000).

4.4 Overflow from combined sewerage systems to surface water

In combined sewerage systems, the same sewers transport both storm water and sewage to the sewage treatment plant. In case of heavy rain, the capacity of the sewers and plants may be insufficient to absorb all the water and transport it to the plant. This can lead to storm water overflows and the emission of pollutants to surface water. In 1992, the Dutch Coordination Committee on the Pollution of Surface Waters Act (CUWVO) recommended that the first step towards minimising the emission of pollutants be a nationwide reduction to the level of a theoretical reference value, since then generally known as the 'basic effort'.

Table 3
Number of premises not connected to the sewerage system and number of premises with an individual waste water treatment system in 2000 and 2005 per water board district

Water board district	Premises not connected	Classified as very vulnerable	Individual waste water treatment systems (IBAs)	Expected IBAs in 2005
Alm en Biesbosch	700	215	0	332
Amstel, Gooi en Vecht	5705	6040	0	160
Stichtse Rijnlanden	2135	803	n.a.	170
Delfland	2015	515	n.a.	n.a.
Rijnland	7250	1450	35	1600
Schieland	1300	800	2	310
Uitwaterende Sluizen	11000	4500	5	4000
West-Brabant	5702	1400	n.a.	n.a.
De Aa	4500	1000	0	2000
Dommel	2840	2120	20	500
Maaskant	2000	n.a.	2	1300
Friesland	16750	1000	0	13550
Groot-Salland	9000	320	20	7000
Hunze en Aa	7644	n.a.	25	3000
Noordzijlvest	4809	1476	40	3853
Regge en Dinkel	*12597*	*2006*	20	9000
Rijn en Ijssel	11600	3100	50	6000
Reest en Wieden	1787	233	n.a.	n.a.
Vallei en Eem	7000	1200	11	900
Veluwe	8329	n.a.	n.a.	n.a.
Velt en Vecht	2869	420	9	1700
Zeeuwse Eilanden	3000	80	30	2380
Zeeuws-Vlaanderen	3032	316	6	n.a.
Zuiderzeeland	4150	400	15	4150
Limburg	8000	2000	n.a.	n.a.
Holl. Eilanden en Waarden	6000	360	25	3000
Rivierenland	6000	600	3	2400
Total	157714	32354	318	67305

Source: Rioned, 2000.
n.a.: not available

In this study, information has been collected and put together about the number of combined or mixed systems (Table 4), overflow locations (Figure 11), the number of overflows (Table 5), the pressure exerted by overflows on the water system (emission to surface water based on geographical discharge units) (Figure 12) and the relationship between geographical discharge units (Figure 13).

Note
4 In Dutch: Individuele Behandeling Afvalwater (IBA).

Approximately 80 percent of the existing sewerage system in the Netherlands is mixed (Table 4). Ten percent of the existing sewerage system consists of a separate discharge of storm water and sewage, while another 10 percent consists of improved systems enabling storage of 4 mm rainfall over the whole area connected to the sewerage system and a storm water pumping capacity of 0,3 mm/hour (Commissie Integraal Waterbeheer, 2001).

Table 4
Number of inhabitants connected (or not) and type of sewer system in 1999

Total number of inhabitants	15 760 200	100%
• of which connected	15 437 116	98%
> of which separate system	1 489 339	10%
> of which improved separate system	1 733 622	11%
> of which mixed system	12 214 155	79%
• of which not connected	323 084	2%

Source: Rioned, 2000.

The annual number of overflows per water board area is presented in Table 4. In approximately 2% of the cases, the overflow is classified as dangerous to human health. In 2001, 92 (16%) of the 571 municipalities found in the water board districts meet the basic effort, i.e. the reference value set by the CUWVO. The number between brackets in the last but one column in Table 5 refers to the total number of municipalities found in each water board district. By the year 2010, it is expected that about 90% of all municipalities meet the basic effort.

Information about overflow locations (based on x and y co-ordinates) is also available from the Dutch Emission Registration System. In Figure 11 this is illustrated for Lake IJsselmeer. All overflow locations in the Netherlands have been included in the GIS data base and presented in Figure 11 as green dots. Most overflows occur in the north (water board districts Groningen, Friesland and Uitwaterende sluizen) and south-west of the Netherlands (water board districts Rijnland and Hollandse Eilanden en Waarden), while most municipalities currently meeting the basic effort are found in the south of the Netherlands (water board districts Limburg, West-Brabant, Dommel) (Table 5)[5].

The pressure exerted by overflow is shown in Figure 12. Figure 12 is based on the geographical discharge units in the Netherlands. The pressure is indexed in shades of red. An arbitrary distinction is made between eight different pressure classes. Included in the pressure index are the emission of P and N in thousands of kilograms. Although these substances are not directly a health hazard and they are not part of the compliance regimes in the BWQ Directive, they are used here as very rough indicators of the potential pollution and contamination of bathing sites in view of the fact that information about microbiological contamination in terms of FS and FC at overflow locations is not available.

Note

5 A small part of the total number of annual overflows (approximately two and a half per cent) occurs on the national rivers for which the Department of Public Works and Water Management is responsible and not the regional water boards.

Table 5
Annual number of overflows and number of municipalities meeting the basic effort per water board district

Water board district	Number of annual overflows	Classified as dangerous to human health	Municipalities meeting basic effort in 2001	Municipalities meeting basic effort in 2010
Groningen	1035	0	n.a.	n.a.
Fryslân	1135	18	10 (31)	31
Drenthe (Hunze en Aa)	703	72	4 (19)	19
Regge en Dinkel	335	9	0 (22)	22
Groot-Salland	535	17	0 (18)	18
Fleverwaard	15	0	n.a.	n.a.
Rijnland	1268	0	5 (42)	42
Rijn en IJssel	493	5	1 (39)	n.a.
Rivierenland	730	1	0 (28)	28
Veluwe	206	24	n.a.	n.a.
Vallei en Eem	358	0	2 (25)	25
Stichtse Rijnlanden	476	24	1 (21)	15
Amstel, Gooi en Vecht	816	0	3 (27)	27
Uitwaterende Sluizen	1179	7	4 (48)	48
Delfland	735	2	n.a.	n.a.
Holl. Eilanden en Waarden	*1747*	*25*	*4 (43)*	*43*
Schieland	297	13	4 (10)	10
Zeeuwse Eilanden	453	7	0 (10)	10
Zeeuws-Vlaanderen	207	5	0 (7)	7
De Aa	203	10	3 (21)	21
Alm en Biesbosch	120	n.a.	0 (3)	3
Dommel	409	7	14 (35)	35
Maaskant	253	3	2 (14)	14
West-Brabant	711	33	15 (21)	21
Limburg	709	0	20 (54)	50
Noorderzijlvest	n.a.	n.a.	0 (20)	20
Reest en Wieden	n.a.	n.a.	n.a.	n.a.
Velt en Vecht	n.a.	n.a.	0 (7)	7
Zuiderzeeland	n.a.	n.a.	0 (6)	n.a.
Total	15128	282	92 (571)	516

Source: Rioned, 2000.
n.a.: not available

Note: the numbers between brackets in the last but one column refer to the total number of municipalities found in each water board district.

Figure 11
Illustration of overflow locations (green dots) around Lake IJsselmeer as a potential source of bathing water pollution and contamination

In Figure 12, emission data collected at local and regional level has been linked to geographical discharge units. This is the most detailed level at which this type of information is available. Furthermore, the most recent data has been used in Figure 12. The emission data refer to the year 1998, while overflow locations are based on the year 1999.

Since the geographical discharge units are physically related, their connections have also been modelled in GIS. This allows the origin of overflows to be determined. Certain geographical units discharge to each other. Hence, the original cause of overflow pressures on bathing water quality may not always be the nearest overflow location found in the direct close surroundings of the bathing water location, but also overflow locations located further away.

How these spatial relationships can be traced with the help of the GIS application is shown in Figure 13. By clicking on a specific geographical discharge unit in the GIS module, the areas releasing water on this specific unit are shown in phases (first discharge from the nearest unit to the specific unit of interest, secondly the one but nearest unit etc.). Also the destiny of overflow pressures from one discharge unit to other units can be shown in the GIS module (again in different phases depending on the number of physically related discharge units).

Figure 12
Overflow pressure per geographical discharge unit in the Netherlands as a potential source of bathing water pollution and contamination (very roughly indicated by the P and N content of the overflow)

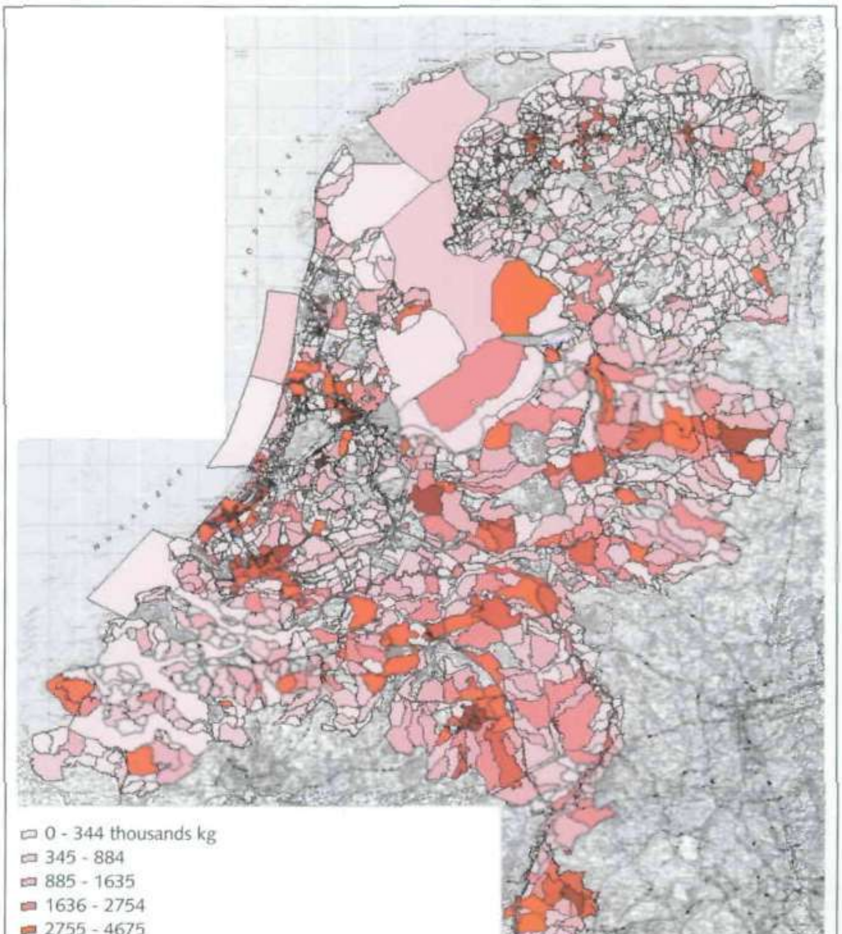


Figure 13
Illustration of the spatial connections between geographical discharge units

- Phase 4 (to)
- Phase 3 (to)
- Phase 2 (to)
- Phase 1 (to)
- Orginal source (discharge unit) (from)

0 3 6 kilometers

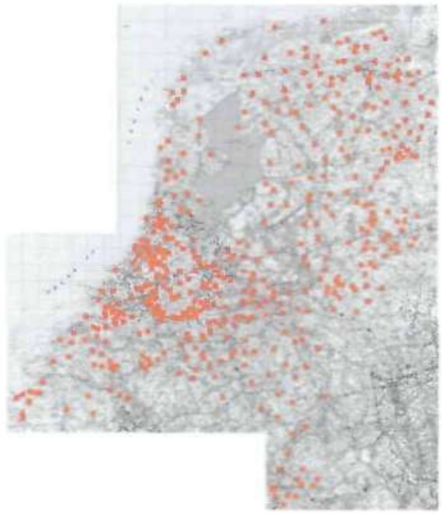
- Selected discharge unit (to)
- Phase 1 (from)
- Phase 2 (from)

0 3 6 kilometers

4.5 Untreated or unsatisfactory treated discharge from waste water treatment plants

Waste water treatment plants (WWTP) may be another potential source causing pollution of bathing waters. Information has been collected about the exact location of WWTP in the Netherlands (Figure 14).

Figure 14
Location of waste water treatment plants in the Netherlands (red dots) as a potential source of bathing water pollution and contamination



The red dots in Figure 14 indicate the location of WWTP in the Netherlands (again based on x and y co-ordinates). In total, there are 409 WWTP in the Netherlands with a total treatment capacity of almost 25 million inhabitant equivalents (i.e.). The number of WWTP per province and their average treatment capacity is shown in Table 6.

In the Netherlands, most WWTP use both mechanical and biological treatment of waste water (steps one and two). Mechanical treatment includes grating and filtration, while biological treatment means microbiological degradation of organic matter together with some nutrient removal. Measures that are explicitly aimed at the reduction of nutrient emissions can be added in an additional third step. Environmentally harmful substances such as pathogenic organisms and organic micro-pollutants are sometimes removed by using specific techniques in an additional (fourth) purification process.

Table 6
Waste water treatment plants and their treatment capacity per province

Province	Number of WWTP	Total treatment capacity (1000 i.e.)	Actual treatment (10^3 m^3/day)	Actual treatment (10^6 m^3/year)
Groningen	31	820	217	79
Friesland	30	1053	216	79
Drente	19	872	190	69
Overijssel	40	1960	406	148
Flevoland	5	302	65	24
Gelderland	54	3018	734	268
Utrecht	25	1520	384	140
Noord-Holland	45	3943	822	300
Zuid-Holland	79	4500	1259	460
Zeeland	23	650	153	56
Noord-Brabant	40	4534	985	360
Limburg	18	1642	447	163
Netherlands	409	24814	5879	2146

Source: Rioned, 2000.

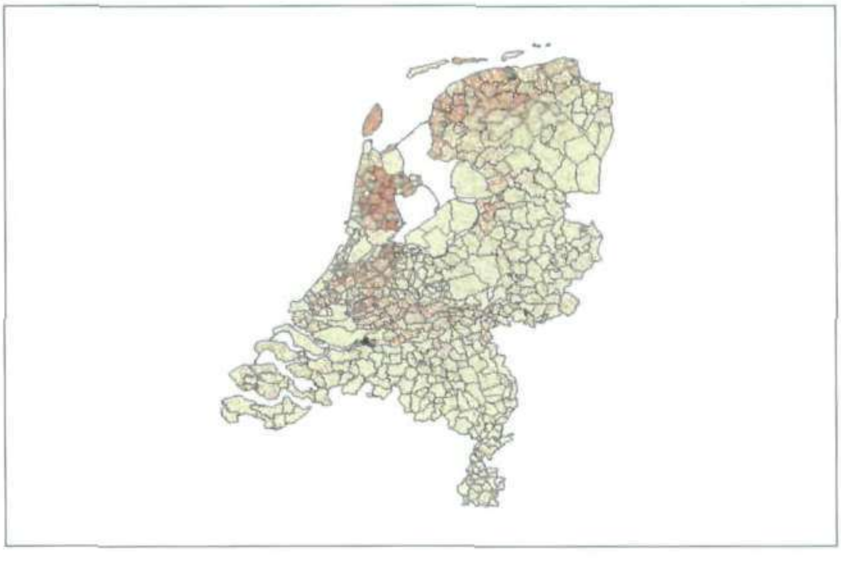
In general, most biological micro-organisms (99%) are killed in the first two steps (Kleijn *et al.*, 2000). However, if non-treated waste water is discharged from a nearby WWTP, this may have a negative effect on bathing water quality. Over a third (36%) of the WWTP are found in the most densely populated western part of the Netherlands, with a share in the total treatment capacity of 40 percent. The lowest treatment capacity is found in the provinces Flevoland (polder in Lake IJsselmeer) and Zeeland (most south-west situated province of the Netherlands).

4.6 Manure discharge from livestock

Manure discharge from livestock is another potential source of surface water contamination. Based on livestock density (Figures 15 and 16) and total manure production, the average amount of manure per hectare could be calculated in thousands of kilograms (Figure 17).

Figure 15
Total number of cows per municipality (1 dot equals 100 cows)

Figure 16
Total number of sheep per municipality (1 dot equals 100 sheep)



Besides livestock density and manure production per hectare, information is also available about the emission of manure to surface water in kilograms N and P per PAWN district[6]. Also this information has been included in GIS (Figure 18). A remarkable difference exists between Figures 17 and 18. In Figure 17, manure production per hectare from cows and sheep taken together is highest in the centre and south of the Netherlands in the provinces Gelderland and Noord-Brabant. However, looking at Figure 18, most emissions of manure into surface water take place in the northern part of the Netherlands in the province Friesland.

Figure 17
Manure production in the Netherlands as a potential source of bathing water pollution and contamination (municipality level)

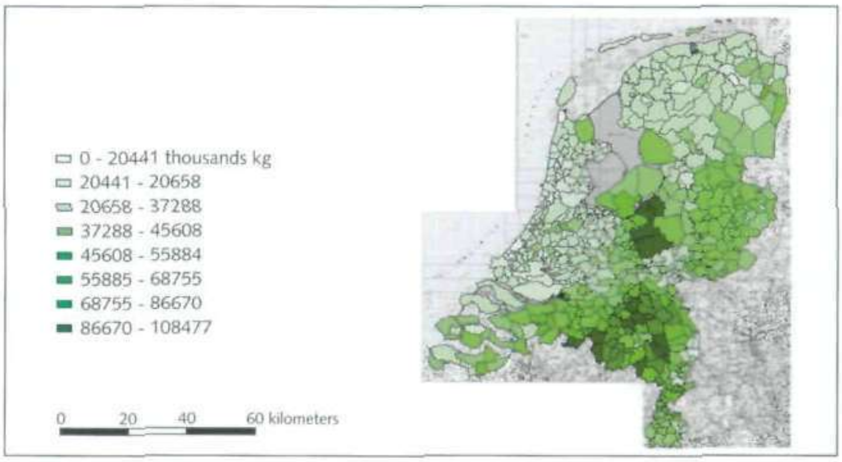
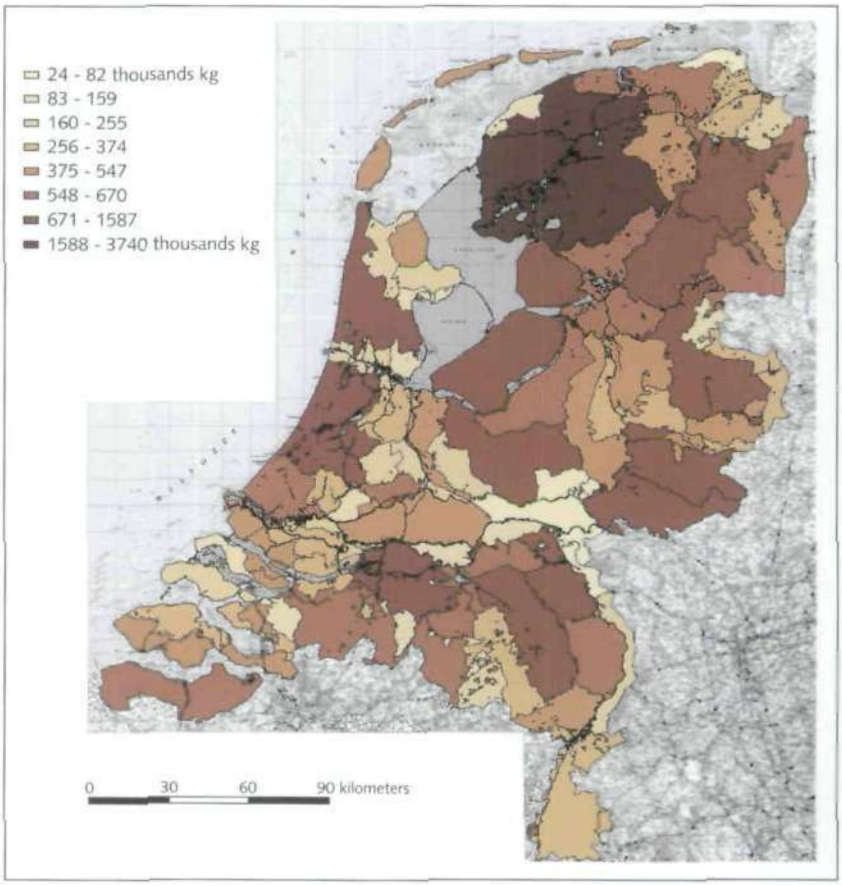


Figure 18
Emission of manure measured in thousands of kilograms N to surface water (per geographical discharge unit)



Note

6 In the 1980s, the Netherlands has been subdivided in approximately 80 hydro-geographical units called Policy Analysis Water Management Netherlands (PAWN) districts.

5 Possible management measures

In this section, possible measures to abate pollution and contamination related to the six main sources presented in the previous section will be briefly discussed. These possible measures include:

- Restriction of the number of visitors (who bathe) to the bathing water location/temporary closure of the site.
- Installation of waste water tanks in boats and waste water disposal facilities (including pumps) at harbours and marinas.
- Reduction of untreated discharge from households not yet connected to the sewerage system.
- Improved or separate sewerage systems to eliminate the detrimental effects of overflow on BWQ.
- Measures (BAT[7]) to reduce untreated or unsatisfactory treated discharge from waste water treatment plants.
- Closed in-house systems for livestock or management measures on agricultural land to keep livestock away from ditches, channels or rivers.

It is important to point out that the measures presented here are defined in a very broad way. Depending upon the specific circumstances at bathing water locations which do not comply with BWQ standards, these measures will have to be elaborated in more detail. Obviously, also combinations of measures are possible, again depending upon site specific conditions, in particular the contribution of various polluting sources to the water quality problem.

5.1 Restriction of the number of bathers at the bathing water site

One possible measure to reduce the impact of large numbers of visitors at bathing water sites (especially recreation sites with closed water systems) is to restrict access to the water at these sites[8]. However, especially for popular bathing resorts this measure may be hard to implement. In view of the public's right of access to bathing sites in the Netherlands, the introduction of price mechanisms is also not considered feasible.

Temporary closure of beaches when BWQ standards are breached or notice boards recommending not to swim in the water is considered to be more effective and acceptable to the public at large.

Note

7 Best Available Techniques (BAT).

8 Restricting access to bathing water locations was originally introduced in the Revision of the Bathing Water Quality Directive as an ex post measure to protect health, not as a measure to reduce the pressure exerted by bathers themselves on the water quality.

5.2 Installation of waste water tanks in boats and waste water disposal facilities at harbours and marinas

The number of motor and sailing boats on the Dutch waterways is expected to grow. Additional mooring sites and marinas will be needed over the next 25 years. In order to reduce the pressure from these boats on the surface water, existing and additional sites will need to be equipped with disposal facilities for waste water tanks. Increasing the number of sites where these facilities are found is expected to have a positive effect on the number of boats which will install waste water tanks. At present, the dilemma seems to be that boat owners do not install waste water tanks because there are insufficient disposal facilities, while marinas and harbours do not provide the facilities, because only a very limited number of boats have a waste water tank.

The Dutch Association for Recreational Navigation (SRN) has therefore started building 200 waste water tanks along the Dutch waterways (ANWB, 2002). A number of provinces furthermore subsidize the purchase of waste water tanks by boat owners (maximum of € 136,=/boat) and the installation of waste water tanks at marinas (maximum € 4545,=).

5.3 Reduction of untreated discharge from households not yet connected to the sewerage system

In order to reduce the discharge of untreated sewage from households not yet connected to the sewerage system, these households can either be connected to the existing sewerage system or use an individual waste water treatment system. In view of the fact that the total number of premises not yet connected in the Netherlands is already very low (2%) and most of these premises are found in remote rural areas, this last measure is considered technically speaking most feasible and promising.

Plans exist to increase the number of IBAs in the Netherlands in the next 5 years to a total number of 67 thousand (Table 3). Seven percent of these individual waste water treatment systems will be installed at locations which are currently classified as 'very vulnerable' (Rioned, 2000). This would reduce the present number of premises classified as 'very vulnerable' by half.

5.4 Improved or separate sewerage systems to eliminate the detrimental effects from overflow

In order to reduce overflow from storm water (heavy rainfall), the majority of existing combined sewerage systems will have to be improved or replaced by separate systems. In general, these types of measures are laid down in so-called municipality sewer plans (GRP) or basic sewer plans (BRP). Measures are often related to permits. By the year 2010, it is expected that about 90% of all municipalities meet the basic effort (Table 5). Most of these municipalities are included in the 2% currently responsible for overflows classified as dangerous to human health.

5.5 Measures to reduce untreated or unsatisfactory treated discharge from waste water treatment plants

Depending upon the exact nature of the bathing water quality problem, the most important measures to reduce the emission of untreated or unsatisfactory treated waste water from waste water treatment plants are to expand existing treatment capacity if this is causing (part of) the problem or to include a fourth step in the purification process of waste water using ultra violet (UV) radiation. Other alternatives than the use of UV radiation are ozon or hydrogen peroxide. UV, ozon and hydrogen peroxide work as disinfectants, killing bacteria and virus. UV radiation is based on the use of low or high pressure mercury lamps. Important for the UV radiation to be effective is the absence of suspended particles in the waste water. Ozone and hydrogen peroxide are added to waste water as gas. UV radiation is applied on a large scale by Dutch drinking water companies to prepare drinking water.

5.6 Closed in-house systems for livestock or management measures on agricultural land to keep livestock away from ditches, channels or rivers

In order to reduce the emission of manure from livestock directly into surface water, the most obvious management measure would include fencing or buffer strips in order to keep the livestock away from the water or prevent manure spreading during the bathing season. However, often these waterfronts serve as a drinking place for cows and sheep. Farmers allow cattle near the water to drink. Another option would be to reduce the intensity of livestock on agricultural land in order to reduce the amount of manure entering the water system or to keep livestock indoors and store the slurry or manure. In some cases, leaking from slurry or manure storage may also be a source of pollution and should obviously be prevented.

6.2 Installation of waste water tanks in boats and waste water disposal facilities at harbours and marinas

The expected effectiveness of installing waste water tanks in boats is limited (Provincie Drenthe, 2000) and depends upon a number of factors such as flowing or still water, the water surface etc. An important side-effect may be that awareness of boaters is raised with respect to maintaining good water quality. However, the extent to which this can be legally imposed is uncertain, especially in view of the fact that the number of foreign visitors can be substantial.

The installation costs of waste water tanks in existing boats depends to a certain extent on the remaining available space on board. Different sizes can be installed, depending on the available space. Making space includes labour costs. When installing the waste water tank oneself, the price of the smallest tank available (25 litres) is approximately € 135,=. Estimated all-in prices of larger tanks (including tubes and connections, excluding labour costs) are presented in Table 7.

Table 7
Estimated costs of waste water tanks

Tank capacity (litres)	Estimated costs [1] (€)
25	135
100 (12 volt)	770-840
150 (12 volt)	840-885

Source: expert judgement
1 Excluding labour costs and replacement/removal of existing material.

Based on expert judgement, the installation of a waste water tank at a professional boatyard costs between € 1300,= and € 2700,=. The estimated installation costs of waste water facilities on-site are approximately € 4500,=.

Assuming that three quarters of the existing fleet will be equipped with a waste water tank at an average cost of € 750,= the total costs are approximately € 85 million. Increasing the number of waste water tank facilities on-site at approximately three quarters of the 800 marinas found in the Netherlands results in an estimated additional cost of € 3 million (600 x € 4500,=). Hence, the total costs amount to about € 88 million.

6.3 Reduction of untreated discharge from households not yet connected to the sewerage system

Connecting the currently not yet connected households to the sewerage system is expected to be very effective. However, at the same time the costs involved are expected to be very high as well as this is generally acclaimed to be main reason why premises in remote areas have not yet been connected.

The average construction costs range from € 3000,= per premise for combined systems to € 3800,= for separate systems (Rioned, 2000). Hence, connecting the remaining 90 thousand premises (157 thousand minus the 67 thousand which are expected to use an individual waste treatment system; see Table 3) results in total construction costs ranging between € 270 and € 342 million, depending upon the type of sewerage system applied.

On top of these construction costs come the annual costs associated with the running, maintenance and replacement of the sewerage system. In 2000, these were estimated at € 160/year/premise (Rioned, 2000). Discounted over a period of say 50 years at 4%[11], this results in an additional operation cost figure of € 3437,= per premise. Multiplied by 90 thousand premises this amounts to € 310 million. Hence, the total costs of connecting the remaining 90 thousand premises in the Netherlands to the existing sewerage system range between € 580 and € 652 million.

However, this is probably an underestimation of the real costs in remote rural areas. Approximately ten percent of the total annual costs related to the present running and managing the sewerage system are related to remote rural areas. This amounts to about € 100 million per year. These costs are expected to increase exponentially if the remaining premises in *remote areas are also connected to the sewerage system. Another more* cost-effective solution are individual biological waste water treatment systems such as active slurry, helophyte filtering and submerged beds. The cost effectiveness of these alternatives is presented in Table 8.

Table 8
Cost-effectiveness of different (individual) waste water treatment systems

	Waste water treatment system (treatment capacity 4 i.e.)			
	Septic tank	Active slurry	Submerged bed	Helophyte filter
Purchasing costs (€)	1545	2455	5090	3000
Construction costs (€)	455-1820	910-2270	1360-3640	1360-2045
Running costs (€/year)	0	68	114	45
Maintenance costs (€/year)	90	135	182	135
Discounted (4%) running/ maintenance costs (€)[1]	1933	2869	4184	1518
Discounted (4%) running/ maintenance costs (€)[2]	1933	4360	6358	3866
Total costs over lifetime	3933-5298	6234-7594	10634-12914	5878-6563
Estimated midpoint	4615	6914	11774	6220
Total costs over 50 years	3933-5298	12773-16173	22483-28183	25666-29091
Estimated midpoint	4615	14473	25333	27378
Lifetime (years)	50	20	20	10
Effectiveness (%)	50	98.8	98.8	98.8
Cost-effectiveness (€/%)[1]	92.3	70.0	119.2	62.9
Cost-effectiveness (€/%)[2]	92.3	146.5	256.4	277.1

Source: Kleijn *et al.* (2000).
1 Over the estimated technical lifetime.
2 Over 50 years.

The annual costs in Table 8 are discounted over the relevant life time of the measures and over a 50 years period at a discount rate of 4%. In order to be able to compare measures in terms of their cost-effectiveness in a methodologically correct way, their different life time spans have to be taken into account. Therefore, the total costs for the last three measures include replacement of the treatment system after their technical lifetime has run out. The cost-effectiveness of the measures is calculated by dividing the presented midpoint estimates by the kill-off rate (effectiveness) of a measure.

Assuming that the remaining 90 thousand premises all apply the most cost-effective solution (septic tank), the estimated total costs are € 415 million.

Note
11 The discount rate prescribed by the Ministry of Finance for large projects carried out by the Government in the Netherlands.

6.4 Improved or separate sewerage systems to eliminate the detrimental effects from overflow

The effectiveness and costs of this type of measure were discussed in the previous section (section 6.3). By 2010, 90 percent of the municipalities will meet the basic effort, i.e. reduce the total number of overflows and eliminate overflows currently classified as dangerous to human health. If this is the case then meeting the basic effort implies that overflow should not have any impact anymore on meeting future BWQ standards, and hence almost no additional measures have to be taken.

6.5 Measures to reduce untreated or unsatisfactory treated discharge from waste water treatment plants

In general, the effectiveness of the introduction of a fourth step in the waste water purification process is expected to be high (99%)[12]. UV radiation kills all bacteria and virus as long as suspended particles are absent in the waste water.

No general cost estimations are available for this type of treatment, only very limited information from incidental studies. The costs per unit waste water treatment (m^3) depends upon the total amount of waste water treated at one and the same time. Depending upon the amount of waste water and the presence of suspended particles, more or less lamps are used. In a study carried out in 1997 in the WWTP in Huizen (H_2O, 1997), the total costs were estimated at € 0,10/m^3. In a study carried out in 1999 in the WWTP in Driebergen (DHV, 2000), similar cost estimates were found for the use of UV radiation (UV oxidation) to reduce the amount of organic pesticides (diuron) from waste water[13]. However, only for the running costs of the system, not the initial construction costs.

Since information about the total amount of waste water which has to be treated in order to meet current and future BWQ standards at different bathing water locations is not available, the expected total costs of this management measure can not be calculated.

6.6 Closed in-house systems for livestock or management measures on agricultural land to keep livestock away from ditches, channels or rivers

Reducing the emission of manure from livestock into surface water is expected to be another effective measure. The associated costs depend upon the exact management measure implemented. When fencing the water side, information has to be collected first of all about the length of the fence. This can then be multiplied by the unit price of a fence. However, unit prices can differ significantly depending upon the type of fence put in place. Also labour costs have to be taken into account.

Note

12 However, a residual of one percent can still be sufficient to cause a bathing water quality problem.

13 Huizen is located at the south-west shore of Lake IJsselmeer, approximately 30 kilometres east of Amsterdam, while Driebergen is located approximately 40 kilometres exactly south of Huizen near Utrecht.

Another option would be to reduce the livestock density on agricultural land located near or at water which is also used as bathing water. The direct costs associated with this measure consist of the benefits foregone by the farmer, i.e. the economic production value of a cow or sheep. In order to be able to assess these direct costs, the number of cows or sheep has to be estimated which will be removed from the land. This number will then have to be multiplied by the production value per cow. However, simply reducing the number of cows or sheep on agricultural land is not expected to be very effective if livestock is not kept away from the waterfront at the same time.

Finally, keeping livestock indoors instead of allowing them to graze outside is expected to be an effective measure as well. In a study carried out in the beginning of the 1990s (Leneman *et al.*, 1992), the total costs of having dairy cattle during the whole year in the stable were estimated at € 7,600/farm/year. Public perception of this measure (not allowing livestock ever to graze outside during the summer months) may also play a role here.

7 Usefulness and reliability of the GIS application

In this one but last section, the usefulness and reliability of the data included in GIS will be assessed. This is done by comparing the preliminary results from the GIS application with respect to the identification of potential sources with the results from a study carried out in 2000 at twelve different bathing water locations across the Netherlands (van Pelt, 2000). In this latter study, representatives from regional water boards responsible for maintaining water quality at the sites were asked for their expert opinion about potential sources and management actions. The sites consist of two coastal waters, one estuarine water and nine fresh water locations (rivers, confined waters and lakes). The results of the comparison are presented in Table 9. For confidentiality reasons, the locations are not mentioned by name, but referred to as numbers.

The results presented in Table 8 are mixed. At three of the twelve sites (sites 5, 8, 9) the GIS application comes up with exactly the same potential sources as the trial study in 2000. At three other bathing water sites (4, 6, 12) the GIS model is unable to predict any of the potential sources mentioned by regional experts. An important reason for this is that these specific potential sources (bathers, wildlife, dogs, birds) at or near bathing water locations are not included in the GIS model at all as data about these sources at a national level is not available.

However, a remarkable result is that in eight out of the twelve cases (at sites 1 to 3 and 5 to 9) potential sources emerge from the GIS application which were not mentioned by the regional experts before[14]. Moreover, in some cases (for instance bathing sites 10 and 11) the description of the potential sources seems to be more detailed with the help of the GIS application[15].

Although it is difficult to conclude anything from this preliminary assessment of the usefulness of the GIS application, the results presented here do seem to offer some promise for its future use. More specifically, using the GIS model allows researchers, policy makers and water managers to quickly:

1) scan the number and location of the various complying and non-complying bathing water sites at different standards;
2) scan potential sources causing non-compliance.

Note

14 In most cases the GIS data refers to more or less the same period as the one in which the experts were consulted.

15 The description of the sources identified in the 2000 trial presented in Table 9 is copied literally from the report. No detailed information is available from the interviews with the experts at these bathing water locations. It is therefore not possible to conclude whether the GIS application does indeed produce a more detailed description of potential sources. It is also not possible to check whether the potential sources identified with the GIS application but not by the experts are indeed significant contributors to the problems encountered at the specific bathing water locations.

As mentioned several times throughout this paper, the extent to which these potential sources are indeed relevant at specific sites and the extent to which they contribute to problems at non-complying bathing water sites has to be investigated in more detail before any conclusion can be drawn about the appropriateness, effectiveness and associated costs of management actions.

Table 9

Potential sources of pollution identified in the 2000 trials by regional experts and potential sources identified with the GIS application

Location	Description from 2000 trial	Water quality in GIS[1] (covering the period 1996-2000)	Sources identified in 2000 trial	Potential sources from GIS application
1	Fresh water, confined, usage: swimming, boating (also motorised)	Current standard (2000) 95% compliance New standard (400) 80-90% compliance New standard (250) 80-90% compliance	Waste water treatment work, overflows municipalities, some untreated sewerage water, industrial discharge, boats.	Waterway for boats just in front of the bathing site. Marina and mooring place at site. No WWTP in close surrounding. Across the lake municipality overflow, with discharge to lake and bathing site. Camping site just north of the bathing site and two car parks just north and south of the bathing site.
2	Fresh water, confined, artificial	Current standard (2000) 95% compliance New standard (400) 95% compliance New standard (250) 80-90% compliance	Fish food, snackbar, in contact with river via ground water.	Nearby municipality overflow and WWTP which discharge to bathing location. Low manure production in the area (2108 kg/ha).
3	Fresh water, open, river	Current standard (2000) 95% compliance New standard (400) 80-90% compliance New standard (250) 80-90% compliance	Five WWTP upstream bathing water site. Industrial activities upstream. Agricultural activities. Occasionally dead animals in the river.	The bathing site is located at a small river which functions as a waterway for recreational boating. At least seven municipality overflows (of which four upstream) have been identified which discharge directly or indirectly to the river Linge. Two WWTP which also discharge to the river Linge and could have an impact on the bathing water location. Number of cattle at municipality level: 43200. Manure production: 36233 kg/ha. Pressure of *manure on surface water intermediate (12121 kg N/ha; 698 kg P/ha).*
4	Fresh water, confined, artificial,sandy beach surrounded byforest, usage is swimming only.	Current standard (2000) 95% compliance New standard (400) 95% compliance New standard (250) 80-90% compliance	Bathers, wildlife.	Natural bathing location in the middle of a forest. No immediate sources detectable. Two overflows and one WWTP well outside the forest have no impact on the lake. Although the manure production level in the area is high (59930 kg/ha), the impact on the surface water is very low (7131 kg N/ha and 332 kg P/ha).
5	Fresh water, open, river	Current standard (2000) 80-90% compliance New standard (400)) <80% compliance New standard (250) <80% compliance	Motorised boats.	Waterway with boats and several nearby mooring places. Sluice a little bit upstream where boats may have to wait or moor as well. Surrounding pasture land in dike enclosures and in flood plains. Cattle grazing in flood plains potential source. Grazing density in flood plains lower than in dike enclosure, but high surface water pressure (17503 kg N/ha and 1834 kg P/ha). Nearest WWTP no influence, but two WWTP further upstream (in)direct effect on this bathing water location. Discharge from nearby municipal overflow locations (upstream and downstream) seem to have no direct effect on bathing water site.
6	Fresh water, confined, river	Current standard (2000) 95% compliance New standard (400) 95% compliance New standard (250) 95% compliance	Numerous river discharges, motorised boating, birds.	No direct detectable effect of grazing cattle (some agriculture in close surrounding, but pressure on surface water relatively low). No direct impact of nearby overflow locations. *Overflow pressure in the area low.* Only potential influence of discharge from WWTP eastwards of bathing water location.

1 The BWQ standard is given between brackets in cfu/100 ml.

Table 9 Continued

Potential sources of pollution identified in the 2000 trials by regional experts and potential sources identified with the GIS application

Location	Description from 2000 trial	Water quality in GIS[1] (covering the period 1996-2000)	Sources identified in 2000 trial	Potential sources from GIS application
7	Fresh water, open, lake, sandy/grassy beach surrounded by agricultural land; usage is swimming and non-motorised boating.	Current (2000) 95% compliance New standard (400) <80% compliance New standard (250) <80% compliance	Runoff from agricultural back country, some households not connected to sewer network.	Very high cattle grazing density and manure production (92924 kg/ha). Very high pressure of manure to surface water (9695 kg N/ha and 588 kg P/ha). Fairly high overflow pressure. Four out of the five municipality overflow locations discharge into the lake at which the bathing water location is situated. One overflow location further up north (upstream) also discharges into the lake. Camping and big marina just a few hundred metres upstream of the bathing water site.
8	Fresh water, open, lake, usage is swimming, boating	Current standard (2000) 95% compliance New standard (400) 80-90% compliance New standard (250) 80-90% compliance	Some streams discharge close to the bathing site. These streams flow through agricultural land (cattle, arable land). The streams can therefore contain manure and nutrients.	Long beach, 4 car parks, camping site just upstream. Marina in front of beach. Boating in lake where beach is located. Very high cattle grazing density on surrounding agricultural land. Very high manure production (103324 kg/ha) and manure discharge to surface water (9695 kg N/ha; 588 kg P/ha). Very high overflow pressure. Two distant municipal overflow locations indirectly affect the bathing water location.
9	Fresh water, open, lake, surrounded by agricultural land and grassland, usage is swimming	Current standard (2000) 95% compliance New standard (400) 95% compliance New standard (250) 95% compliance	The beach is mainly influenced by a small river. A water treatment plant is situated 2 kilometres upstream. During heavy rainfall one can expect higher coliform values as a consequence of emergency overflow. Run-off from agricultural land is also possible. In quiet periods birds are on the beach.	Nearby camping, just a few hundred metres upstream. Nearby sluice, also just a few hundred metres upstream. Nearby harbour and boat activities. Although grazing density on surrounding agricultural land is medium (47270 kg/ha), the corresponding pressure on surface water is high (9695 kg N/ha; 588 kg P/ha). Although overflow pressure appears low, one WWTP and three overflow locations in a nearby city have their discharge in a canal which discharges in turn into the lake.
10	Brackish water, open, estuarial	Current (guide[2]) standard (100) 95% compliance New standard (200) 80-90% compliance New standard (50) <80% compliance	Numerous (river discharge).	One overflow location in town at beach. Low overflow pressure though. Medium grazing density, manure production and runoff to surface water from agricultural land.
11	Coastal water, open	Current (guide) standard (100) 95% compliance New standard (200) 80-90% compliance New standard (50) 80-90% compliance	Numerous (river discharge).	Camping site in dunes. Car park to beach. Very high manure discharge to surface water although surrounding grazing densities and manure production is low. Various overflow locations in canal which discharges into the sea. However, no direct discharge from the se potential sources of pollution via the canal to the sea.
12	Coastal water, open	Current (guide) standard (100) 80-90% compliance New standard (200) 80-90% compliance New standard (50) 80-90% compliance	Discharge from river, sailing boats, dogs.	No sources directly detectable. Beach conveniently located in bay. No direct waterways, mooring sites, harbours. Low manure pressure on surface water. Potential pollution from waterways up north and Maasvlakte, not very likely in view of the beach's closed off location.

1 The BWQ standard is given between brackets in cfu/100 ml.
2 For brackish and coastal waters the indicator faecal streptocolli is used here, for which only a guide standard is given the current directive (no imperative standard).

8 Conclusions and recommendations

In the study presented here, a quick scan was carried out of the data and information presently available to assess the implications of a revised Bathing Water Quality Directive with more stringent water quality standards in the Netherlands in terms of:

- Compliance.
- Sources of pollution in case of non-compliance.
- Management measures.
- Cost-effectiveness of these measures.

The available information about bathing sites, historical bathing water quality at these sites, compliance and potential sources of pollution was included in a Geographical Information System. A comparison of this information system with an in-depth study carried out in 2000 about bathing water quality and sources of pollution showed that the GIS module may help to provide useful preliminary information about potential sources of pollution. However, currently available information to define and assess relevant management actions in case of a more strict bathing water quality regime and their cost-effectiveness is very limited. Moreover, the costs and effectiveness of different (often complementary) management actions largely depend upon the specific circumstances at bathing water locations. More detailed information is needed at least at the level of representative clusters of bathing water locations in different management areas in order to better understand the consequences of more strict bathing water quality standards in the Netherlands in terms of appropriate management actions, their costs and effectiveness at a national level.

Another important issue remains the statistical analysis of the available data about bathing water quality over the past five years. Even though a large amount of data is available for analysis, it remains difficult to conclude whether failure to comply with imposed standards (non-compliance) is caused by incidental or structural factors. Obviously, these first two steps (assessment of compliance and sources of non-compliance) have important consequences for the next step of identifying relevant management actions. In order to be able to carry out a cost-effectiveness analysis of relevant management actions, information has to be available about (1) the extent to which each source of pollution contributes to the specific BWQ problem, (2) the extent to which each management action contributes to solving this problem, and (3) the associated (unit) costs.

Although no robust conclusions can be drawn about specific cost-effective management actions in the Netherlands and the expected total costs of a revised BWQ Directive based on the preliminary assessment presented here, the analysis of presently available information provides valuable insight into the variables and uncertainties about which more information has to be collected in order to be able to adequately inform the BWQ revision process. The use of local and regional expert judgement at different clusters of bathing water locations is considered an important next step to further investigate the relevant sources of pollution and the various management actions that can be taken to tackle these sources. The GIS application developed in this study can be used as a first step in this in-depth follow-up investigation. More detailed information based on expert judgement and primary data collection about the effectiveness and unit costs of specific management measures is needed in order to be able to identify cost-effective solutions in different management districts or even at individual sites in a satisfactory (reliable) way. Contrary to existing data bases for specific nutrient emission abatement measures, no up-to-date national data base exists which contains more detailed information about unit costs and effectiveness of various micro-biological management measures. The demand for this type of information (for nutrient and micro-biological pollution abatement measures) is expected to increase further in the near future in view of the information requirements following from the national implementation of the EU Water Framework Directive.

In this study, a number of potential sources and measures were discussed and a preliminary attempt was nevertheless made to get a better understanding of the order of magnitude of the costs involved when applying these measures all at the same time. The costs of equipping the existing recreation fleet with waste water tanks and providing waste water disposal facilities on shore were estimated, for instance, at about € 88 million, while the least cost solution to deal with the emission of untreated waste water from those premises in the Netherlands which are currently not yet connected to the sewerage system was estimated at about € 415 million. The problem of overflows and their potential impact on the deterioration of BWQ is expected to be solved largely through existing municipality sewer plans by the year 2010.

However, an educated guess of these costs (including the costs of potential measures at WWTP to reduce the impact of untreated or unsatisfactory treated waste water, or measures in agriculture to reduce the emission of manure to the water system at or near bathing water locations) is only possible if the contribution of these management measures (individually and combined) to achieving a given standard is assessed first in more detailed management district specific cost-effectiveness analyses.

Finally, the national (public) benefits of a revision of the Bathing Water Quality Directive in terms of higher bathing water quality norms are expected to be substantial, especially along the Dutch coast, which attracts many visitors every year during the bathing season. However, how large these benefits are (compared to the costs) is unknown. One way of assessing the public benefits of good bathing water quality through more stringent standards is to estimate the number of people who currently bathe at the different bathing water locations in order to get a better idea of the target group, i.e. the number of people who would benefit from improved bathing water quality. Or to use a public survey in which the public at large is asked whether they would go swimming if water quality is improved and hence the risks to their health reduced.

In environmental economics various methods are available to estimate the monetary value of these public benefits[16]. However, these methods are not undisputed. Moreover, the question is whether a full monetization of the public benefits of higher bathing water quality standards and their inclusion in a cost-benefit analysis, to see whether the estimated benefits exceed their costs, is the way forward to inform the decision-making process about the revision of the Bathing Water Quality Directive. First, the costs of meeting more strict standards have to be calculated. Next, the question is whether the Government, the specific target groups or the public at large are willing to pay the calculated total costs associated with the least cost solution. The answer to this question can be left to the decision-maker(s) (Government), representing the interests of the public at large, or (a representative sample of) the public self through, for instance, a referendum type of contingent valuation survey[17]. In the latter case, an attempt is made to make public preferences and benefits more explicit in terms of public willingness to pay. In the former case, public benefits are implicitly accounted for in the political process of setting the standard through policy maker(s) judgements about the overall value of different water quality standards compared to their corresponding costs.

Note

16 The value people attach to unpriced natural resources (e.g. water) and the services these resources provide (e.g. bathing) is measured in money terms through the concept of individuals' willingness to pay (WTP) or willingness to accept compensation (WTA). Of these two, the WTP approach has become the most frequently applied and has been given peer review endorsement through a variety of studies.

17 Contingent valuation is a social survey based method where individuals from the public are asked a number of questions about their knowledge, attitudes, preferences and willingness to pay for specific environmental changes, in this case changes in bathing water quality.

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Note

18 In view of the fact that one of the main objectives of this study was to assess currently available knowledge and information, the list of references includes all the literature which has been consulted in the study, not only the literature to which has been referred in the text.

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Appendix

Appendix I Current on directive the quality of bathing water

Council directive
of 8 December 1975
concerning the Quality of Bathing Water (76/160/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Articles 100 and 235 thereof,
Having regard to the proposal from the Commission,
Having regard to the opinion of the European Parliament,
Having regard to the opinion of the Economic and Social Committee,

Whereas, in order to protect the environment and public health, it is necessary to reduce the pollution of bathing water and to protect such water against further deterioration;

Whereas surveillance of bathing water is necessary in order to attain, within the framework of the operation of the common market, the Community's objectives as regards the improvement of living conditions, the harmonious development of economic activities throughout the Community and continuous and balanced expansion;

Whereas there exist in this area certain laws, regulations or administrative provisions in Member States which directly affect the functioning of the common market; whereas however, not all the powers needed to act in this way have been provided for in the Treaty;

Whereas the programme of action of the European Communities on the environment provides that quality objectives are to be jointly drawn up fixing the various requirements which an environment must meet inter alia the definition of parameters for water, including bathing water;

Whereas, in order to attain these quality objectives, the Member States must lay down limit values corresponding to certain parameters; whereas bathing water must be made to conform to these values within 10 years following the notification of this Directive;

Whereas it should be provided that bathing water will, under certain conditions, be deemed to conform to the relevant parametric values even if a certain percentage of samples taken during the bathing season does not comply with the limits specified in the Annex;

Whereas, to achieve a certain degree of flexibility in the application of this Directive, the Member States must have the power to provide for derogations; whereas such derogations must not, however, disregard requirements essential for the protection of public health;

Whereas technical progress necessitates rapid adaptation of the technical requirements laid down in the Annex; whereas, in order to facilitate the introduction of the measures required for this purpose, a procedure should be provided for whereby close cooperation would be established between the Member States and the Commission within a Committee on Adaptation to Technical Progress;

Whereas public interest in the environment and in the improvement of its quality is increasing; whereas the public should therefore receive objective information on the quality of bathing water,

Has adopted this directive:

Article 1

1. This Directive concerns the quality of bathing water, with the exception of water intended for therapeutic purposes and water used in swimming pools.
2. For the purposes of this Directive:
   (a) 'bathing water' means all running or still fresh waters or parts thereof and sea water, in which:
   - bathing is explicitly authorized by the competent authorities of each Member State, or
   - bathing is not prohibited and is traditionally practised by a large number of bathers;

   (b) 'bathing area' means any place where bathing water is found;
   (c) 'bathing season' means the period during which a large number of bathers can be expected, in the light of local custom, and any local rules which may exist concerning bathing and weather conditions.

Article 2

The physical, chemical and microbiological parameters applicable to bathing water are indicated in the Annex which forms an integral part of this Directive.

Article 3

1. Member States shall set, for all bathing areas or for each individual bathing area, the values applicable to bathing water for the parameters given in the Annex. In the case of the parameters for which no values are given in the Annex, Member States may decide not to fix any values pursuant to the first subparagraph, until such time as f igures have been determined.
2. The values set pursuant to paragraph I may not be less stringent than those given in column I of the Annex.
3. Where values appear in column G of the Annex, whether or not there is a corresponding value in column I of the Annex, Member States shall endeavour, subject to Article 7, to observe them as guidelines.

Article 4

1. Member States shall take all necessary measures to ensure that, within 10 years following the notification of this Directive, the quality of bathing water conforms to the limit values set in accordance with Article 3.
2. Member States shall ensure that, in bathing areas specially equipped for bathing to be created by the competent authorities of the Member States after the notification of this Directive, the 'I values' laid down in the Annex are observed from the time when bathing is first permitted.

However, for bathing areas created during the two years following the notification of this Directive, these values need not be observed until the end of that period.

3. In exceptional circumstances Member States may grant derogations in respect of the 10-year time limit laid down in paragraph 1. Justification for any such derogations based on plans for the management of water within the area concerned must be communicated to the Commission as soonas possible and not later than six years following the notification of this Directive. The Commission shall examine these justifications in detail and, where necessary, make appropriate proposals concerning them to the Council.
4. As regards sea water in the vicinity of frontiers and water crossing frontiers which affect the quality of the bathing water of another Member State, the consequences for the common quality objectives for bathing areas so affected shall be determined in collaboration by the riparian Member States concerned. The Commission may participate in these deliberations.

Article 5

1. For the purposes of Article 4, bathing water shall be deemed to conform to the relevant parameters: if samples of that water, taken at the same sampling point and at the intervals specified in the Annex, show that it conforms to the parametric values for the quality of the water concerned, in the case of:
   - o 95 % of the samples for parameters corresponding to those specified in column I of the Annex;
   - o 90 % of the samples in all other cases with the exception of the 'total coliform' and 'faecal coliform' parameters where the percentage may be 80 % and if, in the case of the 5, 10 or 20 % of the samples which do not comply:
   - o the water does not deviate from the parametric values in question by more than 50 %, except for microbiological parameters, pH and dissolved oxygen;
   - o consecutive water samples taken at statistically suitable intervals do not deviate from the relevant parametric values.
2. Deviations from the values referred to in Article 3 shall not be taken into consideration in the calculation of the percentage referred to in paragraph I when they are the result of floods, other natural disasters or abnormal weather conditions.

Article 6

1. The competent authorities in the Member States shall carry out sampling operations, the minimum frequency of which is laid down in the Annex.
2. Samples should be taken at places where the daily average density of bathers is highest. Samples should preferably be taken 30 cm below the surface of the water except for mineral oil samples which shall be taken at surface level. Sampling should begin two weeks before the start of the bathing season.
3. Local investigation of the conditions prevailing upstream in the case of fresh running water, and of the ambient conditions in the case of fresh still water and sea water should be carried out scrupulously and repeated periodically in order to obtain geographical and topographical data and to determine the volume and nature of all polluting and potentially polluting discharges and their effects according to the distance from the bathing area.

4. Should inspection by a competent authority or sampling operations reveal that there is a discharge or a probable discharge of substances likely to lower the quality of the bathing water, additional sampling must take place. Such additional sampling must also take place if there are any other grounds for suspecting that there is a decrease in water quality.
5. Reference methods of analysis for the parameters concerned are set out in the Annex. Laboratories which employ other methods must ensure that the results obtained are equivalent or comparable to those specified in the Annex.

Article 7

1. Implementation of the measures taken pursuant to this Directive may under no circumstances lead either directly or indirectly to deterioration of the current quality of bathing water.
2. Member States may at any time fix more stringent values for bathing water than those laid down in this Directive.

Article 8

This Directive may be waived:

(a) in the case of certain parameters marked (0) in the Annex, because of exceptional weather or geographical conditions;

(b) when bathing water undergoes natural enrichment in certain substances causing a deviation from the values prescribed in the Annex.

Natural enrichment means the process whereby, without human intervention, a given body of water receives from the soil certain substances contained therein. In no case may the exceptions provided for in this Article disregard the requirements essential for public health protection.

Where a Member State waives the provisions of this Directive, it shall forthwith notify the Commission thereof, stating its reasons and the periods anticipated.

Article 9

Such amendments as are necessary for adapting this Directive to technical progress shall relate to:

- the methods of analysis
- the G and I parameter values set out in the Annex.

They shall be adopted in accordance with the procedure laid down in Article 11.

Article 10

1. A Committee on Adaptation to Technical Progress (hereinafter called 'the committee') is hereby set up. It shall consist of representatives of the Member States and be chaired by a representative of the Commission.
2. The committee shall draw up its own rules of procedure.

Article 11

1. Where the procedure laid down in this Article is to be followed, matters shall be referred to the committee by the chairman, either on his own initiative or at the request of the representative of a Member State.
2. The representative of the Commission shall be submit to the committee a draft of the measures to be adopted. The committee shall deliver its opinion on the draft within a time limit set by the chairman having regard to the urgency of the matter. Opinions shall be adopted by a

majority of 41 votes, the votes of the Member States being weighted as provided in Article 148 (2) of the Treaty. The chairman shall not vote.

3. (a) The Commission shall adopt the measures envisaged where they are in accordance with the opinion of the committee.
   (b) Where the measures envisaged are not in accordance with the opinion of the committee, or if no opinion is adopted, the Commission shall without delay propose to the Council the measures to be adopted. The Council shall act by a qualified majority.
   (c) If, within three months of the proposal being submitted to it, the Council has not acted, the proposed measures shall be adopted by the Commission.

Article 12

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive within two years of its notification. They shall forthwith inform the Commission thereof.
2. Member States will communicate to the Commission the texts of the main provisions of national law which they adopt in the field covered by this Directive.

Article 13

Member States shall, four years following the notification of this Directive and at regular intervals thereafter, submit a comprehensive report to the Commission on their bathing water and the most significant characteristics thereof.

After prior consent has been obtained from the Member State concerned the Commission may publish the information obtained.

Article 14

This Directive is addressed to the Member States.

Done at Brussels, 8 December 1975.

For the Council

The President

M. PEDINI

Current quality requirements for bathing water

	Microbiological parameters	G	I	Minimum sampling frequency	Method of analysis and inspection
1	Total coliforms/100 ml	500	10 000	Fortnightly (1)	Fermentation in multiple tubes.
2	Faecal coliforms/100 ml	100	2 000	Fortnightly (1)	Subculturing of the positive tubes on a confirmation medium. Count according to MPN (most probable number) or membrane filtration and culture on an appropriate medium such as Tergitol lactose agar, endo-agar, 0.4% Teepol broth, subculturing and identification of the suspect colonies. In the case of 1 and 2, the incubation temperature is variable according to whether total or faecal coliforms are being investigated.
3	Faecal streptococci/100 ml	100	-	(2)	Litsky method. Count according to MPN (most probable number) or filtration on membrane. Culture on an appropriate medium.
4	Salmonella/litre	-	0	(2)	Concentration by membrane filtration. Inoculation on a standard medium. Enrichment - subculturing on isolating agar - identification
5	Enteroviruses PFU/10 litres	-	0	(2)	Concentrating by filtration flocculation or centrifuging and confirmation

	Physico-chemical parameters	G	I	Minimum sampling frequency	Method of analysis and inspection
6	pH	-	6-9 (0)	(2)	Electrometry with calibration at pH 7 and 9.
7	Colour	-	No abnormal change in colour (0)	Fortnightly (1) (2)	Visual inspection or photometry with standards on the Pt.Co scale.
8	Mineral oils mg/litre	≤ 0.3	No film visible on the surface of the water and no odour	Fortnightly (1) (2)	Visual and olfactory inspection or extraction using an adequate volume and weighing the dry residue.
9	Surface-active substances reacting with methylene blue mg/l (Lauryl sulphate)	≤ 0.3	No lasting foam	Fortnightly (1) (2)	Visual inspection or absorption spectro-photometry with methylene blue.
10	Phenols mg/l (phenol indices) $C_6 H_5 OH$	≤ 0.005 ≤ 0.05	No specific odour	Fortnightly (1) (2)	Verification of the absence of specific odour due to phenol or absorption spectro-photometry 4-aminoantipyrine (4 A.A.P.) method.
11	Transparency	2	1 (0)	Fortnightly (1)	Secchi's disc.
12	Dissolved oxygen % saturation O_2	80 to 120	-	(2)	Winkler's method or electrometric method (oxygen meter).
13	Tarry residues and floating materials such as wood, plastic articles, bottles, containers of glass, plastic, rubber or any other substance. Waste or splinters	Absence	-	Fortnightly (1)	Visual inspection.
14	Ammonia mg/litre NH_4	-	-	(3)	Absorption spectrophotometry, Nessler's method, or indophenol blue method.
15	Nitrogen Kjeldahl mg/litre N	-	-	(3)	Kjeldahl method.

	Other substances regarded as indications of pollution	G	I	Minimum sampling frequency	Method of analysis and inspection
16	Pesticides mg/litre (parathion, HCH, dieldrin)	-	-	(2)	Extraction with appropriate solvents and chromatographic determination.
17	Heavy metals such as: arsenic mg/litre As cadmium Cd chrome VICr VI leadPb mercury Hg	-	-	(2)	Atomic absorption possibly preceded by extraction.
18	Cyanides mg/litre Cn	-	-	(2)	Absorption spectrophotometry using a specific reagent.
19	Nitrates mg/litre NO_3 and phosphates PO_4	-	-	(2)	Absorption spectrophotometry using a specific reagent.

G = Guide.

I = Mandatory.

(0) Provision exists for exceeding the limits in the event of exceptional geographical or meteorological conditions.

(1) When a sampling taken in previous years produced results which are appreciably better than those in this Annex and when no new factor likely to lower the quality of the water has appeared, the competent authorities may reduce the sampling frequency by a factor of 2.

(2) Concentration to be checked by the competent authorities when an inspection in the bathing area shows that the substance may be present or that the quality of the water has deteriorated.

(3) These parameters must be checked by the competent authorities when there is a tendency towards.

Appendix II Draft revised directive on the quality of bathing water

Draft Directive on the quality of Bathing Water **25 July 2001**

DIRECTIVE 200Y/XXX/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Concerning the quality of Bathing Water

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

Having regard to the proposal from the Commission,

Having regard to the Opinion of the Economic and Social Committee,

Having regard to the opinion of the Committee of the Regions,

Acting in accordance with .....,

HAVE ADOPTED THIS DIRECTIVE:

ARTICLE 1: SCOPE AND DEFINITIONS

1. This Directive concerns: the quality of bathing waters, with the exception of water intended for therapeutic purposes, water used in swimming pools and of confined surface waters that are subject to chemical disinfection. Confined surface waters mean water *volumes* which were artificially created and which are separated from surface freshwater or coastal water.

2. For the purposes of this Directive,

a) **Bathing** is defined as: "*exercising water activities where whole body contact takes place or during which there is significant risk of swallowing water*".

b) **Water identified as a bathing water** means: "*All running and still inland surface waters, transitional waters and coastal waters or parts thereof which are actively promoted (or which are likely to be promoted in the foreseeable future) - locally, regionally, nationally or internationally - for bathing or which are* regularly *visited by local or visiting people for this purpose.*

c) **Bathing season** means: the period during which bathers can be expected, in the light of local custom, any local rules which may exist concerning bathing and weather conditions.

ARTICLE 2 LIST OF BATHING WATERS

Member States should establish the list of identified bathing waters under this Directive. This list will have to be communicated to the Commission and be made public. This list should be reviewed and updated at regular intervals to take into account newly identified bathing areas and the de-identification of bathing waters. The Commission and the public should be notified of any change in this list. The de-identification, due to, amongst others, changes in customs, changes in the constitution and use of bathing areas, must be demonstrated.

ARTICLE 3 MANAGERIAL MEASURES FOR BATHING WATERS

1. A management structure should be established for each individual identified bathing water or a group of adjacent bathing areas. This management should be composed of representatives and stakeholders of the bathing area and will be responsible for any action that will have to be taken to preserve or improve bathing water quality, to protect those waters against further deterioration and to prevent human exposure to pollution. The co-ordinates of the person or authority to contact this management should be notified to the Commission and to the public through ……

2. Member States should establish for each identified bathing water a profile as described in **Annex I**.

This profile should be made for the first time when this Directive comes into force. It should be reviewed thereafter once every 3/5 year or each time when significant changes/works have been carried out at and/or in the vicinity of the bathing water which are likely to have an influence on the water quality.

3. Member States should establish for each identified bathing zone the water quality trend, based on 3/5 years pooled data. This trend will determine the water quality according to the criteria set out in **Annex 2** : (see classification matrix).

This trend will be established for the first time based on the last 3/5 years data gathered under Directive 76/160/EEC and will then be reviewed for the first time once 3/5 years data have been gathered under this directive. The trend should then be recalculated every year again, taking into account the newest acquired data and by taking out the oldest data. If significant (infrastructural) management actions have taken place, the trend will have to be calculated from the moment that these actions take effect.

4. Member States should assess whether the water quality trend is explained by the potential sources of pollution stated in the risk/potentiality assessment.. This assessment is made to ensure that the bathing water management team fully appreciates (not necessarily knows definitively) the issues of concern for beach management.

If the risk of /potential for pollution is not reflected in the water quality trend, then the assessment must be repeated. If after the re-assessment there is still no match between water quality and potential sources of pollution, then it would be reasonable to include uncertainty as to the cause of contamination events by defining the potential sources as unknown.

ARTICLE 4 MONITORING

1 Bathing waters with good water quality and no or negligible risk/potentiality of pollution will be subject to routine sampling

2. Bathing waters with good, intermediate or poor water quality and/or risk/potentiality of pollution will be subject to enhanced sampling.

These sampling regimes are set out in **Annex III**.

4. Sampling programmes and calendar should be established and be notified to the Commission and be made public before the start of each bathing season.

ARTICLE 5 ASSESSMENT OF WATER QUALITY DATA AND SOURCES OF POLLUTION

1. Bathing waters having good or intermediate water quality and an established risk/potentiality of pollution, and bathing areas with poor water quality are subject to a thorough study and analysis of all (significant) sources and circumstances likely to cause or contribute to pollution or contamination. These studies and analysis are needed to acquire sufficient confidence that all sources and risks and potentialities are understood in order to commit aimed preventive and remedial actions.

2. This study should contain at least an investigation of:
- the conditions prevailing up-stream in the case of fresh running water, and
- the ambient conditions in the case of fresh still water and sea water
and should be carried out scrupulously and repeated periodically in order to obtain geographical and topographical data and to determine the volume and nature of all polluting and potentially polluting discharges and their effects according to the distance from the bathing area.

ARTICLE 6 PARAMETERS AND PARAMETRIC VALUES FOR BATHING WATER QUALITY

1. The parameters applicable to bathing water quality are set out in **Annex IV**.

2. Member States may at any time fix more stringent values for bathing water than those laid down in this Directive.

ARTICLE 7 COMPLIANCE WITH VALUES

Considerations on quality compliance are forwarded in **Annex VI**.
Possible/appropriate management actions are described in **Annex V**.

ARTICLE 8 MEASURES TO INFORM AND REACT ON UNFORESEEN CHANGES IN WATER QUALITY

These changes can be caused by floods, accidents, breakdowns,….

ARTICLE 9 INFORMATION OF THE PUBLIC

ARTICLE 10: COOPERATION ON TRANSBOUNDARY WATERS

ARTICLE 11: TECHNICAL ADAPTIONS TO THE DIRECTIVE

1. A Committee on Adaptation to Technical Progress (hereinafter called 'the committee') is hereby set up. It shall consist of representatives of the Member States, (a) representative(s) of the European Parliament and be chaired by a representative of the Commission.
2. The committee shall draw up its own rules of procedure.
3. The committee will have the power to adapt the Directive Annexes to scientific, technical and managerial progress with the sole aim of strengthening the public health protection provisions.

ARTICLE 12: REGULATORY COMMITTEE

ARTICLE 13: IMPLEMENTATION

ARTICLE 14: REPORTING OBLIGATIONS

Every year the Member States shall send to the Commission a summary report on the implementation of this Directive in the current year. The Commission shall publish a Community report on the implementation of the Directive within four months of receiving the reports from the Member States.

ARTICLE 15 TRANSITIONAL PROVISION BETWEEN 76/160/EEC AND THIS DIRECTIVE

1. A transition period is foreseen for the acquisition of data based on the new parameters until a trend calculation on 3/5 year pooled data is possible with then new data.
2. A yearly quality assessment is made based on the data for the each bathing season untill enough data are acquired with reference to art 3.3.
3. Implementation of the measures taken pursuant to this Directive may under no circumstances lead either directly or indirectly to deterioration of the current quality of bathing water.

ARTICLE 16: ADDRESSEES

Draft Directive on the quality of Bathing Water **25 July 2001**

This Directive is addressed to the Member States.

Annexes: All annexes form an integral part of this Directive

I. Bathing Water Profile

With reference to Article 3.3, such a profile consists of

a) a description of the physical, geographical and hydrological characteristics of the bathing water;
b) an identification – quantitative and qualitative - of all potential sources of pollution;
c) an assessment of *alternative wording 1*[their risk to the health of bathers] – *alternative wording 2* /their potential to pollute/contaminate the bathing water, thus impairing the health of bathers]. This assessment should be made, in terms of time - accidental or chronic risk/potentiality - and in terms of magnitude.
d) the co-ordinates of the management

Elements a) and b) should also be provided/made available on a detailed map.
Other relevant information can be attached or included as deemed appropriate.

Compulsory Brief Profile

General information

Name of beach and bathing water:
Location (Grid Reference):
Limits of bathing area: length width gradient
Type of bathing water: river/lake/estuarine/marine/open/ confined/natural/artificial
Type of beach area: sandy rocky pebbles grassy other.........
Beach/bathing water usage: swimming sailsports motorsports other..................
Average number of users (with swimming costume):
Character of surrounding area: urban/residential/industrial/agricultural/dunes/marsh
River mouth/hills&mountains/grassland/others...........

Characteristics of bathing water

Average water temperature:
Prevailing wind direction:
Residual current direction:
River flow (mean/Q_{95}/Q_5):
Tidal amplitude:
Distance between mean high and low water:

Administration

Beach manager or contact person in case of pollution incident:
Phone:
Address:

This is an informal discussion document provided by the European Commission Services which does not commit the Commission

II Criteria for determination quality category of bathing waters.

With reference to Article 3.3, the historical water trend will determine bathing water quality.

See WHO Farnham document, classification matrix on page 30

III Routine and Enhanced Monitoring Programmes

A. The table indicates the monitoring regimes that should be implemented pursuant Article 4

Bathing season	Reduced = **28 days(1)**			Routine = **14 days(1)**			Enhanced = **7 days(1)**			
Months	No.	PS(2)	Total	No.	PS(2)	Total	No.	PS(2)	Total	(3)
≤2,5				5	+1	**6**	10	+1	**11**	*3*
3	3	+1	**4**	6	+2	**8**	12	+2	**14**	*3*
3,5	3	+2	**5**	7	+2	**9**	14	+2	**16**	*3*
4	4	+2	**6**	8	+2	**10**	16	+2	**18**	*3*
5	4	+2	**6**	10	+2	**12**	20	+2	**22**	*3*
etc.	5	+2	7							

(1) The minimum sampling frequency equally spaced throughout a declared bathing season.

No. = number of samples specified for each category depending on length of bathing season .

PS = Peak season. This is the time of the bathing season where ....

(2) Additional obligatory samples to be taken equally spaced during the peak season (ex. 15 July-15August or August).

Total = Minimum total number of samples required. Although these frequencies are considered to be the absolute minimum frequencies, we suggest taking more samples to ensure scientific and statistical reliability.

(3) If monitoring indicates continuous poor water quality try and determine the source of pollution. If the source is identified: remedial actions should be undertaken to solve the source of pollution (if feasible). When remedial action is long-term, keep a minimum sampling frequency regime of 3 samples per season (*3*) in order to keep an eye on the *dimensions/improvement of the problem. Restore 7 days sampling regime for at least one* bathing season when action plan is finished to confirm the effectiveness of the remedial action taken.

B. The actual sampling dates should be fixed before the bathing season and be provided to the Commission and made available to the public. No derogation is to be allowed without prior notice and justification. Weather conditions are not accepted as a justification.

C. Samples should be taken following the guidelines hereafter.
Sampling point = the defined/discrete location(s) on a bathing water where, on average throughout the bathing season, most bathers will be found.

Annexes to a DRAFT Directive on the quality of Bathing Water 25 July 2001

IV Parameters, standards and methods of analysis

Analysis for the following microorganisms using stated methodologies:

Coastal waters	Intestinal enterococci	50 /100ml	ISO 7899-1, 96 or membrane filt
	Esherichia Coli	400/100ml	ISO 9308-3, 96 or membrane filt
Fresh waters	Intestinal enterococci	50 /100ml	ISO 7899-1, 96 or membrane filt
	Esherichia Coli	400/100ml	ISO 9308-3, 96 or membrane filt

1.per bathing season and per cycle of rolling (with every new year monitored, the data of oldest year fall) 3/5 year (95%ile of all samples of 1 bathing season and 95%ile of pooled data per cycle?)

This is an informal discussion document provided by the European Commission Services which does not commit the Commission

V Management Actions

Beach management actions will be developed for each bathing water. The primary objectives of the beach management actions will be to:

i) maintain good bathing water quality or improve water to good quality
ii) protect human health by preventing/avoiding exposure to contamination.

Fulfillment of these objectives will require a wide range of potential actions, depending on the specific location and the environmental factors relating to each bathing water. The determination of beach management actions will be specific to each bathing water, but it is likely that a number of key beach management actions may be incorporated:

1. Provision of information on beach management and bathing water quality to the public
2. Engineering solutions by improvement to existing or provision of new infrastructure (wastewater treatment, sewerage etc.) where bathing water quality demonstrates continued or intermittent faecal contamination
3. Management of beaches to prevent human contact with bathing waters of continued or predicted poor quality
4. Development of an emergency action plan.

Each of the above will have to be developed locally. However, to give an indication of the types of action that may be deemed appropriate, the following have been identified:

Provision of Information

This may range from passive transmission of information, for example through the use of notice boards with appropriate beach and bathing water information, through to active dissemination by beach managers, lifeguards etc. A communication strategy should be developed, either for each bathing water or nationally, that allows the public access to appropriate beach management information. This may include posting information on the web.

Engineering solutions

Where wastewater or other sources are identified, it may be appropriate to design and construct engineering solutions. These may range from: upgrading sewerage capacity to reduce CSO spill frequency; upgrading WwTWs to tertiary disinfection; rerouting of wastewater outfalls etc..

Beach Management

A number of measures can be implemented to prevent human contact to continued/intermittent or predicted poor water quality. These may range from: discouraging bathing in specific areas; restricting access (eg closing car parks, access etc.); fencing off areas; closure of services to discourage local usage (not toilets);

restrict public transport access; encourage use of adjacent non-contaminated beaches; etc.

These actions may be optimised if prediction of contamination events can be improved. For example, where CSO spills are likely after a certain amount of rainfall, access to the discharge zone could be restricted for this period and a time afterwards.

Emergency Action Plan

All bathing waters will be required to develop an emergency action plan. The emergency action plan will be developed by the authority(/ies) responsible for beach management in consultation with other relevant local and national authorities and/or regulators. The plan will describe the beach management actions required in response to identification of poor bathing water quality or where infrastructure has or is likely to have malfunctioned that may have implications for human health.

The emergency action plan should include as a minimum the name, address and telephone number of the beach management authority and beach manager. Where potential sources of faecal contamination have been identified in the risk assessment that are capable of malfunction, for example WwTWs and emergency overflow, the action plan should identify the appropriate contacts and telephone numbers at the sewerage and WwTW facility operations centres. Beach management actions to prevent human exposure to the contamination incidents must be specified in the plan. These may include actions described in the earlier sections. Recognition will have to be made of the emergency response team structure.

V.1 In-season actions

If a sample during the bathing season is not compliant with parameters set out in Annex IV, the management team should:
a) Resample as quick as possible - and continue resampling if necessary – in order to establish the severity (in terms of time and magnitude) of the problem,
b) Inform as quickly as possible the public and all directly concerned parties and take any pre-cautionary action necessary,
c) In case of gross pollution close the beach for as long as the pollution lasts.

V.2 Actions to reduce/eliminate the risk of pollution/contamination.
- Investigate the pollution event (in terms of time, magnitude) taking into account the profile and the historical water quality in order to get a full understanding of the pollution and the risk of occurrence.
- model if necessary the pollution process under different conditions to determine which measures will be the most cost-effective.
- take if necessary structural measures (waste water collection and treatment, rainwater collection, storage treatment and controlled discharge or re-use, …)
- take if necessary measures in terms of imposing different practises (farming practises,….)
- inform the public about these actions.

These actions should bear results within the timeframe set out in Article 6.

VI Ideas and concepts on compliance rules

In its 2000 Communication, the Commission states that the revised Directive should have a greater emphasis on the application of suitable, prompt management actions, without however forgetting the fact that water quality objectives also have to be met. Under the new scheme, **there will be requirements both for compliance with the quality standards and also for reaction when these standards are breached.** This shift in emphasis from bathing water quality *monitoring* to bathing water quality *management* is in line with the principles enshrined in the Water Framework Directive.

A concept for defining compliance brought forward is:

1. Bathing Water meeting standards with a percentile "X" (to be defined) is compliant.

2. Bathing Water meeting standards with a lower percentile "X" (still to be defined), but accompanied by evidence of risk assessment, beach management and appropriate remedial action is also compliant

3. Bathing Water with a lower percentile "Y" (to be defined) or when beach management and remedial actions are not taken: non compliance.

Colophon

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