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INPUT OF POLLUTANTS TO THE OSLO COMMISSION AREA

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PREFACE

The input study reported here was originally conceived as an integral part of the Oslo Commission baseline survey, for which results for the levels of pollutant residues in fish and shellfish have already been reported (Coop. Res.Rep., No.69 (1977)). The report of this study represents the most complete account so far available of the input to a maritime region involving the participation of several countries. The survey conducted has many deficiencies. A number of rough estimates have had to be made, often based on rather sweeping assumptions. Nevertheless, broad conclusions can be drawn and areas of weakness can be identified which need attention before more reliable estimates can be made. A major objective of a study of this kind must be to draw the attention of relevant national and international regulatory bodies to the need to strive for better quality information. No sensible conclusions can be drawn, or regulatory action taken, as to the need for controlling inputs of pollutants via particular input routes without a much better quantitative understanding of the relationship between input and level in particular situations. There are many gaps to be filled, and there can be no doubt that the quality of input information lags far behind that, for instance, available for selected pollutant levels in fish and shellfish. It is hoped that the timely production of this report will serve to highlight the need for greater effort in the production of accurate input data.

A. Preston

Chairman, ICES Working Group on Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas.

June, 1977.

INPUT OF POLLUTANTS TO THE OSLO COMMISSION AREA

Introduction

This report on the input of pollutants to the Oslo Commission Area represents a considerable extension in the geographical area for which pollutant inputs have been studied by the International Council for the Exploration of the Sea (ICES). The initial input study, compiled in 1968, sought to determine inputs of domestic sewage, industrial waste, pesticides and oil pollution to the North Sea by the surrounding countries. The data from this study represented an important first step in the study of pollution in the North Sea, but indicated also the need to intensify research regarding the types and quantities of pollutants discharged into the sea and their ecological effects. The results of this study are reported in Cooperative Research Report series A, No.13 (1969).

In 1971 a plan was drawn up for an International Study of the Pollution of the North Sea and its Effects on Living Resources and their Exploitation. This study included a baseline survey to determine the levels of pollutants in food fish and a more detailed assessment of the rates of input of the various pollutants to the North Sea. For this latter study, an Inputs Questionnaire was developed and sent to all countries which border the North Sea. Each country was asked to divide its coastline into zones and, for each zone, to provide data on the flows of domestic sewage and industrial effluents, giving details on the quantities of, e.g., nutrients, metals, organochlorine pesticides and PCBs. Also requested was information on dumping activities in the North Sea and programmes to monitor atmospheric inputs of pollutants to the sea. Data on discharges of pollutants via rivers and to estuaries were also sought.

The replies received provided data which were considerably more detailed than those available for the earlier report. However, few countries were able to provide adequate information on all the pollutants which were likely to be present in the discharges. In many cases, order-of-magnitude estimates were made for the input of a pollutant based on detailed data provided by several countries. The results of this study, along with the results of other projects conducted by the Working Group for the International Study of the Pollution of the North Sea, are published in Cooperative Research Report, No.39 (1974).

In 1974, the North Sea Working Group was superseded by the Working Group on Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas. This new Working Group was created in anticipation of the establishment of the Oslo Commission for the Prevention of Marine Pollution by Dumping from Ships and Aircraft and, additionally, to reflect the interest in extending the area of study to the entire North Atlantic.

The Working Group was specifically charged with compiling up-to-date pollutant input data which would represent an improvement on existing North Sea data and extend the information available to the entire area covered by the Oslo Commission as well as that of the International Commission for the Northwest Atlantic Fisheries (ICNAF).

In deciding to conduct a new input study, it was agreed that a new questionnaire was needed. Some countries had found the questionnaire utilised in the 1972-3 inputs study to be unclear in its definition of exactly what information was required, especially regarding the separation of sewage and industrial waste discharges and how data were to be provided for river inputs. Accordingly, a new questionnaire (Annex 1) was devised in which the intention was made clear that it sought order-of-magnitude data on the input of major categories of pollutants to the Oslo Commission area and parts of the ICNAF area via five pathways:

a) direct inputs to the marine environment, estuaries and coastal waters (e.g., by pipeline discharges),

b) river input to the marine environment,

c) inputs via the atmosphere,

d) dumping, and

e) other sources (e.g., incineration at sea).

As with the previous inputs study, each country was asked to divide its coastline into appropriate sections and provide data for each section.

The Working Group recognised the difficulties involved in assessing what proportion of a pollutant entering an estuary reaches the open sea. It was, therefore, agreed that estuaries should be regarded as integral parts of the study area without distinction, but that note should be made accordingly if information were available on flux out of the estuary to the open sea. Additionally, each major estuary should count as a coastal area in its own right; in cases such as the Schelde Estuary, which is bordered by more than one country, the countries concerned were expected to collaborate and produce a joint response.

In the amended questionnaire, the list of pollutants to be featured in the replies was expanded in the light of the responses obtained from the earlier questionnaire and the increasing array of pollutants recognised as being of interest.

As in previous studies, radioactive substances were not included because this subject is already adequately covered by several speciality organisations, such as the International Atomic Energy Agency and the European Nuclear Energy Agency, and ICES policy is not to duplicate such efforts.

Results

All replies submitted were received by mid-1976; in most cases the data supplied covered the years 1974 or 1975. No data had been received from France, Spain, Portugal, the northern part of Scotland or the United States by the time this report was prepared. However, the United States have indicated that they intend to present a full report on their input of pollutants to the ICNAF area at the 1977 ICES Statutory Meeting. Canada has also indicated that it will present further input information at that time. These data, along with those from western Greenland, will be published in a later volume in this series covering inputs to the ICNAF area of the North Atlantic. Data from eastern Greenland have been included in the present report.

The data contained in the replies have been compiled into Tables 1-12 and Figures 1-3. Most countries provided data on the flows of rivers, domestic sewage and some industrial wastes into the study area. Where full information was not available, either figures from Cooperative Research Report, No.39 were used or rough estimates were made. Such estimates were based either on other data provided by the country concerned or on averages of data provided by two or more other countries. In all cases where estimates or other data have been used, this is clearly indicated in the tables: data from Cooperative Research Report, No.39 are accompanied by an asterisk and figures estimated on the basis of other data are given in square brackets. Data indicated to be an estimate by the respondent country are given in parentheses.

It has not been possible to present the data in a way similar to that in Cooperative Research Report, No.39. The differences in the two questionnaires, especially the greater detail required by the more recent one, led to submission of data in a somewhat different format. Both the area covered by this study and the number of participating countries are greater. Additionally, several countries, including Norway, Denmark, Scotland and the Netherlands, changed the division of their coastline from that used in Cooperative Research Report, No.39, thus making comparison of the data more difficult.

As was reported in Cooperative Research Report, No.39, pollution concentrations in discharges vary from country to country, depending partially on the *per capita* water consumption and, particularly, on the degree of separation of domestic sewage from industrial effluents and on the amount and kind of treatment such discharges receive.

Several respondents indicated that inputs from rivers and estuaries had been difficult to estimate due to the uncertainty regarding the fate of materials discharged into an estuary or fjord. Nonetheless, because the Working Group had agreed that such inputs should be included in the report, even though only a proportion of the total pollutant input to an estuary reaches the sea proper, this information has been included in the tables on the assumption that in most instances most of this load reaches the sea. In the absence of evidence to the contrary, it is sensible to work on the worst possible estimate. Where no information regarding pollution load via rivers was given, estimates were made on the basis of the mean of data given for pollution loads from Dutch and English/Welsh rivers, the only countries providing detailed river data.

The estimates of inputs of pollutants via rivers show that this is a significant source of pollution in the North Atlantic area.

Most countries' replies indicated that information on the pollution content of industrial effluents is still rather limited. Norway, and to some extent England/Wales, provided fairly detailed information on the types of industry present, the amounts of their discharge and the amounts of nutrients, heavy metals and other substances contained therein. The Netherlands did not specify the industrial sources, but industrial waste discharges are included in the total river load to the sea, as most of the industries discharge into rivers. The data from other countries were less complete, and in some cases virtually no information on industrial discharges was provided. Due to the individual nature of industry placement and composition in the various countries, no attempt has been made to estimate inputs from industrial effluents.

It appears that relatively complete data were provided with regard to the amounts and general types of substances which were dumped into the sea. This should be the case, because dumping is regulated in the study area by the Oslo Convention which requires reporting of marine dumping activities. Although many of the countries which allow dumping were able to provide estimates of the amounts of harmful substances contained in the wastes, not all were able to do so.

A number of the countries provided reports on their investigations on the atmospheric input of pollutants to the sea. Although these investigations cover only the North Sea portion of the study area, they represent a significant increase in the amount of information available regarding atmospheric deposition of heavy metals than at the time of the earlier North Sea report and some work has now been done to provide preliminary estimates of fallout of organochlorines. This work is still in its early stages and little has yet been done to estimate input over the open Atlantic portions of the study area.

Although information had been requested on the input of organochlorine pesticides and other organohalogen compounds to the study area, very few data were able to be obtained. Three countries, however, (Denmark, Norway, and Ireland) provided information on the use of certain pesticides in the country as a whole. This information is contained in Table 12. There is presently no known way to relate pesticide usage on land with eventual input to the marine environment.

In the more-detailed discussion of the results which follows, the figures from the various tables have been rounded off in recognition of the fact that they are mainly order-of-magnitude estimates.

Inputs of Pollutants in Sewage

The replies to the questionnaire with regard to inputs due to sewage discharges are presented in Tables 3-6, which also include equivalent data on industrial and river inputs. Summary figures are given in Summary Tables 3-6. According to the information supplied, the total population contributing to sewage discharges to estuaries or the open sea in the study area is 37.3 million persons. This figure compares poorly with the population figure of 31 million quoted in the earlier North Sea Study. Because the more recent figure covers a far greater geographical area, different methods of calculating the population contributing to a particular catchment area must have been used in the data submitted for this report compared to that for the earlier report. For example, there is a decrease of nearly 6 million persons in the population figures quoted for the E12 region of England in this report compared to the earlier report. Similarly, an 0.6 million-person decrease is shown in the Norwegian population data and an 0.3 million-person decrease in the reported Swedish population. This decrease is probably accounted for by the inclusion of some sewage discharges in the river data rather than in the figures for direct discharge of domestic sewage.

The volume of sewage effluent entering the study area per year is 5.7×10^9 m^3/year, of which 3.7×10^9 m^3/year enter the North Sea. This amount is significantly higher than the 1972 value of 2.7×10^9 m^3/year, even though the population reported for the North Sea decreased by about 26% from that in the earlier report. Even allowing for the inclusion of river inputs, it is difficult to determine the cause of this apparent sharp increase, but, as many of the earlier figures were based on estimates and approximations, it is probable that the earlier figure was too conservative an estimate. The present figures are, for the most part, based on more solid data and can thus be taken to be more accurate.

This apparent increase in the volume of sewage discharges to the North Sea does not appear to be due to a significant increase in *per capita* water consumption levels. For example, the latest *per capita* water consumption figure for Sweden is 0.400 m^3/day, only slightly above the figure of 0.391 m^3/day quoted for the Scandinavian countries in the earlier report.

In the 1972 data, there was a significant difference between the per capita water consumption figures from the Scandinavian countries in the northern part of the North Sea and England in the southern portion. Although the new figures are incomplete, the difference among the reporting countries does not appear to be so great. For example, although no new water consumption values were received for England, Ireland reported a water consumption value of 0.200 - 0.400 m^3/day/person, clearly higher than the 1972 English value of 0.178 m^3/day/person and in the same range as the Danish figure (0.360 m^3/day/person).

Although data regarding treatment of domestic sewage are incomplete, it appears that about one-half of the sewage discharged into the study area receives no treatment before discharge; approximately one-quarter receives primary treatment (settlement only), while the remainder receives secondary treatment (settlement and biological) or better. Detailed information was only available for Norway and England/Wales; where no details were provided, figures from the earlier North Sea report were used, if possible. Examination of the detailed figures shows that for England and Wales, 51% of the domestic sewage receives both settlement and biological treatment, 13% receives settlement treatment only, and 36% is discharged directly without treatment. A high proportion of the sewage receives both settlement and biological treatment in areas of heavy population, for example, the Thames River (88%, E12) and surrounding areas (96%, E11) and in biologically sensitive areas, for example, the Wash (99%, E8). In these three areas, the proportion of sewage receiving secondary or better treatment appears to have increased significantly since the North Sea report was prepared. The Norwegian data show that, although most areas in Norway discharge more than 90% of their domestic sewage without any form of treatment, in the heavily populated area of Oslo, 48% of the sewage receives tertiary treatment and 31% receives primary treatment. In Ireland, 52% of the domestic sewage receives primary treatment, while in Northern Ireland 75% of the sewage receives such treatment.

The biochemical oxygen demand (BOD) figures for each country and area are found in Table 4. As can be seen, not all countries reported separate values for BOD due to domestic sewage and that due to industrial waste, consequently the BOD load which is shown attributed solely to domestic sewage, 4.5×10^5 tonnes/year, is low. The expected value can be estimated to be about one and one-half times this figure based on the average of values reported by countries for domestic BOD loads. Per capita figures for BOD were reported by Sweden and Iceland as 70 grams/day/person and by Denmark as 60 grams/day/person. From Norwegian data, these values were calculated to be 58 grams/day/person and from English/Welsh data, 62 grams/day/person. Northern Ireland reported calculating biological oxygen demand using values of 500 grams/day/person for untreated sewage and 50 grams/day/person for treated sewage. These values appear to be one order of magnitude too high, when compared with the figures for the other countries. Thus, the values for Northern Ireland in the tables have been changed to reflect this.

Chemical oxygen demand (COD) values were reported by only a few countries, so no breakdown between domestic and industrial COD load was made in their presentation in Table 9. For those countries not reporting COD data, no estimates have been attempted due to the fact that the relationship between BOD and COD differs according to the nature of the organic matter which is decomposed. Thus, the composition of the discharge must be known in each case to be able to attempt to make any valid calculations. Because the necessary information was not available in this case, estimates of COD were impossible.

As was pointed out in the earlier North Sea inputs study, although the oxygen demand may seem very large, the capacity of the sea water outside estuaries and fjords to maintain normal oxygen levels is very high. This is due to the relative ease of oxygen transfer between the atmosphere and the sea and the fact that each sea area of 1 km^2 to a depth of 10 metres (10^7 m^3 in volume) contains 70 tonnes of dissolved oxygen. Thus, there appears to be little danger of reduced oxygen levels in the open sea areas of the Northeast Atlantic due to the present BOD load. Moreover, in comparison with the natural BOD load in the sea, the BOD load reported here due to pollutants is only about 2% of the natural level. However, it should be recognised that the majority of the input is to coastal waters. Localised effects of reduced oxygen could occur in certain estuaries, fjords and other areas when the BOD load is heavy and, for example, free exchange with the open sea is poor.

The inputs of nutrient nitrogen and phosphorus as reported by the various countries appear in Table 4. As with the BOD figures, not all countries reported separate figures for domestic and industrial inputs of nitrogen or phosphorus. The input of nitrogen to the study area attributed to domestic sources is 1.1 x 10^5 tonnes/year. Phosphorus inputs from domestic sewage amount to 3.0 x 10^4 tonnes/year. The per capita values for nitrogen reported by the different countries varied from country to country. The value reported by Iceland was 12 grams N/day/person and by Sweden, 11 grams N/day/person. For Sweden, this represents a 2 gram/day/person decrease from the per capita nitrogen value reported in 1972 of 13 grams/day/person. Per capita figures were calculated for Norway at 11.4 grams N/day/person and England/Wales at 10.1 grams N/day/person. For phosphorus, Iceland reported a per capita value of 4 grams/day/person. The Swedish figure of 3.2 grams/day/person represents an 0.8 gram/day/person decrease from the earlier data. Calculations for Norway gave a value of 2.8 grams P/day/person and for England/Wales 3.0 grams P/day/person, which latter figure is significantly above the previous English figure of 1.6 grams P/day/person used in the North Sea study.

Information regarding the content of suspended solids in domestic sewage was only provided by a few of the countries, as shown in Table 4. In the absence of reliable per capita figures, no estimates could be made for those countries lacking such data. From the partial data available from Norway, England/Wales, and Northern Ireland, at least 3.9 x 10^5 tonnes of suspended solids are discharged via sewage into the study area per year. This figure is obviously far below the actual level of inputs.

As was found in the North Sea study, few countries have details of the input of organochlorine pesticides in domestic sewage. In fact, the only relevant data available was the input of organohalogen compounds in general found in the domestic sewage from Norway (Table 9). It is clear that there has been little further work since this gap was revealed by the North Sea report; much more work is still needed.

Although there is still a lack of empirical data on the content of metals in sewage effluents, enough information was available from English/Welsh, Swedish, Norwegian and Danish returns to compute per capita values for many of the metals studied (Table 7). Because in most cases these values were in fairly good agreement with one another, averages of these per capita figures were used to compute estimated metal inputs from domestic sewage for those countries which had been unable to provide these data. Metal estimates and data are found in Tables 5 and 6.

Of the metals studied, the one discharged in the greatest quantity was iron. The only per capita value available, that for England/Wales, is 75 grams/year/person. This value was used to estimate iron discharges in sewage for Scotland, Northern Ireland and Ireland. It should be noted that in making these estimates, figures for Ireland in particular are likely to be somewhat higher than the actual values. However, it was judged better to present maximum values rather than no information whatsoever. This comment applies for all other similar estimates for Ireland. These values, plus data from Norway, give a total input from these countries of 5.0×10^3 tonnes of iron per year (see Table 5).

Only England/Wales provided data on manganese. Its per capita figure of 10 grams Mn/year/person was utilised to estimate input figures for Scotland, Northern Ireland and Ireland. On this basis, it was estimated that the total discharge from these areas amounts to a minimum of 300 tonnes of manganese per year in domestic sewage.

England/Wales, Norway and Sweden provided data on the content of cadmium in sewage discharges. However, the per capita figure from England/Wales (1.5 grams/year/person) differed so greatly from that of Sweden (0.1 grams/year/person) that no overall average could be provided. Instead, as above, the per capita figure for England/Wales was used to produce cadmium input estimates for Scotland, Northern Ireland, and Ireland. The total from all available information shows an input of at least 43 tonnes Cd/year.

Per capita values for copper were calculated for England/Wales (23 grams/year/person), Norway (1.2 grams/year/person), Sweden (3.8 grams/year/person) and Denmark (2.9 grams/year/person). With the exception of the English/Welsh figure, the other national averages agree rather well and were used to calculate estimated discharges for all those countries lacking these data. Although the English/Welsh data show values significantly higher than those of the other countries, these values are reported to have been derived from actual measurements. A possible cause is a difference in plumbing practices: The UK uses copper piping for most domestic plumbing and individual house storage facilities. The total copper input to the study area from estimates for nearly all participating countries amounts to about 600 tonnes/year.

Chromium values on a per capita basis were determined for four countries: England/Wales (3.1 grams/year/person), Norway (8.1 grams/year/person), Sweden (1.7 grams/year/person) and Denmark (3.3 grams/year/person). As these values are in reasonable agreement, their mean was used to estimate figures for those countries lacking these data. On this basis, the total input of chromium via domestic sewage effluents to the study area is estimated to be approximately 180 tonnes/year. These figures are shown in Table 6.

Determinations of nickel discharges on a per capita basis were made for England/Wales (6 grams/year/person), Sweden (5.6 grams/year/person) and Denmark (6.3 grams/year/person). Due to the close agreement of these figures, their mean was used to find estimates of inputs of nickel from the other countries. The total figure obtained from the available data and estimates suggests an input of around 220 tonnes of nickel per year to the study area via sewage.

Lead discharge figures for domestic sewage were provided by four countries, with per capita values as follows: England/Wales, 4.6 grams/year/person; Norway, 3.5 grams/year/person; Sweden, 2.3 grams/year/person; and Denmark, 11.5 grams/year/person. Discarding the high value from Denmark (because it is nearly three times higher than the other figures), the mean of 3.5 grams/year/person was used to determine estimated inputs of lead by the other countries. This procedure produces a total estimated input of lead to the study area via domestic sewage of about 250 tonnes/year.

Zinc input data were also provided by four countries, with resulting <u>per capita</u> values of 28.0 grams/year/person for England/Wales, 13.2 grams/year/person for Norway, 25 grams/year/person for Sweden and 31 grams/year/person for Denmark. With the exception of the Norwegian figure, these values are not significantly different, so the average of the three comparable figures was used to estimate inputs for the other countries, yielding an estimated input of zinc to the study area of 1.3 x 10^3 tonnes per year via sewage effluents.

Only a very limited amount of data were available on mercury in sewage and the resulting per capita values were out of agreement by one order of magnitude. Thus, only estimates for Scotland, Northern Ireland and Ireland were made, utilising the English/Welsh per capita figure of 0.6 grams/year/person. The total mercury input, as determined from this small amount of data is about 17 tonnes/year. This figure is clearly lower than the true value.

Inputs of Pollutants in Industrial Wastes

The replies to the questionnaire on the inputs of industrial waste are summarised in Tables 3-6. All countries, except Denmark and the Federal Republic of Germany, provided estimates of quantities of industrial effluents discharged directly into the study area. For these two countries, some values from the earlier North Sea study have been included as the best available estimates, but it must be recognised that they are very incomplete. The industrial data from the Netherlands is not particularised, but is included with the river data, as the rivers are the recipients of most industrial waste. The reply from Greenland indicated that no industries are located in the eastern portion of the country, thus no industrial waste products are discharged from the east coast.

As in the North Sea study, Belgium stated that it had very few direct discharges of industrial effluents into the sea and Denmark made a similar statement regarding the west coast of Jutland (DK4). Consequently, where information on industrial effluents had been available, both countries had included the data in the sewage discharge sections of their replies.

In general, some respondents have reported industrial and sewage discharge data as one figure. Industrial effluent values include cooling water volumes primarily only where they have been mixed with wastes before discharge. For the most part, the industrial figures reported do not include simple cooling water discharges from, e.g., power plants, because the only input contained in such water is thermal energy. This was not considered to be a problem in the earlier North Sea study and, in the absence of any new evidence to the contrary, no special attention was paid to this subject in the current study.

According to the information available, a total flow of at least 3.4 x 10^9 m^3 of industrial effluents is discharged to the study area per year. However, this figure is low due to the incomplete information from Denmark and the Federal Republic of Germany. A breakdown of the industrial discharges according to industry type and area of location was provided by only one country, Norway, consequently it was not considered appropriate to include it in the tables.

The quantity of industrial effluents entering the North Sea portion of the study area amounts to at least 2.4 x 10^9 tonnes/year. This figure is 30% greater than the 1.8 x 10^9 tonnes/year reported in the earlier North Sea study. However, that value was known to be an underestimate and the higher value now is merely a reflection of somewhat better information being available.

As in the earlier North Sea study, the level of discharge of industrial effluents appears to be lower than that of domestic sewage inputs of 5.7×10^9 tonnes/year. There are two reasons for this: (1) the fact that in many countries the domestic sewage input includes at least a portion of light industrial effluent, and (2) the acknowledged incomplete data from most countries on industrial effluents directly discharged to the sea. Taking both domestic and industrial wastes together, the total discharge into the study area amounts to about 9.4×10^9 tonnes/year.

The major industries listed by each country are shown in Table 8. Certain industries, such as chemicals, mining and metallurgy, and oil refineries, are found in most of the countries in the study area. Other industries are more localised, such as the large proportion of pulp and paper industries located in Norway and Sweden.

Each country was asked to provide information on the content of nitrogen, phosphorus, suspended solids, metals, organochlorine pesticides and PCBs, and the BOD or COD load of industrial effluents. However, few countries were able to give data for all their coastal zones and even where this had been attempted, the information provided was incomplete. Although many of the replies give pollutant inputs resulting solely from industrial sources, a significant amount of the data involves combined industrial/domestic inputs, without an indication of the proportional distribution between the two. In the following discussion, totals are given based on those figures provided for industrial effluents only. As these totals do not include mixed figures for domestic/industrial discharge, a second total is given for each substance which includes this mixed value as well as the quoted figures for separate industrial and domestic inputs, thus giving the total estimate for domestic and industrial input.

Most countries provided data on the biochemical oxygen demand due to industrial effluents, although in several cases separate figures were not provided for industrial and domestic wastes. The total of the separately reported figures for BOD attributed to industrial waste is approximately 3.8×10^5 tonnes/year. Taken together with the data for domestic sewage and the data for combined domestic/industrial BOD, the total biochemical oxygen demand resulting from input of domestic and industrial waste is about 1.1×10^6 tonnes/year. As with the other figures in this report, this is undoubtedly a conservative estimate. These figures are shown in Table 4.

The available data on chemical oxygen demand are shown in Table 9. As indicated in the discussion on domestic sewage, these figures represent the composite COD from all sources reported by the various countries (industrial, domestic and in some cases rivers). The figures are, however, incomplete.

Inputs of nutrient nitrogen and phosphorus in industrial effluents were reported by most countries, however, as with BOD figures, not always as values excluding the contribution from domestic sewage. The total nitrogen input reported separately to be attributed to industrial effluents is estimated as 7.0×10^4 tonnes/year. When domestic and mixed domestic/industrial figures are included, the total nitrogen input to the study area due to these sources amounts to around 2.0×10^5 tonnes/year. The data for total phosphorus input via industrial wastes show, as a conservative estimate, 2.5×10^4 tonnes/year entering the study area. The combined figure for all domestic, industrial and mixed discharges is 5.6×10^4 tonnes/year. These values, it must be emphasised, are conservative estimates.

Only a few countries were able to provide information on the discharge of suspended solids. Figures primarily from Norway and England/Wales give a very incomplete total of 9.4×10^6 tonnes/year. When added to the available data on domestic sewage and mixed domestic/industrial effluents, the total obtained is 9.9×10^6 tonnes/year. This is clearly far short of the actual value due to the very incomplete data base.

Only a few countries were able to provide data on the discharge of metals in industrial effluents (see Tables 5 and 6). Because it is impossible to produce estimates on metal discharge figures for countries lacking these data, the figures for these substances necessarily fall far short of the true value.

Some information on discharges of iron in industrial effluents were reported by Norway and England/Wales, giving a joint yearly input from these two countries of at least 1.6×10^4 tonnes/year of iron in industrial wastes. Adding this figure to the data on iron in domestic sewage and the mixed figures for domestic/industrial iron input, a total of about 2.8×10^4 tonnes iron/year is obtained.

No data were reported on the content of manganese in industrial waste effluents.

Cadmium contents in at least some industrial waste discharges were reported by Norway, Ireland and England/Wales, which in total discharged around 38 tonnes Cd/year into the study area. Combined with estimates on cadmium in domestic sewage, the total figure for input of cadmium/year is estimated as 80 tonnes.

The quantities of copper contained in at least some industrial effluents were reported by four countries, indicating a total input of about 890 tonnes/year. Adding the data and estimates of the copper content in domestic sewage for all countries, a total domestic and industrial discharge value of approximately 1.5×10^3 tonnes/year is obtained.

Five countries were able to provide some data on chromium discharge in industrial wastes, suggesting that at least 170 tonnes of chromium were discharged per year via industrial effluents. This figure, added to mixed data and the estimates of chromium content in domestic sewage, produces a total annual input of chromium of about 380 tonnes/year. These data are found in Table 6.

A total of approximately 170 tonnes of nickel per year was reported by three countries to be discharged into the study area via industrial effluents. When added to the estimates of nickel content in domestic sewage, a total of around 390 tonnes of nickel is found to be discharged per year.

The total quantity of lead reported to be discharged by five of the respondent countries amounts to around 790 tonnes/year. Along with estimates for lead contents in domestic sewage and a mixed domestic/industrial input value from the Netherlands, a total of at least 1.7×10^3 tonnes of lead is discharged into the study area per year.

Zinc inputs via industrial waste were reported by a majority of the countries, amounting to a total of approximately 1.1×10^4 tonnes/year. This amount rises to 1.4×10^4 tonnes/year when mixed domestic/industrial and domestic wastes are included.

In contrast, very little information was available on mercury inputs to the study area. Data from three countries suggest a total input of only 6.3 tonnes Hg/year due to industrial sources and, including figures from several other countries, about 23 tonnes/year due to both industrial and domestic sources. These figures are clearly underestimates.

Several countries provided information in their replies on the discharge of oil, phenol, syndets and other substances via industrial effluents. As this miscellaneous information varied from country to country, it was impossible to make any overall evaluations for any of these substances. These data are contained in Table 9.

River Inputs to the Marine Environment

For many pollutants, rivers appear to be important and perhaps main pathways of transfer from land to the marine environment. The pollutant load in rivers results not only from direct domestic sewage and industrial waste discharges, but also from agricultural and other uses of the land. Agriculture can, in fact, be the main source of some pollutants. For example, the use of nitrate fertilisers can lead to major inputs of nitrates to rivers in times of heavy rainfall. Similarly, land drainage and irrigation can significantly affect the suspended particle loading of rivers. Today, the increasing use of ammonia as a nitrogen fertiliser decreases the importance of this source. However, the use of ammonia gives rise to the airborne transport of nitrogen, which will eventually reach the rivers and the sea.

It must be recognised that a major uncertainty exists with regard to river sources of pollutants concerning the possible retention or delay of a pollutant in an estuary or fjord. To date, few studies have been conducted on the transport of pollutants through estuaries. Even for substances which have been brought directly into the open sea, there is an uncertainty regarding to what extent they remain in the dynamic environment. In the absence of data to indicate precisely how significant such effects are, it has been assumed here that the total input is to the marine environment in a broad sense. Thus, for data presented in terms of pollutant loads on a river, the total value has been utilised on the assumption that the entire load eventually reaches the open sea. This will probably lead to an overestimate of the contribution of river inputs of pollutants to the marine environment, but the magnitude of this error cannot be determined at present.

Data on the total flow of river water into the study area were provided by all countries, except Norway, Belgium and Iceland, with only partial data from Sweden (see Table 3). Greenland did not report river flow because there are no domestic or industrial waste discharges into rivers in that country. The total from the reporting countries shows an annual flow of river water of about 3.2×10^{11} m^3/year into the study area. Of this total, 2.2×10^{11} m^3/year, or over two-thirds, flow into the North Sea.

Of the countries reporting river data, nearly all were able to provide at least some information regarding BOD, total nitrogen, total phosphorus and suspended solids loads from the rivers.

Data on metal inputs via rivers were provided by the Netherlands, England/Wales and, to a certain extent, Sweden. Input concentrations (in mg/m^3) for each of the metals were determined for both Dutch and English/Welsh rivers and were found to be in good agreement (see Table 7). The averages of these two sets of input concentrations were used to estimate metal inputs for all other countries which had provided information on river flow. In this way, estimates were able to be obtained for the river input of most of the metals here studied.

Several countries provided data on the river input of "total metals". These figures were not utilised here because of the uncertainty of the exact composition and the fact that iron, when included in the figure, is usually the dominant component, thus obscuring the levels of toxic metals.

In view of the uncertainty referred to above regarding the proportion of river input which actually reaches the sea, no detailed discussion of the inputs of the various pollutants is given. The apparent contributions by area are shown in Tables 4-6, with summary information provided in Summary Tables 4-6.

It is probable that rivers would represent an important source of input of pesticides, herbicides and other such contaminants to the marine environment. Little or no data on this were provided and it is not possible to formulate any estimates regarding the magnitude of this possible input.

Inputs of Pollutants by Marine Dumping

The intentional dumping of harmful and potentially harmful substances into the study area has been regulated by international law since the entry into force in April 1974 of the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft. Under this Convention, the dumping of certain substances, e.g., mercury, cadmium and their compounds and harmful organohalogen compounds (listed in Annex I to the Convention) is prohibited, unless they occur only as trace contaminants in waste to which they have not been added for the purpose of being dumped. Other substances (listed in Annex II), for example, arsenic, lead, copper, zinc and their compounds and pesticides not listed in Annex I, may be dumped only after an appropriate permit has been obtained. Member States must submit annual data on all permits granted and dumping activities to the Oslo Commission.

In the replies to the Inputs Questionnaire, nearly all countries reported marine dumping of harbour dredgings and most reported dumping of sewage sludge, although not all countries provided detailed data on these activities. Dumping of at least some industrial wastes was also reported by nearly all countries. Only one country, Sweden, indicated that it has a national ban on the dumping of industrial wastes into the sea, which it has enforced for several years. A summary of the dumping information contained in the replies, most of which covers the year 1975, is found in Table 10.

From this information, it appears that a total of 8.2×10^7 tonnes of waste is dumped into the Oslo Convention area per year. Of this amount, nearly 75%, or 6.0×10^7 tonnes/year, is harbour and river dredgings. Sewage sludge represents the next largest quantity of waste dumped, estimated at 9.6×10^6 tonnes/year. Approximately 3.2×10^6 tonnes of industrial waste are dumped per year, of which about 9.3×10^5 tonnes are from titanium dioxide production. The origin of industrial wastes was not always indicated in the replies, but it appears that wastes from chemical industries are also a significant source.

Some of the countries were able to provide a breakdown of the amounts of heavy metals, organic compounds and other substances contained in these wastes. On the basis of this information, which is far from complete, partial totals may be estimated for the input of various substances.

Of the prohibited substances listed in Annex I to the Oslo Convention, an estimated 35 tonnes of mercury and 89 tonnes of cadmium per year reach the sea via dumped waste, primarily in harbour and river dredgings. Approximately 37 tonnes/year of chlorinated hydrocarbons are contained in dumped industrial waste and, to a smaller extent, dredgings. An additional unknown amount of chlorinated hydrocarbons are deposited as a result of incomplete combustion during incineration of wastes (see discussion below). Of the Annex II substances, approximately 4 250 tonnes lead/year, 2 430 tonnes copper/year and 9 130 tonnes zinc/year were contained in dumped wastes. Approximately

23 tonnes of arsenic were deposited in the sea, primarily via industrial wastes, but 3 tonnes were dumped in sealed containers. A total of 205 tonnes of cyanide was reported dumped by England/Wales in containers into deep water in the Atlantic Ocean. Non-regulated heavy metals reported to be found in wastes included chromium (2 710 tonnes/year) and nickel (530 tonnes/year).

Some of the replies indicated the amounts of organic matter and nutrients contained in the wastes. This partial data suggests that annually at least 15 100 tonnes of organic matter, 22 200 tonnes nitrogen and 13 050 tonnes phosphorus are deposited in the study area via dumpings. The Netherlands and Denmark reported on the COD load contained in dumped wastes, which totalled 21 000 tonnes/year for these two countries.

Only the Netherlands reported on the disposal of wastes via incineration at sea in special vessels. This information is found at the end of Table 10. In 1975, approximately 40 250 tonnes of waste were incinerated at sea, of which at least 82% were chlorinated hydrocarbons. The respondent assumed that the efficiency of combustion was $\geq 99.9\%$, so that the maximum input of chlorinated hydrocarbons as a result would be ≤ 40 tonnes. Studies have been undertaken by the Netherlands to determine more precisely the efficiency of incineration in different types of vessels.

Input of Pollutants via Atmospheric Deposition

Five countries, Sweden, Denmark, Ireland, England and Scotland, reported the results of programmes designed to measure the input of pollutants via atmospheric deposition. Summaries of the results of these investigations are contained in Table 11.

Sweden has a station network for air and precipitation chemistry which is part of the European Atmospheric Chemistry Network. Samples of air and precipitation have been collected monthly since 1967 at 38 stations. These samples are analysed for a number of common anions and cations, pH and conductivity. The results are used to estimate the airborne nitrogen (NO_3 + NH_4) and acid transported to the sea.

Another Swedish programme, investigating airborne fallout of chlorinated hydrocarbons, shows that significant amounts of PCBs and DDT are transported by the air. Due to fluctuations in the observations, it was impossible to calculate total fallout, however a conservative estimate would be that 700 kg PCBs and 300 kg DDT are transported annually to the North Sea. Sites of measurement and corresponding levels of fallout can be found in Reference 8.

Two Danish programmes are concerned with the airborne fallout of heavy metals. One investigation, conducted in the Little Belt region, has been carried out using stations too near an industrial area to provide data useful to this input study. The other investigation, carried out by the University of Copenhagen, uses land-based stations situated far from all potential sources of pollution. Fourteen stations are located in Denmark, with one on the Faroe Islands and another on the west coast of Sweden. The results of analysis of rainwater samples for Pb, Cd, Cu, Zn, Na, Mg, Fe and Mn, as reported by the investigator in mg $m^{-2}yr^{-1}$, are shown in Table 11. These results have been converted to concentrations of the metals in rainwater in µg/l for comparison with the results of the English/Scottish investigation to be discussed next. Additionally, the total annual estimates of atmospheric fallout of these metals into the North Sea have been calculated based on the initial data.

An investigation of the atmospheric input of trace elements to the North Sea has also been jointly conducted by several laboratories in England and Scotland. Atmospheric inputs were studied in 1972-73 (reported in Reference 1) and from July 1974 - June 1976 (reported in Reference 2). Results from this second study are shown in Table 11. Seven sampling stations from Norway and down the western side of the North Sea to Holland were chosen, located as far as practicable from local sources of contamination and from the immediate influence of sea-spray. Analyses were done for 23 trace elements and heavy metals and annual mean values for their total and dissolved concentrations in rain water were determined. Values for the total content of Cd, Co, Cu, Fe, Hg, Mn, Ni, Pb and Zn in the North Sea were obtained by direct measurement of the concentrations in sea water and integrated over the whole sea.

Results of this investigation show that, for the period mid-1974 to mid-1975, the estimated annual input by rain compared with the content of the sea was about 50% for iron and about 25% for lead. For zinc, the percentage annual atmospheric input was approximately 13%. The atmospheric input of mercury was about 1% of the amount present in the sea, while for cadmium (dissolved component) this value was about 10%. For copper and manganese, annual atmospheric input amounted to between 10% and 15% of the content of the sea and for nickel and cobalt it was about 5%.

A study of the deposition of heavy metals has been conducted by Scotland around the Firth of Forth, where six stations were set up. Monthly samples were collected from February to December 1975 and analysed for Na, Pb, Cu, Zn and Hg. A summary of the results is contained in Table 11, with the entire report in Reference 5. The results show that the deposition of Pb, Cu, and Zn is related to rainfall and may thus be collected through "wet" deposition. In contrast, the deposition of Hg seems to display a negative correlation with rainfall and, therefore, appears to result from a constant fallout, possibly through "dry" deposition.

Another Scottish programme has investigated the atmospheric input of organochlorines to the North Sea. Quarterly samples were collected from June 1975 to May 1976 at seven coastal stations from the Shetland Islands to southeast England. The samples were analysed for PCBs, the DDT group, dieldrin, α-HCH, and γ-HCH. The preliminary results are reported in Reference 6; first-order estimates of the annual inputs to the North Sea are quoted in Table 11. The results indicate that only the deposition rate of α-HCH seemed to be directly associated with rainfall. It appeared likely that, for the other substances, dry deposition is the primary means of fallout.

Ireland has provided some information on an air pollution monitoring programme measuring SO_2, smoke and dust at stations located near towns. This information has not, however, been related to the actual deposition of these substances into the sea.

The results of the studies reported here show that progress is clearly being made with respect to the estimation of atmospheric input of pollutants to the North Sea. Nonetheless, much work must still be done before estimates can be made for the open areas of the North Atlantic.

Summary and Conclusions

This study of the input of pollutants to the Oslo Commission Area has extended our knowledge in several important ways: (1) the sea area for which we have input estimates has been considerably expanded in the northern and western coastal areas of the Oslo Commission, (2) information has been collected for the first time on the input of pollutants via rivers to the area, and (3) further studies have produced better estimates of atmospheric deposition of pollutants.

In spite of the substantial advance which this input study represents, it must be recognised that there are serious limitations in the accuracy and comprehensiveness of much of the data presented. As was pointed out in the discussion, the data on dumping now appear to be complete and this no doubt reflects the need brought about by the Oslo Convention that the countries party to that Convention maintain accurate records of the amounts and composition of materials dumped and the positions of such dumpings.

The summary table of inputs (Table 1) provides a simple compilation of the known inputs to the study area. It should be recognised that the distribution of these known inputs is not equally dispersed throughout the area and the different limitations on the data summarised make it very difficult and probably dangerous to make comparisons of the different sources of inputs. Thus, although it is clear that atmospheric input is a significant source of several metals, it would be completely wrong to assume that the input of, e.g., zinc via the atmosphere is roughly the same as that from industrial sources or that the amount of nickel dumped at sea is roughly the same as the amount entering in domestic and industrial sewage. The completeness of the two sets of data is simply not equal. The industrial and sewage data are far from complete and in many cases industrial input data are either absent or lost in the sewage input data.

A further and perhaps particularly good example is afforded by mercury. The annual input of mercury to the world's oceans has been estimated to be about 10 000 tonnes/year, roughly equally distributed between man-influenced activities and natural sources. Of this, at least 1 000 tons must enter the study area and yet only about 100 tons can be accounted for. The dumping and atmospheric inputs (North Sea only) are probably fairly accurate but the industrial input is known to be far from complete and that from domestic and industrial sewage is based on very tenuous data.

With a careful reading of the preceding text, some of these deficiencies are obvious, others less so. A great deal of further work will be required in order to improve the present knowledge. In particular, much better information is needed on the pollutant content of sewage effluents. Far more complete data are required on industrial inputs, both in terms of quantity and in terms of the types and amounts of potentially harmful substances.

Input by atmospheric deposition is another area where more research is required to allow better estimates, not only for the North Sea, but for the North Atlantic. There has been enough progress in the North Sea that it might be possible to establish more international collaboration in air-fallout studies, which could certainly be beneficial to this assessment.

Finally, information is completely lacking from the southern portion of the Oslo Commission Area, namely inputs from France, Spain and Portugal. It is important that data be provided for these regions to allow a complete picture of inputs to the entire area.

As can be seen by the relatively complete data on dumping inputs, the stimulus provided by the relevant Commissions is very important to the advancement of work on the study of pollutants. It is hoped that this stimulus will result in more detailed input studies in the future.

Table 1. Summary of estimated inputs of pollutants (tonnes/year).

Source	Total Flow (10^6 m^3/yr)	Inputs												
		Nitrogen	Phosphorus	Suspended Solids	BOD	Iron	Manganese	Cadmium	Copper	Chromium	Nickel	Lead	Zinc	Mercury
Domestic Sewage	5 664.4	109 999	29 759	388 000	452 000	4 958	310.4	[42.6]	[598.2]	[175.7]	[218.7]	[247.5]	[1 279.7]	16.97
Industrial Waste	3 432.1	70 255	25 042	9 354 100	395 000	16 051	-	37.7	890.8	169.8	172.8	785	11 052.7	6.34
Domestic + Industrial	9 392.8	202 481	56 249	9 893 100	1 125 000	28 336	-	[80.3]	1 492.0	[381.5]	[391.5]	1 726.5	13 719.4	23.33
River Water	316 514	973 010	94 794	5 188 000	938 000	246 588	[30 207]	[420.9]	[2 786.3]	[2 677.8]	[2 417.5]	[3 830.7]	[19 275.1]	36.43
Dumping Activities	-	22 202	13 048	-	-	-	-	89	2 426	2 712	527	4 248	9 131	35
Atmospheric Deposition	-	-	-	-	-	105 000+)	4 100+)	530+)	4 900+)	720+)	1 650+)	5 600+)	14 500+)	5.6+)
Total	325 906.8	1 197 693	164 091	15 081 100	2 063 000	379 924	34 617.4	1 120.2	11 604.3	6 491.3	4 986	15 405.2	56 625.5	100.36

+) North Sea only.

NOTE: Figures given in square brackets are estimates made by the compiler of the data.

Furthermore, it must be recognised that this type of data is essential for the proper interpretation of monitoring data and that the scientific assessment of monitoring data by bodies such as ICES will be severely hampered until accurate data are available.

The report, as presented so far, essentially summarises the raw data. No attempt has yet been made to assess it in terms of relative distribution of pollutant input or in relation to levels of contamination in particular areas. This will be the next and perhaps more difficult stage, especially bearing in mind the incomplete nature of the data now available.

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Table 2. Key to area codes for each country.

Country		Code	Full description
NORWAY		N1	Oest-fold
		N2	Oslo/Akershus
		N3	Buskerud
		N4	West-fold
		N5	Telemark
		N6	Aust-Agder
		N7	West-Agder
		N8	Rogaland
		N9	Hordaland
		N10	Sogn and Fjordane
		N11	Møre and Romsdal
		N12	Sør-Trøndelag
		N13	Nord-Trøndelag
		N14	Nordland
		N15	Troms
		N16	Finmark
SWEDEN		S1	Mouth of River Enningsclalsälven - west of River Orekilsälven
		S2	West of River Orekilsälven - north of River Nordre Älv
		S3	North of Nordre Älv - south of River Göta Älv
		S4	South of River Göta Älv - north of River Ätran
		S5	North of River Ätran - west of Halmstad
		S6	West of Halmstad-Kullen
DENMARK		DK1	From Gilbjerg Head to Gniben
		DK2	From Hassenoere to Skagen
		DK3	The Limfjord
		DK4	West coast of Jutland from Skagen to German border, excluding the Limfjord
		DK5	Faroe Islands
GERMANY, FED.REP. OF		G1	Niedersachsen (coast west of the River Elbe)
		G2	Schleswig-Holstein (coast north of the River Elbe)
		G3	Hamburg
		G4	Bremen
		G5	Bremerhaven
NETHERLANDS		NL1	Western Scelt Estuary
		NL2	Southern Delta Coast
		NL3	Northern Delta Coast
		NL4	Closed Holland Coast
		NL5	Wadden Coast
		NL6	Eems Dollard Estuary
BELGIUM		B1	From Dunkirk to the Netherlands Border

/Cont'd.

Table 2 (Continued)

Country	Code	Full description
ENGLAND and WALES	E1	Scotland/England border-River Tyne (North limit)
	E2	River Tyne Estuary
	E2a	River Tyne to River Wear
	E3	River Wear
	E4	River Wear to River Tees
	E5	River Tees Estuary
	E6	River Tees to Flamborough Head
	E7	Flamborough Head to Spurn Head
	E7a	Humber Estuary
	E8	Humber to the Wash (Gibraltar Point)
	E9	The Wash (Gibraltar Point to Hunstanton)
	E10	Gore Point to Colne Point
	E11	Colne Point to Haven Point
	E12	River Thames (Haven Point to Long Rock Whitstable)
	E13	Whitstable to Hastings Pier
	E14	Hastings Pier to Selsey Bill
	E15	Hengistbury Head (Southern/Wessex Water Authority)
	E16	Pokers Pool (Lyme Regis)
	E17	Start Point
	E18	Lands End
	E19	Hartland Point
	E20	Foreland Point
	E21	Severn Beach (Wessex/Severn Trent Water Authority)
	E22	Beachley Point
	E23	Liverock Point
	E24	Worms Head
	E25	St. Davids Head
	E26	St. Davids Head to Braich y Pwll
	E27	Braich y Pwll to Dove Point Hoylake
	E28	Mersey Estuary
	E29	Marshside to Haverigg Point
	E30	Haverigg Point to Barnkirk Point (Scottish Border)
SCOTLAND	SC1	English border to Ballantrae
	SC2	Ballantrae to Sound of Mull
	SC3	From Inverness to Montrose
	SC4	Firth of Tay
	SC5	Firth of Forth
IRELAND	IR1	From UK border to Dungarvan
	IR2	From Dungarvan to River Shannon (Kerry Head)
	IR3	From Kerry Head to Bundoran
	IR4	Donegal
ICELAND	IC1	Faxa Bay
	IC2	Rest of Iceland
GREENLAND	GR1	East Greenland

Table 3. Contributing populations, waste water and river water flow.

Country and Area	Population x 10^3	Waste Water: Domestic Sewage x 10^6 m^3/yr	Treatment (%): Untreated	Treatment (%): Settlement	Treatment (%): Settlement + Biological	Treatment (%): Additional	Industrial Waste x 10^6 m^3/yr	Domestic + Industrial x 10^6 m^3/yr	River Water x 10^6 m^3/yr
NORWAY									
N1	145	13	95	1	4[+)]	0	184	197	-
N2	814	58	13	31	4	48	15	73	-
N3	67	6	85	13	2[+)]	0	329	335	-
N4	130	12	93	4	3[+)]	0	13	25	-
N5	74	7	90	7	3[+)]	0	318	325	-
N6	36.9	4	97	3	0	0	4	8	-
N7	71	6	84	16	0	0	238	244	-
N8	170	15	98	2	0	0	167	182	-
N9	-	20	99	1	0	0	71	91	-
N10	40.6	4	88	0	12[+)]	0	12	16	-
N11	114.9	10	99	0.2	0.8	0	38	48	-
N12	157.1	14	99	0.3	0.7	0	34	48	-
N13	62	57	97	1	2	0	44	101	-
N14	131.7	12	97	2	1	0	154	166	-
N15	65.9	6	87	6	7	0	2	8	-
N16	52.8	5	95	1	4	0	42	47	-
Total	2 132.9	249					1 665	1 914	-
SWEDEN									
S1	38	5.4[1)]	29*	50*	21*	0*	2.5	7.9	-
S2	60	8.4	18*	24*	58*	0*	3.1	11.5	-
S3	534	96.0	70*	6*	13*	11*	6.7	102.7	16 000
S4	74.5	10.1	6*	3*	89*	1*	50.0	60.1	-
S5	4.4	0.9	6*	47*	44*	3*	-	0.9	-
S6	101.6	11.5	5*	14*	54*	8*	0.1	11.6	-
Total	812.5	132.3					62.4	194.7	24 800
DENMARK									
DK1	10	1[2)]	50	50	0	0	neg	1	-
DK2	165	44	-	-	-	-			1 430
DK3	500	(65)	-	-	-	-			2 200
DK4	212	(28)	-	-	-	-			2 000
DK5	39	(5)	-	-	-	-			-
Total	926	(143)					21[*)]	61[*)]	5 630

+) Biological treatment only. 1) Where actual measurements were not conducted, respondent made estimates based on a per capita water consumption of 400 l/day/person.

Cont'd.

2) Where actual measurements were not conducted, respondent made estimates based on a per capita water consumption of 130 $m^3/yr/person$.

*) Data from Coop.Res.Rep. No.39 (1974).

Table 3 (Continued)

Country and Area	Population x 10^3	Waste Water: Domestic Sewage x 10^6 m^3/yr	Treatment (%): Untreated	Settlement	Settlement + Biological	Additional	Industrial Waste x 10^6 m^3/yr	Domestic + Industrial x 10^6 m^3/yr	River Water x 10^6 m^3/yr
GERMANY, FED.REP. OF									
G1	-	1 278	-	-	-	-	-	1 278	2 200
G2	300*)	39*)	0*)	43*)	54*)	3*)	2*)	41*)	-
G3	1 850*)	-	25*)	60*)	15*)	0*)	-	132*)	27 400
G4	600*)	99	10*)	90*)	0*)	0*)	174*)	273	9 100
G5	142*)	10*)	100*)	0*)	0*)	0*)	3*)	13*)	-
Total	2 892*)	(1 426)					179*)	(1 737)	38 700
NETHERLANDS 3)									
NL1	-	-							4 407
NL2	-	-							1 577
NL3	-	-							67 840
NL4	-	-						96	25 893
NL5	-	-							16 670
NL6	-	-							1 034
Total	2 195*)	113*)	75*)	25*)	0*)	0*)	61*)	174*)	117 421
BELGIUM	250	10	90	0	10	0	1	11	-
ENGLAND AND WALES									
E1	280	23	79	11	10		-	23	3 469
E2	944	108	100	0	0		3	111	1 065
E2a	18	1	100	0	0		neg.	1	0
E3	190	16	66	0	34		-	16	321
E4	281	43	100	0	0		-	43	18
E5	385	25	92	1	7		-	25	530
E6	-	18	90	0	10		-	18	528
E7	144	8	100	0	0		-	8	0
E7a	889	170	64	11	25		99	269	5 680
E8	153	46	0	1	99		-	46	62
E9	185	39	16	17	67		4	43	2 268
E10	685	71	31	6	63		5	76	655
E11	313	53	0	4	96		3	56	222
E12	8 360	1 027	2	10	88		537	1 564	4 830
E13	576	38	84	0	16		10	48	346
E14	935	64	77	6	17		0	64	615
E15	948	93	47	3	51		275	368	730
E16	337	31	33	0	67		3	34	2 325
E17	489	40	62	8	30		2	42	2 099
E18	472	47	67	3	30		12	59	1 943
E19	204	11	89	0	11		1	12	365
E20	194	9	91	7	2		neg.	9	1 653

*) Data from Coop.Res.Rep. No.39 (1974).

3) Sections 1, 2, 3, 5 and 6 are river mouths, thus there are no domestic or industrial figures.

England and Wales (Continued)

Table 3 (Continued) (England and Wales)

Country and Area	Population $\times 10^3$	Waste Water: Domestic Sewage $\times 10^6$ m^3/yr	Treatment (%): Untreated	Treatment (%): Settlement	Treatment (%): Settlement + Biological	Treatment (%): Additional	Industrial Waste $\times 10^6$ m^3/yr	Domestic + Industrial $\times 10^6$ m^3/yr	River Water $\times 10^6$ m^3/yr
ENGLAND AND WALES									
E21	269	18	67	5	28		5	23	1 067
E22	642	101	31	59	10		114	215	6 989
E23	-	-	-	-	-		-	-	-
E24	-	-	-	-	-		-	-	-
E25	-	142	64	12	24		17	159	3 112
E26	102	164	46	34	20		-	164	3 590
E27	-	102	26	2	72		43	145	1 872
E28	1 940	141	83	15	2		58	199	1 296
E29	995	153	47	19	34		31	184	3 379
E30	113	7	98	1	2		47	54	3 453
Total	21 043	2 809					1 269	4 078	54 482
SCOTLAND									
SC1	62	(7)	-	-	-	-	(4)	11	5 530
SC2	2 465	-	27	3	70	0	-	285	15 510
SC3	-	-	-	-	-	-	-	-	4 300
SC4	294	-	-	-	-	-	-	39	3 770
SC5	942	160	-	-	-	-	107	267	3 200
Total	3 763	167					111	602	32 310
NORTHERN IRELAND	(160)	(255)	22	75	3	0	2	(257)	3 126
IRELAND									
IR1	1 605	[176] 4)					-	[176]	9 855
IR2	439	[48]					-	[48]	7 450
IR3	760	[84]					-	[84]	15 440
IR4	174	[19]					-	[19]	7 300
Total	2 978	[327]	46	52	1	0	56.7	[383.7]	40 045
ICELAND									
IC1	130	26	-	-	-	-	-	-	-
IC2	45	7	-	-	-	-	-	-	-
Total	175	33					4	37	-
GREENLAND									
G1	3	0.1	100	0	0	0	0	0.1	-

4) Figures estimated on basis of average per capita water consumption of 0.3 m^3/person/day.

Cont'd.

Summary Table 3.

Country	Population x 10^3	Domestic Sewage (x 10^6 m^3/yr)	Industrial Waste (x 10^6 m^3/yr)	Domestic + Industrial (x 10^6 m^3/yr)	River Water (x 10^6 m^3/yr)
NORWAY	2 132.9	249	1 665	1 914	-
SWEDEN	812.5	132.3	62.4	194.7	24 800
DENMARK	926	(143)	21*)	61*)	5 630
GERMANY, FED.REP. OF	2 892*)	(1 426)	179*)	(1 737)	38 700
NETHERLANDS	2 195*)	113*)	61*)	174*)	117 421
BELGIUM	250	10	1	11	-
ENGLAND/WALES	21 043	2 809	1 269	4 078	54 482
SCOTLAND	3 763	167	111	602	32 310
N. IRELAND	(160)	(255)	2	(257)	3 126
IRELAND	2 978	[327]	56.7	[383.7]	40 045
ICELAND	175	33	4	37	-
GREENLAND	3	0.1	0	0.1	-
TOTAL	37 330.4	5 664.4	3 432.1	9 449.5	316 514

*) Data from Coop.Res.Rep. No.39 (1974).

Table 4. Estimates of inputs of nutrients, suspended solids, and BOD.

Country and Area	Total Nitrogen (tonnes/yr)				Total Phosphorus (tonnes/yr)				Suspended Solids (x 10^3 tonnes/yr)				Biochemical Oxygen Demand (x 10^3 tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
NORWAY																
N1	1 628	-	577	1 051	209	-	142	67	130.86	-	1.16	129.7	72.35	-	3.12	69.23
N2	2 996	-	2 313	683	365	-	286	79	4.86	-	2.43	2.43	8.73	-	5.76	2.97
N3	453	-	267	186	79	-	66	13	21.81	-	0.46	21.35	61.79	-	1.35	60.44
N4	1 484	-	523	961	172	-	129	43	4.59	-	1.06	3.53	4.90	-	2.67	2.23
N5	9 893	-	300	9 593	274	-	74	200	26.02	-	0.61	25.41	17.90	-	1.55	16.35
N6	259	-	148	111	65	-	36	29	1.51	-	0.29	1.22	2.37	-	0.78	1.59
N7	546	-	311	235	89	-	72	17	3.73	-	0.57	3.16	7.67	-	1.57	6.10
N8	3 953	-	707	3 246	702	-	162	540	14.31	-	1.46	12.85	12.49	-	3.03	9.46
N9	2 104	-	972	1 132	1 039	-	223	816	88.32	-	2.03	86.29	9.99	-	4.78	5.21
N10	861	-	165	696	90	-	41	49	2.35	-	0.31	2.04	4.26	-	0.79	3.47
N11	3 110	-	469	2 641	350	-	120	230	9.70	-	0.92	8.78	16.80	-	12.88	3.92
N12	1 560	-	676	884	214	-	167	47	73.50	-	1.66	71.84	9.00	-	3.92	5.08
N13	1 670	-	265	1 405	124	-	67	57	1 104.85	-	0.54	1 104.31	8.10	-	1.57	6.53
N14	4 038	-	561	3 477	937	-	140	797	2 603.54	-	1.18	2 602.36	8.13	-	3.20	4.93
N15	841	-	276	565	124	-	69	55	6.12	-	0.85	5.27	4.81	-	1.58	3.23
N16	942	-	230	712	132	-	57	75	3 303.26	-	0.46	3 302.80	5.64	-	1.22	4.42
Total	36 338	-	8 760	27 578	4 965	-	1 851	3 114	7 399.33	-	15.99	7 383.34	254.93	-	49.77	205.16
SWEDEN																
S1	454	300	130[5)]	24	78	22	53[5)]	3	0.07	-	-	0.07	2.02	0.87	0.97[6)]	0.18
S2	756	710	43	3	75	55	20	-	0.01	-	-	0.01	2.43	2.20	0.23	-
S3	11 806	10 000	1 800	6	1 153	700	270	183	-	-	-	-	41.21	38.0	3.20	0.01
S4	4 140	3 800	180	160	384	300	52	32	-	-	-	-	8.41	-	1.01	7.4
S5	3 011	3 000	11	-	162	160	2	-	-	-	-	-	0.02	-	0.02	-
S6	5 850	5 600	250	-	431	410	21	-	-	-	-	-	1.32	-	1.20	0.12
Total	26 017	23 410	2 414	193	2 283	1 647	418	218	0.08	-	-	0.08	55.41	41.07	6.63	7.71
DENMARK																
DK1	200	156	-	-	neg.	-	-	-	neg.				0.4	neg.	0.24[8)]	0.16
DK2	11 400	9 120	1 824[7)]	456	1 000	480	490[7)]	30					19.7	5.32	3.74	10.64
DK3	10 800	6 696	3 564	540[+)]	1 300	247	910	143					20.4	10.81	7.96	1.63
DK4	(9 900)	(3 900)	(4 400)	(1 600)	-	-	-	-					(10.0)	4.0	6.0	-
DK5	200	–	-	-	-	-	-	-					(0.8)	-	-	-
Total	32 500	19 872	9 788	2 596	2 300	727	1 400	173					51.3	20.13	17.94	12.43

Cont'd

+) Fish farms only. 5) Where actual measurements were not taken, respondent estimated total nitrogen and total phosphorus at: Total N 11 g/day/person; Total P 3.2 g/day/person, reduced by treatment as follows:

	Sedimentation	Biological	Chemical	Biological + Chemical
Total N	10%	35%	20%	40%
Total P	10%	25%	90%	90%

6) BOD is BOD7. Where actual measurements were not taken, respondent calculated values using BOD load as 70 g/day/person for untreated sewage, reduced by treatment as follows: sedimentation 30%, biological 80%, chemical 60%, and biological and chemical 90%.

7) Where actual measurements were not taken, respondent estimated total nitrogen and total phosphorus as follows (in kg/yr/person):

	Untreated	Sedimented	Biological
Total N	4.4	3.9	3
Total P	1.43	1.2	1

8) Where actual measurements were not taken, respondent calculated values using BOD load as 22 kg/yr/person for untreated sewage, 16 kg/yr/person with sedimentation treatment, and 2 kg/yr/person with biological treatment.

Table 4 (Continued)

Country and Area	Total Nitrogen (tonnes/yr)				Total Phrophorus (tonnes/yr)				Suspended Solids (x 10^3 tonnes/yr)				Biochemical Oxygen Demand (x 10^3 tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
GERMANY, FED.REP. OF																
G1	370	-	370		2	-	2		60	60	-	-	7	-	7	
G2	-	-	-		-	-	-		-	-	-	-	-	-	-	
G3	137 000	137 000	-		5 500	5 500	-		800	800	-	-	-	-	-	
G4	5 000	5 000	-		20 000	20 000[9]	-		340	340	-	-	43	-	43	
G5	-	-	-		-	-	-		-	-	-	-	-	-	-	
Total	142 370	142 000	370		25 502	25 500	2		1 200	1 200	-	-	50	-	50	
NETHERLANDS																
NL1	48 230	48 230	-		6 770	6 770	-		-	-	-		48.6	48.6	-	
NL2	4 730	4 730	-		440	440	-		-	-	-		2.08	>2.08	-	
NL3	414 950	414 950	-		39 610	39 610	-		1 865	1 865	-		355.22	355.22	-	
NL4	28 140	20 870	7 270		2 890	1 900	990		80	-	80		50.02	16.71	33.31	
NL5	65 700	65 700	-		5 350	5 350	-		126	126	-		114.84	114.84		
NL6	18 510	18 510	-		2 590	2 590	-		-	neg.	-		46.75	46.75		
Total	580 260	572 990	7 270		57 650	56 660	990		2 071	1 991	80		617.51	584.20	33.31	
BELGIUM	1 600*)	-	1 600*)		200*)	-	200*)		-				7.5	-	7.5	
ENGLAND/WALES																
E1	4 672	3 614	1 058	-	766	474	292	-	39.23	33.03	6.20	-	14.66	7.88	6.78	-
E2	4 270	876	3 394	-	1 102	190	912	-	28.25	11.79	16.46	-	40.22	2.63	35.11	2.48
E2a	73	-	-	-	18	-	-	-	0.4	-	-	-	0.46	0	0.46	0
E3	1 934	1 168	766	-	474	292	182	-	12.30	7.37	3.83	1.10	6.13	1.46	3.76	0.91
E4	1 032	10[a)]	1 022	-	292	-	292	-	6.46	-	6.46	-	6.47	0.01	6.46	-
E5	19 600	1 752	1 423	16 425	1 179	219	412	548	112.68	13.07	8.36	91.25	10.58	2.19	8.32	0.07
E6	1 614	694	920	-	270	-	270	-	19.76	14.38	5.38	-	6.21	0.84	5.37	-
E7	402	-	402	-	110	-	110	-	2.63	-	2.63	-	2.63	-	2.63	-
E7a	52 852	41 537	6 387	4 928	8 763	584	1 719	6 460	1 100.58	123.37	6.31	970.90	87.49	35.66	8.14	43.69
E8	622	438	184	-	30[a)]	-	30[a)]	-	0.30	-	0.30	-	0.27	0.11	0.16	-
E9	18 505	16 936	1 496	73	1 570	1 168	402	-	71.61	60.33	3.83	7.45	18.87	9.38	5.77	3.72
E10	6 851	3 686	3 139	26	1 058	110	912	36	29.38	14.82	14.12	0.44	16.76	1.53	14.24	0.99
E11	3 468	2 190	1 278	neg.	987	292	695	neg.	7.62	5.91	1.53	0.18	1.92	0.75	1.10	0.07
E12	59 896	31 280	24 820	3 796[a)]	8 030	110[a)]	7 920	-	326.87	187.76	45.73	92.38	103.56	22.78	52.78	28.00
E13	3 322	1 424	1 862	36[a)]	694	146	548	-	20.87	6.82	13.65	0.40	15.40	1.97	12.19	1.24
E14	5 219	2 117	3 102	-	1 058	182	876	-	80.74	36.97	18.18	25.59	20.0	1.82	18.18	<36.5
E15	8 395	3 394	3 577	1 424	1 095	73[a)]	1 022	-	49.06	13.43	17.85	17.78	27.37	1.93	17.30	8.14
E16	9 818	8 541	1 241	36	694	402	292	-	51.94	47.38	4.12	0.44	9.24	5.11	4.02	0.11
E17	6 534	4 818	1 716	-	511	36[a)]	475	-	112.85	80.48	10.62	21.75	15.11	5.58	9.53	neg.
E18	7 702	5 950	1 752	-	620	-	620	-	94.13	82.60	8.54	2.99	13.25	3.65	9.53	0.07
E19	1 862	1 278	584	-	146	-	146	-	170.48	111.87	3.61	55.00	4.23	0.62	3.61	neg.
E20	3 322	2 847	475	neg.	110	-	110	-	102.75	99.57	3.18	neg.	6.75	3.43	3.21	0.11

9) Value for PO_4-P only.

*) Data from Coop.Res.Rep. No.39 (1974).

a) Incomplete data.

England and Wales (Cont'd)

Table 4 (Continued) (England and Wales)

Country and Area	Total Nitrogen (tonnes/yr) Total	Total Nitrogen Rivers	Total Nitrogen Domestic	Total Nitrogen Industrial	Total Phosphorus (tonnes/yr) Total	Total Phosphorus Rivers	Total Phosphorus Domestic	Total Phosphorus Industrial	Suspended Solids (x 10^3 tonnes/yr) Total	Suspended Solids Rivers	Suspended Solids Domestic	Suspended Solids Industrial	Biochemical Oxygen Demand (x 10^3 tonnes/yr) Total	BOD Rivers	BOD Domestic	BOD Industrial
ENGLAND/WALES																
E21	5 074	4 088	840	146	767	548	219	-	20.15	14.27	4.49	1.39	10.36	4.16	4.89	1.31
E22	25 989	19 199	4 782	2 008	4 085	1 533	2 117	438	216.70	179.87	16.79	20.04	50.92	13.61	13.91	23.40
E23	6 643	-	-	-	183	-	-	-	115.70	-	-	-	-	-	-	-
E24	3 328[a]	1 102[a]	2 226[a]	-	142[a]	51[a]	91[a]	-	99.86	76.61	23.25	-	17.41	3.43	13.98	-
E25	4 161	2 993	730	438	394	179	179	36	52.86	49.09	3.50	0.27	13.85	9.56	3.65	0.64
E26	3 603	2 884	719	-	288	84	204	-	33.69	30.37	3.32	-	8.54	5.26	3.28	-
E27	4 173	1 716	2 201	256	543	73	470	-	74.09	62.67	7.70	3.72	14.97	3.69	7.56	3.72
E28	23 561	14 856	5 785	2 920	3 362	1 314	1 829	219	217.36	95.56	81.58	40.22	112.02	18.10	67.49	26.43
E29	15 659	6 826	3 869	4 964	2 055	927	1 128	-	112.38	76.69	22.26	13.43	53.69	10.29	25.55	17.85
E30	4 312	2 993	407	912	14 393	485	111	13 797	718.33	113.52	2.56	602.25	15.66	8.61	2.56	4.49
Total	318 468	191 207	82 157	38 388	55 789	9 472	24 585	21 534	4 102.01	1 649.60	366.34	1 968.97	725.0	186.04	371.52	167.44
SCOTLAND[10]																
SC1	5 176	4 964	212		204	204	-		20.75	19.71	1.04		15.90	11.32	4.58	
SC2	23 031	12 008	11 023		840	584[a]	256		210.21	170.02	40.19		92.31	25.00	67.31	
SC3	4 683	4 683	-		-	-	-		27.67	22.48	5.19		21.17	7.96	13.21	
SC4	1 478	1 058	420		-	-	-		12.13	8.52	3.61		9.06	5.04	4.02[a]	
SC5	2 150	818	1 332[b]		-	-	-		76.31	55.42	20.89[b]		48.20	6.76	41.44	
Total	36 518	23 531	12 987		1 044	788	256		347.07	276.15	70.92		186.64	56.08	130.56	
NORTHERN IRELAND	110	-	110	-	500	-	500	-	77.35	70.81	6.42	0.12	2.30	1.33	0.89	0.09
IRELAND																
IR1	-	-	-	-	-	-	-	-					57.7	25.7	32.0	
IR2	-	-	-	-	-	-	-	-					28.6	7.8	20.8	
IR3	-	-	-	-	-	-	-	-					14.35	11.9	2.45	
IR4	-	-	-	-	-	-	-	-					5.1	4.5	0.6	
Total	7 500	-	6 000	1 500[b]	753	-	750	3[b]	1.5	-	-	1.5[c]	105.75	49.9	55.85	
ICELAND[11]																
IC1	570	-	570	-	190	-	190	-						-	3.3	-
IC2	200	-	200	-	65	-	65	-						-	1.1	-
Total	770	-	770	-	255	-	255	-	-	-	-	-	7.0	-	4.4	2.6

Cont'd.

a) Incomplete data. b) Agriculture only. c) Mining only.

10) Phosphorus data for PO_4 - P only. 11) BOD estimated by respondent using a per capita value of 70 g/day/person.

Summary Table 4.

Country	Total Nitrogen (tonnes/yr)				Total Phosphorus (tonnes/yr)				Suspended Solids (x 10^3 tonnes/yr)				Biochemical Oxygen Demand (x 10^3 tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
NORWAY	36 338	-	8 760	27 578	4 965	-	1 851	3 114	7 399	-	16	7 383	255	-	50	205
SWEDEN	26 017	23 410	2 414	193	2 283	1 647	418	218	-	-	-	-	55	41	7	8
DENMARK	32 500	19 872	9 788	2 596	2 300	727	1 400	173	-	-	-	-	51	20	18	12
GERMANY, FED.REP. OF	142 370	142 000	370		25 502	25 500	2		1 200	1 200	-	-	50	-	50	
NETHERLANDS	580 260	572 990	7 270		57 650	56 660	990		2 071	1 991	80		618	584	33	
BELGIUM	1 600	-	1 600		200	-	200		-	-	-	-	8	-	8	
ENGLAND/WALES	318 468	191 207	82 157	38 388	55 789	9 472	24 585	21 534	4 102	1 650	366	1 969	725	186	372	167
SCOTLAND	36 518	23 531	12 987		1 044	788	256		347	276	71		187	56	131	
N. IRELAND	110	-	110	-	500	-	500	-	77	71	6	0.1	2	1	1	neg.
IRELAND	7 500	-	6 000	1 500	753	-	750	3	2	-	-	2	106	50	56	
ICELAND	770	-	770	-	255	-	255	-	-	-	-	-	7	-	4	3
TOTAL			109 999	70 255			29 759	25 042			388	9 354.1			452	395
			22 227				1 448				151				278	
	1 182 451	973 010	202 481		151 241	94 794	56 249		15 198	5 188	9 893.1		2 064	938	1 125	

Table 5. Estimates of inputs of iron, manganese, cadmium, and copper.

Country and Area	Iron (tonnes/yr)				Manganese (tonnes/yr)				Cadmium (tonnes/yr)				Copper (tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
NORWAY																
N1	1 783	-	5	1 778					-	-	-	-	0.4	-	0.4	-
N2	107	-	56	51					2.0	-	1.5	0.5	20	-	12	8
N3	2.8	-	1.3	1.5					-	-	-	-	[0.08]	-	(0.08) 12)	-
N4	116	-	52	64					-	-	-	-	[0.46]	-	[0.16]	0.3
N5	28	-	13	15					-	-	-	-	[0.39]	-	[0.09]	0.3
N6	20.4	-	1.1	19.3					-	-	-	-	0.09	-	0.04	0.05
N7	197	-	7	190					-	-	-	-	39.02	-	0.02	39
N8	505	-	157	348					-	-	-	-	1.2	-	0.2	1
N9	1 314	-	232	1 082					8	-	-	8	18.3	-	0.3	18
N10	427	-	-	427					-	-	-	-	[0.05]	-	[0.05]	-
N11	0.3	-	0.1	0.2					-	-	-	-	0.04	-	0.04	-
N12	1 701.4	-	1.4	1 700					1.4	-	-	1.4	400.1	-	0.1	400
N13	1.6	-	-	1.6					-	-	-	-	7.1	-	0.1	7
N14	4 800	-	-	4 800					0.1	-	-	0.1	[15.16]	-	[0.16]	15
N15	-	-	-	-					-	-	-	-	[0.08]	-	[0.08]	-
N16	0.3	-	-	0.3					-	-	-	-	[0.36]	-	[0.06]	0.3
Total	11 003.8	-	525.9	10 477.9					11.5	-	1.5	10	[502.83]	-	[13.88]	488.95
SWEDEN																
S1	170	170	-	-	29	29	-	-	-	-	[neg] 13)	-	[0.237]	-	[0.144] 13)	0.093
S2	465	465	-	-	75	75	-	-	-	-	[neg]	-	[0.229]	-	[0.228]	0.001
S3	5 000	5 000	-	-	680	680	-	-	0.05	-	0.05	-	2	-	2	-
S4	-	-	-	-	-	-	-	-	-	-	[neg]	-	[0.297]	-	[0.285]	0.012
S5	-	-	-	-	-	-	-	-	-	-	[neg]	-	[0.015]	-	[0.015]	-
S6	-	-	-	-	-	-	-	-	[0.01]	-	[0.01]	-	[0.388]	-	[0.388]	-
Total	5 635	5 635	-	-	784	784	-	-	0.06	-	0.06	-	[3.166]	-	[3.060]	0.106
DENMARK																
DK1	-	-	-	-	-	-	-	-	-	-	-	-	[0.03]	-	[0.03] 15)	-
DK2	[578]	[578] 14)	-	-	[144.4]	[144.4] 14)	-	-	[2.6]	[2.6] 14)	-	-	2.2	1.72 14)	0.48	-
DK3	[889]	[889]	-	-	[222.2]	[222.2]	-	-	[4.0]	[4.0]	-	-	[23.45]	[22]	[1.45]	-
DK4	[808]	[808]	-	-	[202.0]	[202.0]	-	-	[3.6]	[3.6]	-	-	[20.61]	[20]	[0.61]	-
DK5	-	-	-	-	-	-	-	-	-	-	-	-	[0.11]	-	[0.11]	-
Total	[2 275]	[2 275]	-	-	[568.6]	[568.6]	-	-	[10.2]	[10.2]	-	-	[46.40]	[43.72]	[2.68]	-

Cont'd.

12) Figures estimated on basis of Norwegian data on average metal discharge per capita (Table 7).

13) Figures estimated on basis of Swedish data on average metal discharges per capita (Table 7).

14) Figures estimated on basis of mean metal inputs via EW and NL rivers (Table 7).

15) Figures estimated on basis of Danish data on average metal discharges per capita (Table 7).

Table 5 (Continued).

Country and Area	Iron (tonnes/yr)				Manganese (tonnes/yr)				Cadmium (tonnes/yr)				Copper (tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
GERMANY, FED.REP. OF																
G1	[969]	[889] 14)	80		[222.2]	[222.2] 14)	-	-	[4.0]	[4.0] 14)	-	-	[22]	[22] 14)	-	-
G2	-	-	-		-	-	-	-	-	-	-	-	[0.78]	-	[0.78] 16*)	-
G3	[11 070]	[11 070]	-		[2 767.4]	[2 767.4]	-	-	[49.3]	[49.3]	-	-	[278.81]	[274]	[4.81]	-
G4	[4 316]	[3 676]	640		[919.1]	[919.1]	-	-	[16.4]	[16.4]	-	-	[92.56]	[91]	[1.56]	-
G5	-	-	-		-	-	-	-	-	-	-	-	[0.37]	-	[0.37]	-
Total	[16 355]	[15 635]	720		[3 908.7]	[3 908.7]	-	-	[69.7]	[69.7]	-	-	[394.52]	[387]	[7.52]	-
NETHERLANDS																
NL1	[1 789]	[1 789] 17)	-		[472]	[472] 17)	-	-	11	11	-	-	104	104	-	
NL2	[640]	[640]	-		[169]	[169]	-	-	[2]	[2] 17)	-	-	[16]	[16] 17)	-	
NL3	40 586	40 586	-		8 710	8 710	-	-	88	88	-	-	970	970	-	
NL4	8 191	1 584	6 607		[2 770]	[2 770]	-	-	4	4	-	-	31	28	3	
NL5	2 883	2 883	-		440	440	-	-	3	3	-	-	37	37	-	
NL6	48	48			4	4	-	-	[1]	[1]	-	-	5	5	-	
Total	[54 137]	[47 530]	6 607		[12 565]	[12 565]	-	-	[109]	[109]	-	-	1 163	1 160	3	
BELGIUM	-	-	-		-	-	-	-	-	-	-	-	[0.65]	-	[0.65] 16*)	
ENGLAND/WALES																
E1	720	694	26	-	75.6	73.0	2.6	-	[9.7]	[9.0] 18)	0.7	-	[41.6]	[35.4] 18)	6.2	-
E2	898	657	146	95	85.8	73.0	12.8	-	[3.6]	[2.8]	0.4	0.4	[57.3]	[10.9]	33.6	12.8
E2a	2	0	2	-	1.5	0	1.5	-	neg.	0	neg.	-	0.4	0	0.4	-
E3	289	274	15	-	[32.3]	[30.5]	1.8	-	[0.8]	[0.8]	neg.	-	[6.9]	[3.3]	3.6	-
E4	[32]	[7] 18)	25	-	[3.9]	[1.7]	2.2	-	0.1	neg.	0.1	-	5.8	neg.	5.8	-
E5	5 909	402	32	5 475	[53.3]	[50.4]	2.9	-	[1.5]	[1.4]	0.1	-	[12.7]	[5.4]	7.3	-
E6	716	694	22	-	[52.0]	50.2	1.8	-	[1.5]	[1.4]	0.1	-	[10.5]	[5.4]	5.1	-
E7	3	0	3	-	0.2	0	0.2	-	neg.	0	neg.	-	0.7	0	0.7	-
E7a	124 265	124 100	165	-	[557.5]	[540.0]	17.5	-	[15.5]	[14.8]	0.7	-	[98.4]	[57.9]	40.5	-
E8	[26]	[25]	1	-	[6.3]	[5.9]	0.4	-	[1.3]	[0.2]	1.1	-	[1.0]	[0.6]	0.4	-
E9	566	548	18	-	[226.1]	[215.5]	10.6	-	[7.0]	[5.9]	1.1	-	[28.6]	[23.1]	5.5	-
E10	[306]	[263]	43	-	[69.2]	[62.3]	6.9	-	[3.9]	[1.7]	2.2	-	[18.4]	[6.7]	11.7	-
E11	[116]	[89]	27	-	[27.7]	[21.1]	6.6	-	[3.2]	[0.6]	2.6	-	[16.9]	[2.3]	14.6	-
E12	[2 252]	[1 937]	315	-	[544.6]	[458.8]	85.8	-	35.9	29.3	6.6	-	128.3	81.6	28.5	18.2
E13	[183]	[139]	44	-	[37.3]	[32.9]	4.4	-	4.4	2.9	1.5	-	26.7	16.1	10.6	-
E14	[318]	[247]	71	-	[65.3]	[58.4]	6.9	-	[4.2]	[1.6]	2.6	-	[23.5]	[6.3]	17.2	-
E15	[366]	[293]	73	-	[78.9]	[69.4]	9.5	-	[4.8]	[1.9]	2.9	-	[26.0]	[7.4]	18.6	-
E16	[951]	[932]	19	-	[223.8]	[220.9]	2.9	-	[6.7]	[6.0]	0.7	-	[28.8]	[23.7]	5.1	-
E17	[879]	[842]	37	-	[203.4]	[199.4]	4.0	-	[6.9]	[5.4]	1.5	-	[30.5]	[21.4]	9.1	-
E18	[826]	[779]	47	-	[146.9]	[141.8]	5.1	-	[6.8]	[5.0]	1.8	-	[31.1]	[19.8]	11.3	-
E19	[160]	[146]	14	-	[36.2]	[34.7]	1.5	-	[1.3]	[0.9]	0.4	-	[7.0]	[3.7]	3.3	-
E20	[674]	[663]	11	-	[158.1]	[157.0]	1.1	-	[4.7]	[4.3]	0.4	-	[19.5]	[16.9]	2.6	-

England/Wales (Cont'd.)

14) Figures estimated on basis of mean metal inputs via EW and NL rivers (Table 7).

16) Figures estimated on basis of mean metal discharges per capita (Table 7).

17) Figures estimated on basis of mean metal inputs via Dutch rivers (Table 7).

18) Figures estimated on basis of mean metal inputs via English/Welsh rivers (Table 7). *) Population figures taken from Coop.Res.Rep. No.39 (1974) used in estimate.

Table 5 (Continued) (England and Wales).

Country and Area	Iron (tonnes/yr)				Manganese (tonnes/yr)				Cadmium (tonnes/yr)				Copper (tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
ENGLAND/WALES																
E21	[446]	428	18	-	[103.2]	[101.4]	1.8	-	[3.2]	[2.8]	0.4	-	[15.3]	[10.9]	4.4	-
E22	[2 864]	[2 802]	62	-	[671.3]	[664.0]	7.3	-	1.5	1.1	0.4	-	20.1	1.5	18.6	-
E23	1 278	-	-	-	-	-	-	-	1.8	-	-	-	-	-	-	-
E24	4 964	2 738	2 226	-	-	-	-	-	-	-	-	-	87.6	36.5	51.1	-
E25	674	657	14	3	[297.1]	[295.6]	1.5	-	1.5	1.1	0.4	-	31.0	27.7	3.3	-
E26	287	274	13	-	74.5	73.0	1.5	-	1.4	0.7	0.7	-	14.3	11.0	3.3	-
E27	714	657	57	-	64.7	54.8	9.9	-	[5.6]	[4.9]	0.3	0.4	74.1	7.3	15.7	51.1
E28	[685]	[520]	165	-	[138.4]	[123.1]	15.3	-	[22.4]	[3.4]	0.7	18.3	[97.5]	[13.2]	39.4	44.9
E29	2 164	1 971	193	-	635.1	620.5	14.6	-	2.0	1.6	0.4	-	85.8	30.3	31.4	24.1
E30	1 251	1 241	10	-	[328.7]	[328.0]	0.7	-	[16.7]	[9.0]	neg.	7.7	69.4	36.5	2.2	30.7
Total	[155 784]	[145 019]	3 914	5 573	[4 998.9]	[4 757.3]	241.6	-	[179.9]	[120.5]	30.8	26.7	[1 115.7]	[522.8]	411.1	181.8
SCOTLAND																
SC1	[2 239]	[2 234]19)	[5]20)	-	[559.1]	[558.5]19)	[0.6]20)	-	[10.1]	[10.0]19)	[0.1]20)	-	[56.7]	[55.3]19)	[1.4]20)	-
SC2	[6 451]	[6 266]	[185]	-	[1 591.1]	[1 566.5]	[24.6]	-	[7.3]	3.6	[3.7]	-	[129.7]	73.0	[56.7]	-
SC3	[1 737]	[1 737]	-	-	[434.3]	[434.3]	-	-	[7.7]	[7.7]	-	-	[43.0]	[43.0]	-	-
SC4	[1 545]	[1 523]	[22]	-	[383.7]	[380.8]	[2.9]	-	[7.2]	[6.8]	[0.4]	-	[44.5]	[37.7]	[6.8]	-
SC5	[1 364]	[1 293]	[71]	-	[332.6]	[323.2]	[9.4]	-	[7.2]	[5.8]	[1.4]	-	[53.7]	[32.0]	[21.7]	-
Total	[13 336]	[13 053]	[283]	-	[3 300.8]	[3 263.3]	[37.5]	-	[39.5]	[33.9]	[5.6]	-	[327.6]	[241.0]	[86.6]	-
NORTHERN IRELAND	[1 275]	[1 263]19)	[12]20)	-	[317.3]	[315.7]19)	[1.6]20)	-	[5.8]	[5.6]19)	[0.2]20)	-	[35.0]	[31.3]19)	[3.7]20)	-
IRELAND																
IR1	[4 101]	[3 981]19)	[120]20)	-	[1 011.4]	[995.4]19)	[16.0]20)	-	[20.1]	[17.7]19)	[2.4]20)	-	[135.5]	[98.6]19)	[36.9]20)	-
IR2	[3 043]	[3 010]	[33]	-	[756.8]	[752.4]	[4.4]	-	[14.0]	[13.4]	[0.6]	-	[84.6]	[74.5]	[10.1]	-
IR3	[6 295]	[6 238]	[57]	-	[1 567.0]	[1 559.4]	[7.6]	-	[28.9]	[27.8]	[1.1]	-	[171.9]	[154.4]	[17.5]	-
IR4	[2 962]	[2 949]	[13]	-	[739.0]	[737.3]	[1.7]	-	[13.4]	[13.1]	[0.3]	-	[77.0]	[73.0]	[4.0]	-
Total	[16 401]	[16 178]	[223]	-	[4 074.2]	[4 044.5]	[29.7]	-	[77.4]	[72.0]	[4.4]	1.0	[689.0]	[400.5]	[68.5]	220
ICELAND																
IC1	-				-				-				[0.34]	-	[0.34]20)	-
IC2	-				-				-				[0.12]	-	[0.12]	-
Total	-				-				-				[0.46]	-	[0.46]	-

19) Figures estimated on basis of mean metal concentrations in EW and NL rivers (Table 7).

20) Figures estimated on basis of English/Welsh data on average metal discharges *per capita* (Table 7).

Cont'd.

Summary Table 5.

Country	Iron (tonnes/yr) Total	Iron Rivers	Iron Domestic	Iron Industrial	Manganese (tonnes/yr) Total	Manganese Rivers	Manganese Domestic	Manganese Industrial
NORWAY	11 004	-	526	10 478	-	-	-	-
SWEDEN	5 635	5 635	-	-	784	784	-	-
DENMARK	[2 275]	[2 275]	-	-	[568.6]	[568.6]	-	-
GERMANY, FED.REP. OF	[16 355]	[15 635]	720		[3 908.7]	[3 908.7]	-	-
NETHERLANDS	[54 137]	[47 530]	6 607		[12 565]	[12 565]	-	-
BELGIUM	-	-	-	-	-	-	-	-
ENGLAND/WALES	[155 784]	[145 019]	3 914	5 573	[4 998.9]	[4 757.3]	241.6	-
SCOTLAND	[13 336]	[13 053]	[283]	-	[3 300.8]	[3 263.3]	[37.5]	-
N. IRELAND	[1 275]	[1 263]	[12]	-	[317.3]	[315.7]	[1.6]	-
IRELAND	[16 401]	[16 178]	[223]	-	[4 074.2]	[4 044.5]	[29.7]	-
ICELAND	-	-	-	-	-	-	-	-
TOTAL	[276 202]	[246 588]	4 958 7 327 28 336	16 051	[30 517.5]	[30 207.1]	310.4	-

Country	Cadmium (tonnes/yr) Total	Cadmium Rivers	Cadmium Domestic	Cadmium Industrial	Copper (tonnes/yr) Total	Copper Rivers	Copper Domestic	Copper Industrial
NORWAY	11.5	-	1.5	10	502.8	-	13.9	488.9
SWEDEN	0.1	-	0.1	-	[3.17]	-	[3.06]	0.11
DENMARK	[10.2]	[10.2]	-	-	[46.40]	[43.72]	[2.68]	-
GERMANY, FED.REP. OF	[69.7]	[69.7]	-	-	[394.52]	[387]	[7.52]	-
NETHERLANDS	[109]	[109]	-	-	1 163	1 160	3	
BELGIUM	-	-	-	-	[0.65]	-	[0.65]	-
ENGLAND/WALES	[179.9]	[120.5]	30.8	26.7	[1 115.7]	[522.8]	411.1	181.8
SCOTLAND	[39.5]	[33.9]	[5.6]	-	[327.6]	[241.0]	[86.6]	-
N. IRELAND	[5.8]	[5.6]	[0.2]	-	[35.0]	[31.3]	[3.7]	-
IRELAND	[77.4]	[72.0]	[4.4]	1.0	[689.0]	[400.5]	[68.5]	220
ICELAND	-	-	-	-	[0.46]	-	[0.46]	-
TOTAL	[503.1]	[420.9]	[42.6] 80.3	37.7	[4 278.3]	[2 786.32]	[598.17] 3 1 491.98	890.81

Table 6. Estimates of inputs of chromium, nickel, lead, zinc, and mercury.

Country and Area	Chromium (tonnes/yr)				Nickel (tonnes/yr)				Lead (tonnes/yr)				Zinc (tonnes/yr)				Mercury (tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
NORWAY																				
N1	26.3	-	2	24.3	-				0.6	-	0.3	0.3	120.6	-	2.3	118.3	1	-	-	1
N2	21	-	13	8	-				8	-	5	3	44	-	26	18	-	-	-	-
N3	[0.9]	-	[0.5] 12)	0.4	-				[0.2]	-	[0.2] 12)	-	1.2	-	0.5	0.7	-	-	-	-
N4	3	-	1	2	-				3.1	-	1.4	1.7	6	-	2.8	3.2	-	-	-	-
N5	0.9	-	0.5	0.4	-				[1.1]	-	[0.3]	0.8	4.4	-	0.8	3.6	0.4	-	-	0.4
N6	0.39	-	0.29	0.1	-				0.01	-	0.01	-	1.5	-	0.6	0.9	-	-	-	-
N7	18.3	-	0.3	18	146	-	-	146	18.03	-	0.03	18	6.4	-	0.4	6	-	-	-	-
N8	7	-	2	5	-				0.1	-	0.1	-	41	-	3.4	37.6	-	-	-	-
N9	4	-	4	-	-				596.1	-	0.1	596	1 064	-	11	1 053	0.2	-	-	0.2
N10	[0.3]	-	[0.3]	-	-				[0.1]	-	[0.1]	-	[1]	-	[0.5] 12)	0.5	-	-	-	-
N11	[0.9]	-	[0.9]	-	-				[0.4]	-	[0.4]	-	0.7	-	0.6	0.1	-	-	-	-
N12	0.3	-	0.3	-	-				[1.2]	-	[0.5]	0.7	1 100.6	-	0.6	1 100	-	-	-	-
N13	0.4	-	0.1	0.3	0.4	-	0.4	-	[0.2]	-	[0.2]	-	37.2	-	0.2	37	-	-	-	-
N14	[2.1]	-	[1.1]	1	-				[1.1]	-	[0.5]	0.6	[89.7]	-	[1.7]	88	-	-	-	-
N15	[0.5]	-	[0.5]	-	-				[0.2]	-	[0.2]	-	[0.9]	-	[0.9]	-	-	-	-	-
N16	[0.4]	-	[0.4]	-	-				[0.2]	-	[0.2]	-	[0.9]	-	[0.7]	0.2	-	-	-	-
Total	86.69	-	27.19	59.50	146.4	-	0.4	146	[630.64]	-	[9.54]	621.1	2 520.1	-	53.0	2 467.1	1.6	-	-	1.6
SWEDEN																				
S1	[0.065]	-	[0.065] 13)	-	[0.221]	-	[0.213] 13)	0.008	[0.087]	-	[0.087] 13)	-	[15.01]	14	[0.95] 13)	0.06	[0.002]	-	[0.002] 13)	-
S2	[0.166]	-	[0.10]	0.066	[0.451]	-	[0.336]	0.115	[0.138]	-	[0.138]	-	[26.7]	25	[1.5]	0.2	[0.007]	-	[0.003]	0.004
S3	0.9	-	0.9	-	2.9	-	2.9	-	1.2	-	1.2	-	473	460	13	-	0.02	-	0.02	-
S4	[0.165]	-	[0.13]	0.035	[0.52]	-	[0.42]	0.1	[0.18]	-	[0.173]	0.007	[2.02]	-	[1.88]	0.14	[0.004]	-	[0.004]	-
S5	[neg]	-	[neg]	-	[0.022]	-	[0.022]	-	[0.009]	-	[0.009]	-	[0.1]	-	[0.1]	-	-	-	[neg]	-
S6	[0.17]	-	[0.17]	-	[0.571]	-	[0.571]	-	[0.235]	-	[0.235]	-	[2.55]	-	[2.55]	-	[0.005]	-	[0.005]	-
Total	[1.466]	-	[1.365]	0.10	[4.685]	-	[4.462]	0.223	[1.849]	-	[1.842]	0.007	[519.38]	499	[19.98]	0.40	[0.038]	-	[0.034]	0.004
DENMARK																				
DK1	[0.03]	-	[0.03] 15)	-	[0.06]	-	[0.06] 15)	-	[0.12]	-	[0.12] 15)	-	[0.31]	-	[0.31] 15)	-				
DK2	2.2	0.97	0.55	0.68	[13.62]	[12.58] 14)	[1.04]	-	6.8	1.7	1.9	3.2	42.6	17.0	5.1	20.5				
DK3	[23.43]	[21.78] 14)	[1.65]	-	[22.51]	[19.36]	[3.15]	-	[39.19]	[33.44] 14)	[5.75]	-	[161.8]	[146.3] 14)	[15.50]	-				
DK4	[20.5]	[19.80]	[0.70]	-	[18.94]	[17.60]	[1.34]	-	[32.84]	[30.4]	[2.44]	-	[139.57]	[133.0]	[6.57]	-				
DK5	[0.13]	-	[0.13]	-	[0.24]	-	[0.24]	-	[0.45]	-	[0.45]	-	[1.21]	-	[1.21]	-				
Total	[46.29]	[42.55]	[3.06]	0.68	[55.37]	[49.54]	[5.83]	-	[79.40]	[65.54]	[10.66]	3.2	[345.49]	[296.3]	[28.69]	20.5				

Cont'd.

12) Figures estimated on basis of Norwegian data on average metal discharge per capita (Table 7).

13) Figures estimated on basis of Swedish data on average metal discharges per capita (Table 7).

14) Figures estimated on basis of mean metal inputs via EW and NL rivers (Table 7).

15) Figures estimated on basis of Danish data on average metal discharges per capita (Table 7).

Table 6 (Continued).

Country and Area	Chromium (tonnes/yr) Total	Chromium Rivers	Chromium Domestic	Chromium Industrial	Nickel (tonnes/yr) Total	Nickel Rivers	Nickel Domestic	Nickel Industrial
GERMANY, FED.REP. OF								
G1	[21.78]	[21.78] 14)	- 16*)	-	[19.36]	[19.36] 14)	- 16*)	-
G2	[1.20]	-	[1.20]	-	[1.8]	-	[1.8]	-
G3	[278.7]	[271.3]	[7.4]	-	[252.22]	[241.12]	[11.1]	-
G4	[92.5]	[90.1]	[2.4]	-	[83.68]	[80.08]	[3.6]	-
G5	[0.57]	-	[0.57]	-	[0.8]	-	[0.8]	-
Total	[394.75]	[383.18]	[11.57]	-	[357.86]	[340.56]	[17.30]	-
NETHERLANDS								
NL1	2	2	-		115	115	-	-
NL2	[15]	[15] 17)	-		[12]	[12] 17)	-	-
NL3	916	916	-		672	672	-	-
NL4	55	19	36		35	35	-	-
NL5	[158]	[158]	-		40	40	-	-
NL6	[10]	[10]	-		2	2	-	-
Total	1 156	1 120	36		889	876	[13] 16*)	-
BELGIUM	[1.0]	-	[1.0] 16*)	-	[1.5]	-	[1.5] 16*)	-
ENGLAND/WALES								
E1	[6.03]	[3.47] 18)	2.56	-	[35.77]	[35.04] 18)	0.73	-
E2	[21.50]	[1.06]	1.10	19.34	[25.36]	[10.76]	3.28	11.32
E2a	0.01	0	0.01	-	0.04	0	0.04	-
E3	[3.45]	[3.31]	0.14	-	[3.60]	[3.24]	0.36	-
E4	[0.40]	[0.18]	0.22	-	[0.91]	[0.18]	0.73	-
E5	[5.72]	[5.46]	0.26	-	[6.08]	[5.35]	0.73	-
E6	[5.62]	[5.44]	0.18	-	3.64	3.28	0.36	-
E7	0.02	0	0.02	-	0.04	0	0.04	-
E7a	[59.96]	[58.50]	1.46	-	[61.75]	[57.37]	4.38	-
E8	[3.20]	[0.64]	2.56	-	[1.36]	[0.63]	0.73	-
E9	[26.28]	[23.36]	2.92	-	[23.64]	[22.91]	0.73	-
E10	[7.48]	[6.75]	0.73	-	[7.62]	[6.12]	1.50	-
E11	[3.02]	[2.29]	0.73	-	[4.06]	[2.24]	1.82	-
E12	89.06	49.64	39.42	-	197.47	106.22	91.25	-
E13	5.84	5.48	0.36	-	12.41	11.31	1.10	-
E14	[7.06]	[6.33]	0.73	-	[8.03]	[6.21]	1.82	-
E15	[8.25]	[7.52]	0.73	-	[9.56]	[7.37]	2.19	-
E16	[26.14]	[23.95]	2.19	-	[24.21]	[23.48]	0.73	-
E17	[21.98]	[21.62]	0.36	-	[22.30]	[21.20]	1.10	-
E18	[20.37]	[20.01]	0.36	-	[20.72]	[19.62]	1.10	-
E19	4.86	[3.76]	1.10	-	[6.98]	[3.69]	3.29	-
E20	[17.75]	[17.02]	0.73	-	[18.89]	[16.70]	2.19	-

Country and Area	Lead (tonnes/yr) Total	Lead Rivers	Lead Domestic	Lead Industrial	Zinc (tonnes/yr) Total	Zinc Rivers	Zinc Domestic	Zinc Industrial	Mercury (tonnes/yr) Total	Mercury Rivers	Mercury Domestic	Mercury Industrial
GERMANY, FED.REP. OF												
G1	[33.44]	[33.44] 14)	- 16*)	-	[146.3]	[146.3] 14)	- 16*)	-	0.008	-	0.008	
G2	[1.05]	-	[1.05]	-	[8.4]	-	[8.4]	-	-	-	-	
G3	[422.96]	[416.48]	[6.48]	-	[1 873.9]	[1 822.1]	[51.8]	-	-	-	-	
G4	[140.42]	[138.32]	[2.1]	-	[622.0]	[605.2]	[16.8]	-	-	-	-	
G5	[0.5]	-	[0.5]	-	[4.0]	-	[4.0]	-	-	-	-	
Total	[598.37]	[588.24]	[10.13]	-	[2 654.6]	[2 573.6]	[81.0]	-	0.008	-	0.008	
NETHERLANDS												
NL1	124	124	-		537	537	-		2	2	-	-
NL2	[23]	[23] 17)	-		[120]	[120] 17)	-		-	-	-	-
NL3	1 119	1 119	-		7 825	7 825	-		30	30	-	-
NL4	347	-	347		1 512	125	1 387		-	-	-	-
NL5	55	55	-		273	273	-		1	1	-	-
NL6	3	3	-		8	8	-		0.1	0.1	-	-
Total	1 671	1 324	347		10 275	8 888	1 387		33.1	33.1	-	-
BELGIUM	[0.9]	-	[0.9] 16*)	-	[7]	-	[7] 16*)	-	-	-	-	-
ENGLAND/WALES												
E1	[56.6]	[55.5] 18)	1.1	-	[204.6]	[197.7] 18)	6.9	-	0.04	-	0.04	-
E2	[109.7]	[17.0]	6.2	86.5	[135.1]	[60.7]	36.1	38.3	0.22	-	0.22	-
E2a	0.1	0	0.1	-	0.4	0	0.4	-	neg.	-	neg.	-
E3	[5.8]	[5.1]	0.7	-	[22.7]	[18.3]	4.4	-	0.04	-	0.04	-
E4	[1.4]	[0.3]	1.1	-	[7.2]	[1.0]	6.2	-	0.04	-	0.04	-
E5	[10.0]	[8.5]	1.5	-	[38.2]	[30.2]	8.0	-	0.04	-	0.04	-
E6	8.4	7.3	1.1	-	16.8	11.3	5.5	-	0.07	-	0.07	-
E7	0.1	0	0.1	-	0.7	0	0.7	-	0.02	-	0.02	-
E7a	[99.3]	[90.9]	8.4	-	[3 728.5]	[323.8]	46.7	3 358.0	0.29	-	0.29	-
E8	[2.5]	[1.0]	1.5	-	[4.2]	[3.5]	0.7	-	0.36	-	0.36	-
E9	[37.8]	[36.3]	1.5	-	[136.6]	[129.3]	7.3	-	0.04	-	0.04	-
E10	[13.4]	[10.5]	2.9	-	[52.3]	[37.3]	15.0	-	0.07	-	0.07	-
E11	[7.2]	[3.6]	3.6	-	[29.4]	[12.6]	16.8	-	0.04	-	0.04	-
E12	70.8	38.7	32.1	-	637.3	389.8	247.5	-	1.82	-	1.82	-
E13	12.1	9.9	2.2	-	108.1	96.4	11.7	-	0.73	-	0.73	-
E14	[13.1]	[9.8]	3.3	-	[54.0]	[35.0]	19.0	-	0.11	-	0.11	-
E15	[15.7]	[11.7]	4.0	-	[63.5]	[41.6]	21.9	-	0.15	-	0.15	-
E16	[38.3]	[37.2]	1.1	-	[139.1]	[132.5]	6.6	-	0.04	-	0.04	-
E17	[35.4]	[33.6]	1.8	-	[130.2]	[119.6]	10.6	-	0.73	-	0.73	-
E18	[33.3]	[31.1]	2.2	-	[123.6]	[110.8]	12.8	-	0.73	-	0.73	-
E19	[6.5]	[5.8]	0.7	-	[24.4]	[20.8]	3.6	-	2.19	-	2.19	-
E20	[26.8]	[26.4]	0.4	-	[97.1]	[94.2]	2.9	-	1.46	-	1.46	-

England/Wales (Cont'd.)

14) Figures estimated on basis of mean metal inputs via EW and NL rivers (Table 7). 16) Figures estimated on basis of mean metal discharges *per capita* (Table 7).

17) Figures estimated on basis of average concentrations of metals in Dutch rivers (Table 7). 18) Figures estimated on basis of average metal concentrations in English/Welsh rivers (Table 7).

*) Population figures taken from Coop.Res.Rep. No.39 (1974) used in estimate.

Table 6 (Continued) (England/Wales)

Country and Area	Chromium (tonnes/yr)				Nickel (tonnes/yr)				Lead (tonnes/yr)				Zinc (tonnes/yr)				Mercury (tonnes/yr)			
	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial	Total	Rivers	Domestic	Industrial
ENGLAND/WALES																				
E21	[12.81]	[10.99]	1.82	-	[11.14]	[10.78]	0.36	-	[17.8]	[17.1]	0.7	-	[65.5]	[60.8]	4.7	-	0.36	-	0.36	-
E22	1.83	1.10	0.73	-	4.01	1.82	2.19	-	10.2	5.5	4.7	-	27.0	2.9	24.1	-	1.82	-	1.82	-
E23	18.25	-	-	-	3.65	-	-	-	32.8	-	-	-	82.8	-	-	-	-	-	-	-
E24	53.65	12.41	41.24	-	-	-	-	-	173.7	94.9	78.8	-	368.7	109.5	259.2	-	-	-	-	-
E25	27.74	26.28	1.46	-	1.09	0.73	0.36	-	23.0	22.3	0.7	-	16.4	12.4	4.0	-	0.36	-	0.36	-
E26	[38.44]	[36.98]	1.46	-	[36.62]	[36.26]	0.36	-	156.2	155.5	0.7	-	226.3	222.3	4.0	-	0.36	-	0.36	-
E27	[22.57]	[19.28]	0.73	2.56	[21.10]	[18.91]	2.19	-	22.9	0.7	4.0	18.2	4 022.0	242.4	20.1	3 759.5	0.11	-	0.11	-
E28	[14.96]	[13.35]	1.46	0.15	[17.47]	[13.09]	4.02	0.36	[55.8]	[20.7]	7.7	27.4	[698.5]	[73.9]	44.2	580.4	4.30	2.19	0.29	1.82
E29	20.81	17.16	1.46	2.19	43.44	38.33	3.65	1.46	46.7	38.3	6.9	1.5	153.3	114.6	37.6	1.1	0.26	-	0.26	-
E30	127.82	47.45	0.07	80.30	18.10	4.38	0.22	13.50	31.7	18.2	0.4	13.1	168.7	69.4	2.6	97.6	2.97	0.04	0.01	2.92
Total	[682.88]	[450.79]	109.30	104.54	[651.06]	[487.22]	133.55	26.64	[1 175.1]	[813.4]	182.2	146.7	[11 583.2]	[2 774.6]	891.8	7 834.0	19.77	2.23	12.80	4.74
SCOTLAND																				
SC1	[54.9]	[54.7]19)	[0.2]20)	-	[49.03]	[48.66]19)	[0.37]20)	-	[84.34]	[84.06]19)	[0.28]20)	-	[369.48]	[367.74]19)	[1.74]20)	-	[0.04]	-	[0.04]20)	-
SC2	[95.2]	87.6	[7.6]	-	[151.28]	[136.49]	[14.79]	-	[139.34]	128.0	[11.34]	-	[324.52]	255.5	[69.02]	-	[2.58]	1.1	[1.48]	-
SC3	[42.6]	[42.6]	-	-	[37.84]	[37.84]	-	-	[65.36]	[65.36]	-	-	[285.95]	[285.95]	-	-	-	-	-	-
SC4	[38.2]	[37.3]	[0.9]	-	[34.94]	[33.18]	[1.76]	-	[58.65]	[57.30]	[1.35]	-	[258.93]	[250.7]	[8.23]	-	[0.18]	-	[0.18]	-
SC5	[34.6]	[31.7]	[2.9]	-	[33.81]	[28.16]	[5.65]	-	[52.97]	[48.64]	[4.33]	-	[239.18]	[212.8]	[26.38]	-	[0.56]	-	[0.56]	-
Total	[265.5]	[253.9]	[11.6]	-	[306.90]	[284.33]	[22.57]	-	[400.66]	[383.36]	[17.30]	-	[1 478.06]	[1 372.69]	[105.31]	-	[3.36]	1.1	[2.26]	-
NORTHERN IRELAND	[31.4]	[30.9]19)	[0.5]20)	-	[28.47]	[27.51]19)	[0.96]20)	-	[48.26]	[47.52]19)	[0.74]20)	-	[213.06]	[207.88]19)	[4.48]20)	0.7	[0.10]	-	[0.10]20)	-
IRELAND																				
IR1	[102.6]	[97.6]19)	[5.0]20)	-	[96.35]	[86.72]19)	[9.63]20)	-	[157.18]	[149.80]19)	[7.38]20)	-	[700.30]	[655.36]19)	[44.94]20)	-	[0.96]	-	[0.96]20)	-
IR2	[75.2]	[73.8]	[1.4]	-	[68.19]	[65.56]	[2.63]	-	[115.26]	[113.24]	[2.02]	-	[507.71]	[495.42]	[12.29]	-	[0.26]	-	[0.26]	-
IR3	[155.2]	[152.8]	[2.4]	-	[140.43]	[135.87]	[4.56]	-	[238.19]	[234.69]	[3.50]	-	[1 048.04]	[1 026.76]	[21.28]	-	[0.46]	-	[0.46]	-
IR4	[72.8]	[72.3]	[0.5]	-	[65.28]	[64.24]	[1.04]	-	[111.76]	[110.96]	[0.80]	-	[490.32]	[485.45]	[4.87]	-	[0.10]	-	[0.10]	-
Total	[410.8]	[396.5]	[9.3]	5.0	[370.25]	[352.39]	[17.86]	-	[636.39]	[608.69]	[13.70]	14.0	[3 476.31]	[2 662.99]	[83.38]	730.0	[1.78]	-	[1.78]	<1.0
ICELAND																				
IC1	[0.52]	-	[0.52]20)	-	[0.78]	-	[0.78]20)	-	[0.46]	-	[0.46]20)	-	[3.64]	-	[3.64]20)	-	-	-	-	-
IC2	[0.18]	-	[0.18]	-	[0.27]	-	[0.27]	-	[0.16]	-	[0.16]	-	[1.26]	-	[1.26]	-	-	-	-	-
Total	[0.70]	-	[0.70]	-	[1.05]	-	[1.05]	-	[0.62]	-	[0.62]	-	[4.90]	-	[4.90]	-	-	-	-	-

Cont'd.

19) Figures estimated on basis of mean metal concentrations in EW and NL rivers (Table 7).

20) Figures estimated on basis of English/Welsh data on average metal discharges per capita (Table 7).

Summary Table 6.

Country	Chromium (tonnes/yr) Total	Rivers	Domestic	Industrial	Nickel (tonnes/yr) Total	Rivers	Domestic	Industrial
NORWAY	86.7	-	27.2	59.5	146.4	-	0.4	146
SWEDEN	[1.5]	-	[1.4]	0.1	[4.1]	-	[4.5]	0.2
DENMARK	[46.3]	[42.5]	[3.1]	0.7	[55.4]	[49.5]	[5.8]	-
GERMANY, FED.REP. OF	[394.8]	[383.2]	[11.6]	-	[357.9]	[340.6]	[17.3]	-
NETHERLANDS	1 156	1 120	36		889	876	[13]	-
BELGIUM	[1]	-	[1]	-	[1.5]	-	[1.5]	-
ENGLAND/WALES	[682.9]	[450.8]	109.3	104.5	[651.1]	[487.2]	133.6	26.6
SCOTLAND	[265.5]	[253.9]	[11.6]	-	[306.9]	[284.3]	[22.6]	-
N. IRELAND	[31.4]	[30.9]	[0.5]	-	[28.5]	[27.5]	[1.0]	-
IRELAND	[410.8]	[396.5]	[9.3]	5	[370.3]	[352.4]	[17.9]	-
ICELAND	[0.1]	-	[0.1]	-	[1.1]	-	[1.1]	-
TOTAL	[3 077.6]	[2 677.8]	[175.1] 36 381.5	169.8	[2 812.8]	[2 417.5]	[218.1] 391.5	172.8

Country	Lead (tonnes/yr) Total	Rivers	Domestic	Industrial	Zinc (tonnes/yr) Total	Rivers	Domestic	Industrial
NORWAY	[630.6]	-	[9.5]	621.1	2 520.1	-	53	2 467.1
SWEDEN	[1.8]	-	[1.8]	neg.	[519.4]	499	[20]	0.4
DENMARK	[79.4]	[65.5]	[10.1]	3.2	[345.5]	[296.3]	[28.1]	20.5
GERMANY, FED.REP. OF	[598.4]	[588.2]	[10.1]	-	[2 654.6]	[2 573.6]	[81]	-
NETHERLANDS	1 671	1 324	347		10 275	8 888	1 387	
BELGIUM	[0.9]	-	[0.9]	-	[7]	-	[7]	-
ENGLAND/WALES	[1 175.1]	[813.4]	182.2	146.7	[11 583.2]	[2 774.6]	891.8	7 834
SCOTLAND	[400.1]	[383.4]	[17.3]	-	[1 478.1]	[1 372.1]	[105.4]	-
N. IRELAND	[48.3]	[47.5]	[0.1]	-	[213.1]	[207.9]	[4.5]	0.7
IRELAND	[636.4]	[608.1]	[13.1]	14	[3 476.4]	[2 663.0]	[83.4]	730
ICELAND	[0.6]	-	[0.6]	-	[4.9]	-	[4.9]	-
TOTAL	[5 243.2]	[3 830.1]	[247.5] 347 1 726.5	785	[33 077.3]	[19 275.1]	[1 279.1] 1 387 13 719.4	11 052.7

Country	Mercury (tonnes/yr) Total	Rivers	Domestic	Industrial
NORWAY	1.6	-	-	1.6
SWEDEN	[0.038]	-	[0.034]	0.004
DENMARK	-	-	-	-
GERMANY, FED.REP. OF	0.006	-	0.008	
NETHERLANDS	33.1	33.1	-	-
BELGIUM	-	-	-	-
ENGLAND/WALES	19.77	2.23	12.80	4.74
SCOTLAND	[3.36]	1.1	[2.26]	-
N. IRELAND	[0.1]	-	[0.1]	-
IRELAND	[1.78]	-	[1.78]	-
ICELAND	-	-	-	-
TOTAL	59.76	36.43	16.97 0.008 23.33	6.34

Table 7. Averages of metal data.

Average input of metals in domestic sewage (in grams/person/year)

Metal	Country				Mean
	England/Wales	Norway	Sweden	Denmark	
Iron	75	-	-	-	-
Manganese	10	-	-	-	-
Cadmium	1.5	-	0.1	-	-
Copper	23	1.2	3.8	2.9	2.6 (Ex:E/W)
Nickel	6	-	5.6	6.3	6.0
Lead	4.6	3.5	2.3	11.5	3.5 (Ex:DK)
Zinc	28.0	13.2	25	31	28 (Ex:N)
Mercury	0.6	-	0.05	-	-
Chromium	3.1	8.1	1.7	3.3	4.0

Average input of metals from river waters (in mg/m^3)

Metal	Country		Mean
	Netherlands	England/Wales	
Iron	406	401	404
Manganese	107	95	101
Cadmium	1	2.6	1.8
Copper	9.9	10.2	10.0
Chromium	9.5	10.3	9.9
Nickel	7.5	10.1	8.8
Lead	14.5	16	15.2
Zinc	76	57	66.5
Vanadium	19	-	-

Table 8. Major industries in each country and area.

Country and Area	Major Industries
NORWAY	
N1	Pulp and paper; chemical industries; edible fats; metal plating.
N2	-
N3	Pulp and paper; mineral industries.
N4	Pulp and paper; edible fats; oil refineries.
N5	Chemical industries; pulp and paper; metallurgic industry.
N6	Pulp and paper; metallurgic industry; metal plating industry.
N7	Metallurgic industries; pulp and paper.
N8	Metallurgic industries; ore mining; fish oils; oil refineries; metal plating.
N9	Metallurgic industries; edible fats and fish oils; pulp and paper; oil refinery.
N10	Metallurgic industry; fish industry.
N11	Bulk chemicals; fish industries; textile industries.
N12	Pulp and paper; ore mining; fish industries.
N13	Pulp and paper; ore mining.
N14	Iron and steel; bulk chemicals; ore mining; metal refineries; fish industries.
N15	Fish industries; ore mining.
N16	Ore mining; fish industries.
SWEDEN	
S1	Oil refineries.
S2	Chemical industries.
S3	Oil refineries.
S4	Paper and pulp.
S5	-
S6	-
DENMARK	
DK1	Chemicals.
DK2	Food processing; ammonia.
DK3	Ships; fertilizer production; distilling; fish processing.
DK4	Fish farming and processing; pesticide manufacture.
DK5	Fish processing.
GERMANY, FED.REP. OF	
All areas	*)Chemicals; oil refineries; breweries; food industries; iron smelting; papermill; ship yards.
NETHERLANDS	
All areas	+)Iron and steel; potato starch; petro-chemicals; bulk chemicals; paper and pulp; oil refineries.
BELGIUM	*)Chemical industries; food industries.

/Cont'd.

*)From Coop.Res.Rep. No.39. +)Personal communication.

Table 8 (Continued)

Country and Area	Major Industries
ENGLAND/WALES	
E1	Pharmaceutical/drug; aluminium smelter.
E2, E2a	Engineering; shipbuilding; chemicals.
E3	Engineering; shipbuilding; chemicals; steel.
E4	Extraction of magnesium from seawater.
E5	Plastics manufacture; chlorinated alkalis; fertilizers; oil refineries; petrochemicals; steel; chemicals.
E6	Steel; malting; vegetable processing.
E7, E7a	Chemicals; distillery; fish processing.
E8	Chemicals, oil refineries; petrochemicals; titanium dioxide production; fish processing.
E9	Vegetable processing; chemicals; sugar beet (seasonal).
E10	Chemicals; metal finishing; vegetable processing; sugar beet (seasonal).
E11	Brewery and malting; vegetable processing; plastics.
E12	Oil refineries.
E13	Paper industries.
E14	None.
E15	Refining; mixed industry; chemicals.
E16	Little mixed industry.
E17	-
E18	Little light industry.
E19	Mining.
E20	Very little.
E21	Mixed industry; paper.
E22	Chemicals; paper making.
E23	Mixed industry; steelmaking.
E24	Mixed industry; steelmaking; coal mining.
E25	Refining.
E26	-
E27	Chemicals; steel; aluminium.
E28	Chemicals; refining; paper making; food; mixed industry.
E29	Chemicals; paper.
E30	Chemicals; paper; nuclear fuels; iron and steel.
SCOTLAND	
SC1	Creameries; plastics factory.
SC2	-
SC3	-
SC4	-
SC5	Cement; fertilizers; docks; brewing; paper mills; oil refining; petrochemicals; chemical and dye stuffs; distilling; coal mining.
NORTHERN IRELAND	-
IRELAND	
IR1	Mining; chemicals; power plants; textiles; agriculture; dairying; food processing.
IR2	Oil refinery; chemicals; power plants; textiles; agriculture; dairying; food processing.
IR3	Agriculture; dairying; food processing; chemicals; power plants; textiles.
IR4	Agriculture; dairying; food processing.
ICELAND	Fish processing.
GREENLAND	
G1	No industry.

Table 9. Miscellaneous input information.

	COD x 10^3 tonnes/yr	Oil tonnes/yr	Tar tonnes/yr	Taints tonnes/yr	Ind. Solvents Org. Halogens tonnes/yr
NORWAY					
N1	167	1 811	1 265	1 520	1 655
N2	10	1 134			1 845
N3	130	1 200			541
N4	5	722		16	646
N5	35	914	0.1	1	1 300
N6	4	495		0.5	130
N7	9	936	10	219	201
N8	15	2 148	345	16	903
N9	13	2 240	9	171	1 006
N10	6	349	63		64
N11	23	1 060	88		
N12	17	1 270		51	
N13	16	800		2.5	1
N14	14	755	420	15	
N15	34	565			
N16	9	850			
Total	507	17 249	2 200	2 012	8 290

	COD x 10^3 tonnes/yr	Oil tonnes/yr	Phenol tonnes/yr	Cooling Water x 10^6 m^3/yr	
SWEDEN					
S1	13	6.5	0.2		
S2	27	10.6	0.4	330	Vinylchloride 2.1 t/y Other C-Cl 0.8 t/y
S3	540	183	0.1		
S4	94	133	0.2	1 261	
S5	72				
S6	190				
Total	936	333	0.9	1 591	

/Cont'd.

Table 9 (Continued).

DENMARK

DK1	Organic solvents	20 t/y
DK2	Perchloroethylene	0.15 t/y
DK3	Cooling water	630×10^6 m^3/y
DK4	Cooling water	540×10^6 m^3/y

GERMANY, FED.REP. OF

	COD $\times 10^3$ tonnes/yr	CN tonnes/yr	Phenols tonnes/yr	Petrol waste tonnes/yr	Heat $\times 10^{10}$ M cal/y
G1	-	-	1.9	200 (Tar inc.)	-
G2	-	-	-	-	-
G3	-	-	-	-	4.5
G4	26	240	220	-	53

NETHERLANDS

	COD $\times 10^3$ tonnes/yr	CN tonnes/yr	Phenols tonnes/yr	Detergents tonnes/yr	Polycycl. aromates tonnes/yr	Petrol waste tonnes/yr	
NL1	337	161	59	684	1 220	3 400	
NL2	>22	-	-	-			
NL3	3 553	-	538	3 193	8 209	54 560	Be 26 t/y Sb 135 t/y Alcohols 450 t/y V 1 293 t/y Benzene 1 t/y
NL4	216	1 147	283	1 063			P-phenol-sulfonic acid 580 t/y
NL5	1 067	-	68	1 686		10 120	
NL6	197	-					
Total	5 392	1 308	948	6 626		68 080	

/Cont'd.

Table 9 (Continued).

	Co (tonnes/yr)	Syndets (tonnes/yr)	Oil (tonnes/yr)	Cooling water (x 10^3 m^3/yr)	Miscellaneous
ENGLAND/WALES					
E1	0.3				Coal wastes
E2	1.1				Coal wastes; Phenol 1 100 t/y
E2a	neg.				Coal wastes
E3	1.5				-
E4	0.2				Mine wastes
E5	-		0.3		CN 750 t/y; CNS 475 t/y
E6	2.1				-
E7	neg.				-
E7a	2.1		21	135	-
E8	3.3				-
E9	0.4	75			-
E10	1.1	2		83	-
E11	0.7	88		875	-
E12	-		122 000		Phenol 1 460 t/y; BHC 6.7 kg/yr; DDT 12 kg/y; PCB 22 kg/yr
E13	0.4				
E14	0.7				
E15	0.7		2 500		
E16	2.9				
E17	0.4				
E18	0.7				
E19	1.1				
E20	0.7				
E21	2.1				
E22	1.1	58			
E23	-				
E24	-				
E25	1.5				
E26	1.5				
E27	1.1			38	
E28	1.5		3 650	962	
E29	1.5	243			Uranium 7 t/y; Mono-dichlorobenzene 47 t/y
E30	neg.	5 000			F 8 000 t/y; Cellulose 3 000 t/y

NORTHERN IRELAND Cooling water 910 x 10^6 m^3/y (Temperature elevated by 15°C)

IRELAND Oil 430 t/y; cooling water 1.6 x 10^9 m^3/y

Table 10. Inputs by marine dumping.

Country and Area (1)	Quantity in 10^3t/yr	Hg	Cd	Cr	Cu	Ni	Pb	Zn	As	PCB	N	P	COD/BOD Organics	Type of waste and/or other information
		← Quantity in tonnes/yr →												
NORWAY														
N2	40	← NO INFORMATION →												Bark chips
N4	200													Dredgings
N5	7													Wood fibres
N15	40													Clay soil
SWEDEN														
S1	1	← NO INFORMATION but see footnote (2) →												Dredgings
S2	8													"
S3	1 300													"
S4	24													"
S5	36													"
S6	75													"
DENMARK														
DK2	76	NEGL.	0.04	-	0.5	0.4	0.7	2.4	-					Dredgings
DK3	2 800	0.4	1.4	29.0	36.0	30.0	79.0	188.0	1.0					"
DK4	1 500	NEGL.	0.2	0.6	1.5	1.3	20.0	10.0	-					"
Deep water (Bay Biscay)	10	← FOR DETAILS OF COMPOSITION SEE FINAL COLUMN AND TYPE OF WASTE →											900t COD	Waste from vitamin, barbiturate and sulfonamides manufacture. Contains 1900t inorganic salts mainly as Na_2SO_4, 600t organic acids/salts, 0.16t aniline, 85 t solvents (mainly alcohol), <50kg perchloroethylene.
GERMANY, FED.REP. of	328	← NO INFORMATION →												Sewage sludge 4.3% solids.
	403													Waste from TiO_2 manufacture. 8.8% H_2SO_4 14.2% $FeSO_4$ + 23 x 10^3t insoluble solids.
NETHERLANDS														
NL A	16 219	-	33	1 218	397	193	746	2 652						Dredgings Dieldrin 0.57t, HCB 0.40t, chlorinated hydrocarbons 25t, oil 112t.
NL B	2 155	-	(6)	(180)	(65)	(21)	(155)	(426)						Dredgings Dieldrin 0.03t, HCB 0.11t, chlorinated hydrocarbons 4.2t, oil 15t.
?	930												1200t COD (O_2/yr)	Industrial wastes. 66% water, containing 322 x 10^3t inorganics and 678t organics - for details see Footnote (3).
BELGIUM														
51°50'N - 3°10'E	300	← FOR DETAILS OF COMPOSITION SEE FINAL COLUMN AND TYPE OF WASTE →												Waste from TiO_2 manufacture. 15% H_2SO_4 & 2-3% $FeSO_4$.
51°30'N - 3°00'E	200													" " " " 27% H_2SO_4 & 6% $FeSO_4$.
51°26'N - 2°58'E	7													Resin manufacture containing 1.5% phenol.
51°25'N - 2°55'E	17													Enzyme manufacture 66% organic matter, 34% Diatomaceous filter.
FRANCE	940	-	8	4	5	5	10				5 950			Industrial wastes.
ENGLAND													Organics	Dredgings / Colliery Spoil / Sewage Sludge / Fly Ash / Industrial
E1	60													Dredgings 100 —)Nature of industrial waste)& full details)of position of)dumping supp-)lied to ICES.
E2	2 450	1		12	18		30	48						Dredgings 24, Colliery Spoil 49, Fly Ash 27
E3	20											1 740		Industrial 100
E4	5 787			17	34	8	82	109						Dredgings 33, Colliery Spoil 65, Fly Ash 2
E5	10										21	5	0.3t	Sewage Sludge 100

/Cont'd.

Table 10 (Continued)

Country and Area (1)	Quantity in 10^3t/yr	Hg	Cd	Cr	Cu	Ni	Pb	Zn	As	PCB	N	P	COD/BOD Organics
		← Quantity in tonnes/yr →											
ENGLAND (contd)													
E5	10										21	5	0.3
E5/6	2 465	7	3	360	280	57	330	680					1.5
E7	10												
E8	1 624	0.2	1	170	290	11	500	-			669	167	15
E10	331	0		5	7		10	20					
E11	8 482	1.3	5	14	111	50	115	466		0.1	11 029	2 836	100
E13	674			2	2		5	10	19				
E14	136	0		1	1	0	3	4					
E15	320	0			3		2	6		0.1	368	77	6.3
E16	1 046												
E17	73				2			2			134	34	1.7
E18	500												
E20/25	540		1	25	22	7	16	28					15
E21/23	12	0	0	0	0		0	0		0	0	0	
E22	6 000	3	9		240	120	450	1 200					
E24	4 000												
E26	40	0	0	0	0	0	0	0		0	0	0	0.6
E27	2 927	3	2	89	111	16	60	169		0.5	6 384	1 250	56.4
E28	10 690	20	18	373	726		1 526	2 772		0.4			
E29	2 600			20	20		60	220					
Deep water	2 570								3				
SCOTLAND													Organics
SC2	1 400	0.3	1	120	48	6	43	126		0.3	2 940	540	50
SC3	40												
SC5	300												
N. IRELAND	220	0.1	0.1	8.6	3		12	21			462	120	7
IRELAND													
IR1	142		0	1.7	2.4	1.5	2.8	11.4					
IR2	1 200				0.1			0.5			200	28	

Country and Area (1)	Dredgings	Colliery Spoil	Sewage Sludge	Fly Ash	Industrial	Type of waste and/or other information
ENGLAND (contd)						
E5			100			)
E5/6	97				3	)
E7	100					)
E8	74		21		5	)All sewage
E10	100					)sludges and
E11	38		62			)industrial
E13	95				5	)wastes dumped
E14	100					)into the wake
E15	31		69			)of the vessel.
E16	100					)Colliery spoil
E17						)and dredgings
E18	87		13			)bottom dumped
E20/25			97		3	)by hopper
E21/23	neg.				100	)barges.
E22	100					)
E24	100					)
E26					100	)
E27	14	21	56		9	)
E28	100					)
E29	100					)
Deep water						Deep water means Atlantic Ocean and in accordance with Oslo requirements for depth etc. Weight given is total weight including containers and packaging. Other main constituents 205t CN and 1 t Sb. In 1975 additionally 1000 t liquid waste containing 1 t phenol discharged to wake.
SCOTLAND						
SC2						Sewage sludge
SC3						Industrial
SC5						Colliery waste
N. IRELAND						Sewage sludge
IRELAND						
IR1						Sewage sludge
IR2						

FOOTNOTES

(1) Areas given in general refer to coastal zones as used in previous input tables; dumping is usually within about 25 miles of coast.

(2) Quantities quoted are means for 1967-72.

(3) Composition of Netherlands industrial waste given as -
H_2SO_4 194,811t, H_3PO_4 925t, HCl 491t, CH_3COOH 638t, Sodium Salts 3,916t, $Cr_2(SO_4)_3$ 235t, $FeSO_4$ 83,042t, other sulphates 36,908t, NaOH 758t, Alcohols 75t, Glycerine 8t, Polymerised Glycerine 45t, 3 tons 1,1,2,2,-tetrachloroethylene, 2,6 dichlorobenzonitrile and 2,6 dichlorobenzamide, Hydrazine and acetate compounds 77t, Albumins 470t.

Incineration

One country, Netherlands, reported that they had disposed of about 40,250 tonnes of industrial wastes by burning at sea on specially designed vessels. Of this quantity no more than 18% was not chlorinated hydrocarbons. Incineration efficiency is assumed to be at least 99.9% and the input of chlorinated hydrocarbons to the marine environment (unburnt) was therefore not more than 40 tons.

Detailed content of the wastes incinerated are as follows:-

/Cont'd.

Table 10 (Continued) (Incinerated wastes)

	Tonnes
Trichloropropene	2,776
Allyl-Chloride	534
1.1.2 Trichloroethane	4,788
1.2 Dichloroethane	479
6 Chlorocresol	32
4 Chlorocresol	24
Phenol, Orthocresol, 4 Chlorophenol	4
Other chlorinated Hydrocarbons	4,309
Cl	8,685
C	257
N	257
Br, Fe, Mn and/or Cr	3
	33,064 t

Table 11. Summary of programmes to determine atmospheric inputs.

SWEDEN

Since 1967, the Institute of Meteorology at the University of Stockholm has taken samples of air and rainfall at monthly intervals. This programme is part of the European Atmospheric Chemistry network. The samples are analysed for sulphate, carbon, nitrate, ammonia, sodium, potassium, magnesium and calcium, alkalinity/acidity, pH and conductivity. Similar analyses are made on filtered and unfiltered air samples, which are taken in an endeavour to separate particulate sulphur from sulphur dioxide. Typical concentrations in precipitation were given for the station at Plöninge near Hamstad where precipitation averages 72.7 mm/month. These values were:

SO_4	52.1	µg mole/l	Na	47.2	µg mole/l
Cl	59.1	"	K	9.5	"
NO_3	42.6	"	Mg	7.9	"
NH_4	51.5	"	Ca	10.0	"
H^+	61.0	"	Conductivity	$10^6 \Omega^{-1}$ cm^{-1}	
pH	4.2	calculated			

These values are uncorrected for sea salt contribution, which is estimated by relation of one element to sodium in rain water and sea water as 49.3µ mole/l S, 8.5µ mole/l K, 2.5µ mole/l Mg and 9.0 µ mole/l Ca.

The Zoological Institute at the University of Lund has carried out a similar programme to assess the airborne fallout of PCB and DDT over Sweden. Samples were taken at about 20 sites using special sampling screens and collectors which are renewed at monthly intervals. Results of this and other related work have been published in the open literature (Refs. 7, 8, and 9). These results show some evidence of seasonal variations, with the highest concentrations in the earlier part of the year. PCB fallout is higher than that of DDT.

DENMARK

Two programmes to assess the atmospheric fallout of metals are conducted in Denmark. The Institute of Ecological Botany at the University of Copenhagen has a set of stations of which 14 are in Denmark, one in the Faroes and one on the Swedish coast. All stations are at least 10 km from the main roads. Most metals are measured at monthly intervals, but nickel, vanadium, strontium,

/Cont'd.

Table 11 (Continued)

lithium and chromium only occasionally. Analysis is by atomic absorption spectrophotometry using a graphite cuvette. Typical values found are:

Rainfall	Quantity in $mg/m^2/yr$							
mm/yr	Pb	Cd	Cu	Zn	Na	Mg	Fe	Mn
505	7.1	0.2	1.44	14.8	1,770	260	85	13.9

If these values are used to calculate the input to the North Sea (assuming an area of 6×10^{11} m^2 including Kattegat), the total inputs are:

	Pb	Cd	Cu	Zn	Na	Mg	Fe	Mn
$\times 10^3$ tonnes/yr	4.3	0.1	0.9	8.9	1,062	156	51	8.3

These generally are of the same order of magnitude as those obtained in the England and Wales programme (see below).

The second programme is run by the company Superfos Ltd. Lead, cadmium, chromium, vanadium, nickel, zinc and sodium are measured six times each year at three stations all within 10 km of Fredericia near the Little Belt. New stations are being set up on several small islands within 30 km of Fredericia. Results are available for 1975.

ENGLAND, WALES AND SCOTLAND

A programme to assess the inputs of heavy metals to the North Sea was carried out for several years by MAFF (Fisheries Department) and the Atomic Energy Research Establishment at Harwell using seven stations around the North Sea, one in Norway, one in the Netherlands and the rest on the UK coastline. All stations are selected as being well away from immediate local sources of land-based contamination and from sea spray. The results of this programme have been reported in the literature (Refs. 1, 2, 3 and 4) and only a brief summary is given here.

Samples were taken of both wet and dry deposition at monthly intervals at all sites. Analysis was by neutron activation for most elements and by atomic absorption spectrophotometry in a few cases.

/Cont'd.

Table 11 (Continued)

Inputs to the North Sea of some of the metals measured are given below:

Element	Input in tonnes/yr	
	Total deposition	Dissolved deposition
Sodium	4.4×10^6	4.4×10^6
Aluminium	1.1×10^5	1.1×10^4
Chromium	720	175
Manganese	4.1×10^3	3.1×10^3
Iron	1.05×10^5	1.6×10^4
Cobalt	82	32
Nickel	1.65×10^3	1.1×10^3
Copper	4.9×10^3	3.0×10^3
Zinc	1.45×10^4	1.15×10^4
Arsenic	420	<420
Cadmium	-	530
Mercury	5.6	-
Lead	5.6×10^3	3.9×10^3

These estimates assume an area of 5.3×10^5 km^2 and a mean annual rainfall of 438 mm. These inputs have been compared to the known concentrations of metals in sea water of the North Sea and its flushing time and it appears that some 50% of the Fe, 25-30% of the Pb and 13-20% of the Zn inventories of the North Sea are accounted for by atmospheric fallout.

A similar but smaller programme has been operated by DAFS, Aberdeen, around the Firth of Forth, using six stations away from the immediate influence of sea spray (see Ref. 5). Analysis of samples was mainly by atomic absorption spectrophotometry and anodic stripping voltammetry. This programme has allowed estimates of the annual deposition of metals over the Firth of Forth to be calculated as follows:

Pb	0.87	µg/cm^2/yr	Zn	8.2	µg/cm^2/yr
Cu	0.25	"	Hg	2.7	ng/cm^2/yr

Additionally, a programme has been established to assess inputs of organochlorine compounds to the North Sea (Ref. 6). Seven stations are operated along the east coast of the UK, all being well away from obvious sources of contamination.

/Cont'd.

Table 11 (Continued)

Assuming the area of the North Sea to be 5.75×10^5 km^2, the annual input to the North Sea of several organochlorine compounds has been computed as follows:

Substance	Annual input (kg/yr)
PCB	2.0×10^3
pp DDE	0.2×10^3
pp DDT	0.9×10^3
op DDT	0.1×10^3
Dieldrin	0.3×10^3
α -HCH	0.8×10^3
γ -HCH	1.1×10^3
Total DDT group	1.2×10^3

IRELAND

Sulphur dioxide, smoke and dust-fall are measured at nine stations in Ireland, although not all stations measure all three inputs. Additionally, estimates are made of the emission of these materials and of nitrogen (as oxide), lead, hydrocarbons and carbon monoxide.

Estimated emissions for 1972 have been given as:

Nitrogen (as oxides)	12,500	tonnes
Hydrocarbons	88,000	"
Lead	700	"
Sulphur dioxide	254,000	"
Smoke	59,000	"
Particulates	634,000	"

Table 12. Use of pesticides in Denmark*) (active compounds).

2-4 D	(2,4 - dichlorphenoxycetic acid)	203 t/y
dichlorprop	2-150 (2,4 - dichlorphenoxy) - propionic acid	1 304 t/y
MCPA	(4-chlor-2-methylphenoxyacetic acid)	626 t/y
TCA	(Sodium trichloroacetate)	592 t/y
DDT		0.8 t/y
Lindane		16.5 t/y
pentachlorphenol		1.5 t/y
thiram	tetramethyl-thiuramdisulfide	54 t/y
maneb	manganese-ethylen-1,2-bis-dithiocarbamate	144 t/y
DNOC	2-methyl-4,6 dinitrophenol	41 t/y
dinoseb	2-(1-methyl-n-propyl)-4,6-dinitrophenol	52 t/y
capstan	N-(trichlormethylthio)-cyclohex-4-en-1,2-dicarboxyimide	51 t/y
parathion		116 t/y
Petroleum		112 t/y
Hg		1.1 t/y
Cu		18 t/y
$NaClO_3$		267 t/y
Other		1 230 t/y
Total		4 829.9 t/y

Use of pesticides in Norway

Chlorinated fatty acids	548 t/y
DDT, Endosulfane, lindane, metoxychlor	6 t/y
Fenoxy compounds	417 t/y
petroleum	335 t/y
sodium chlorate, borates	468 t/y
Carbamates	54 t/y
Other	233 t/y
Total	2 061 t/y

*) Whole area

/Cont'd.

Table 12 (Continued)

Ireland

National usage of pesticides (metric tons of active ingredient per year):

User	DDT	Lindane	Aldrin	Dieldrin	Chlordane
Agriculture	5.7	9.8	0.5	1.9	0.5
Industry	0.1	2.0	-	3.7	-
Total	5.8	11.8	0.5	5.6	0.5

No Endrin, Heptachlor or Heptachlor-epoxide were used in 1974. Since then, there has been a general reduction in agricultural usage, but not in industry. In particular, the usage of Dieldrin by the carpet industry remains high. The figures for industrial usage are probably underestimated but those for agriculture are correct.

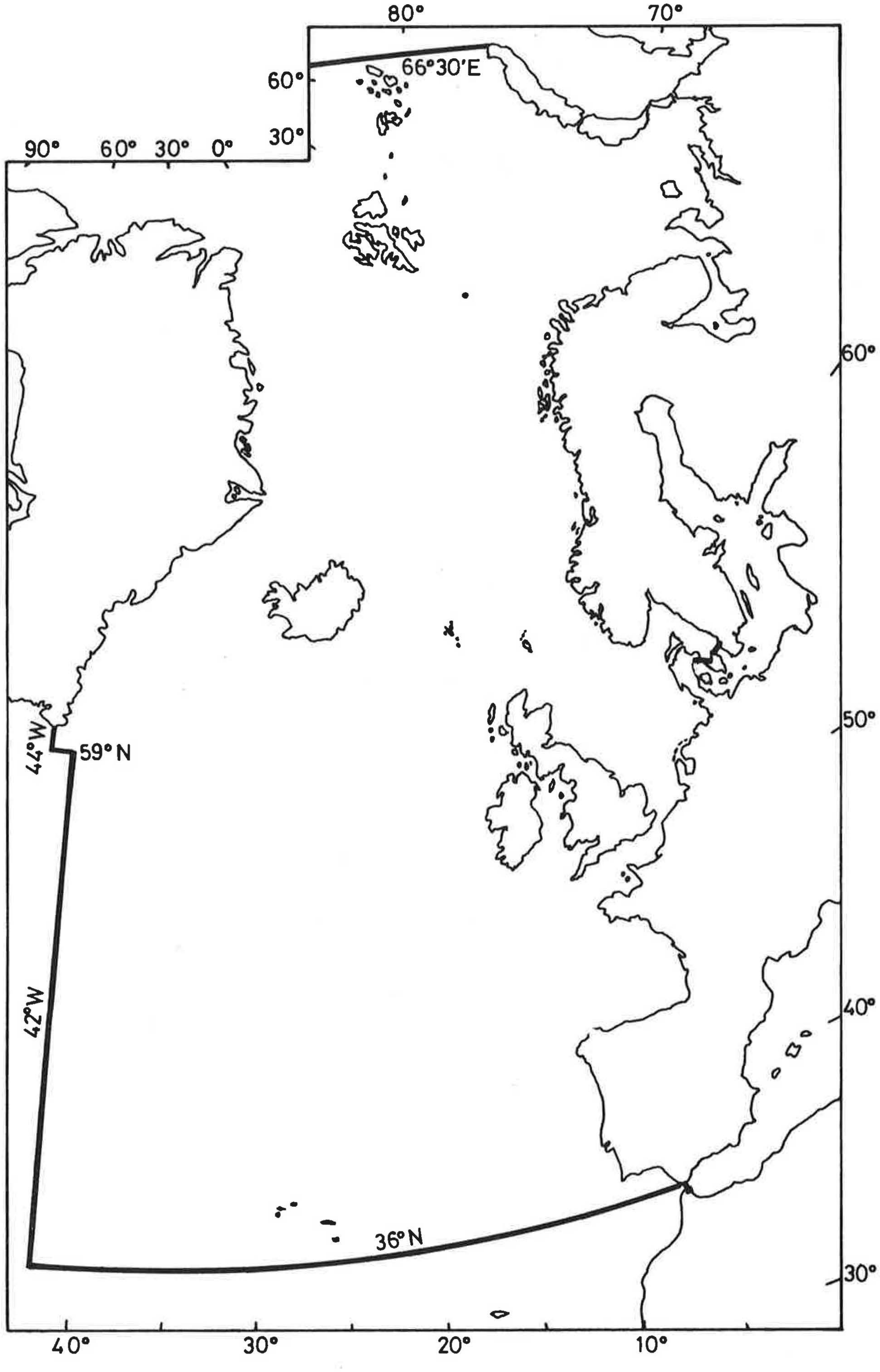

Figure 1. Map of the Oslo Commission area.

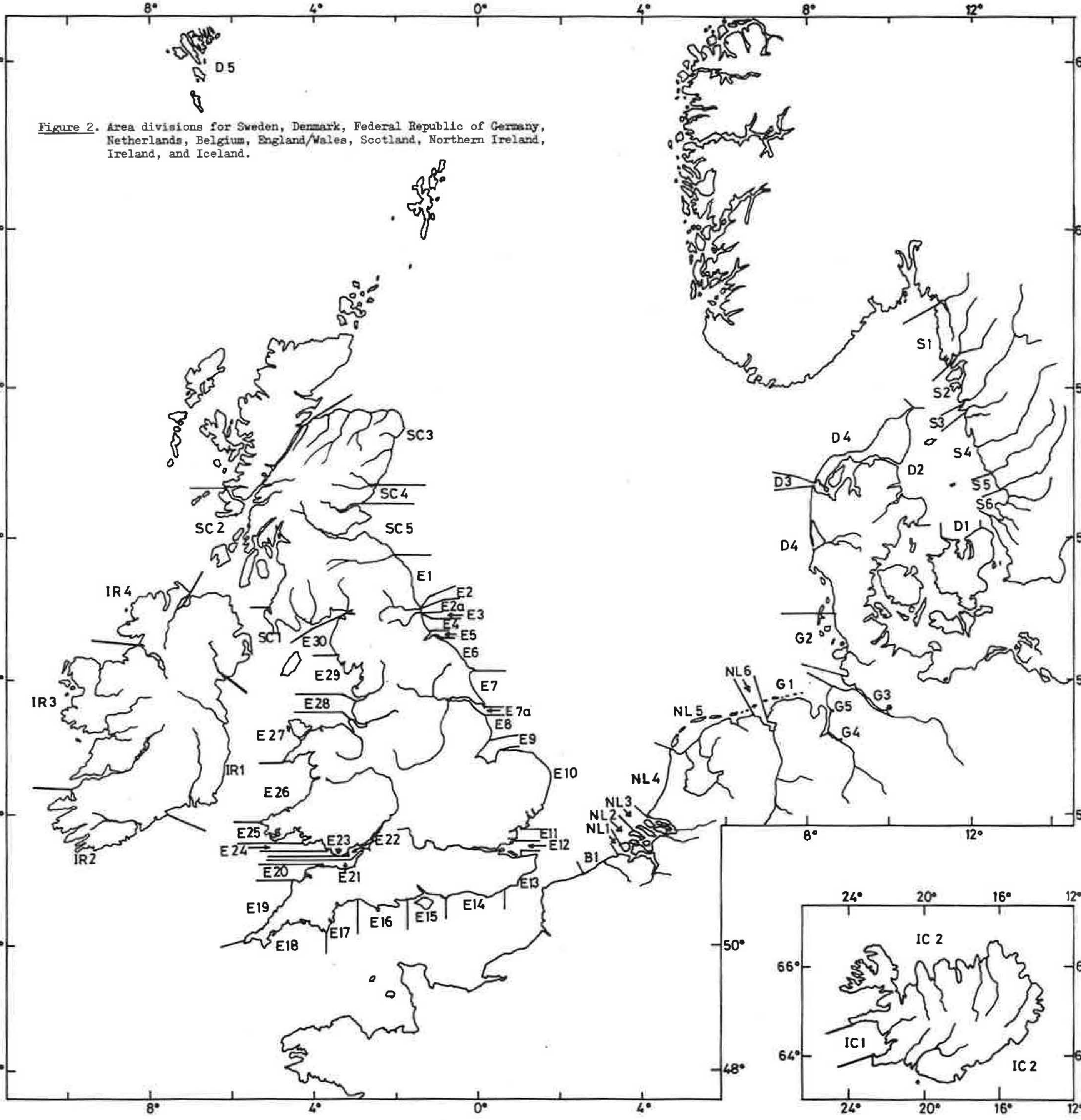

Figure 2. Area divisions for Sweden, Denmark, Federal Republic of Germany, Netherlands, Belgium, England/Wales, Scotland, Northern Ireland, Ireland, and Iceland.

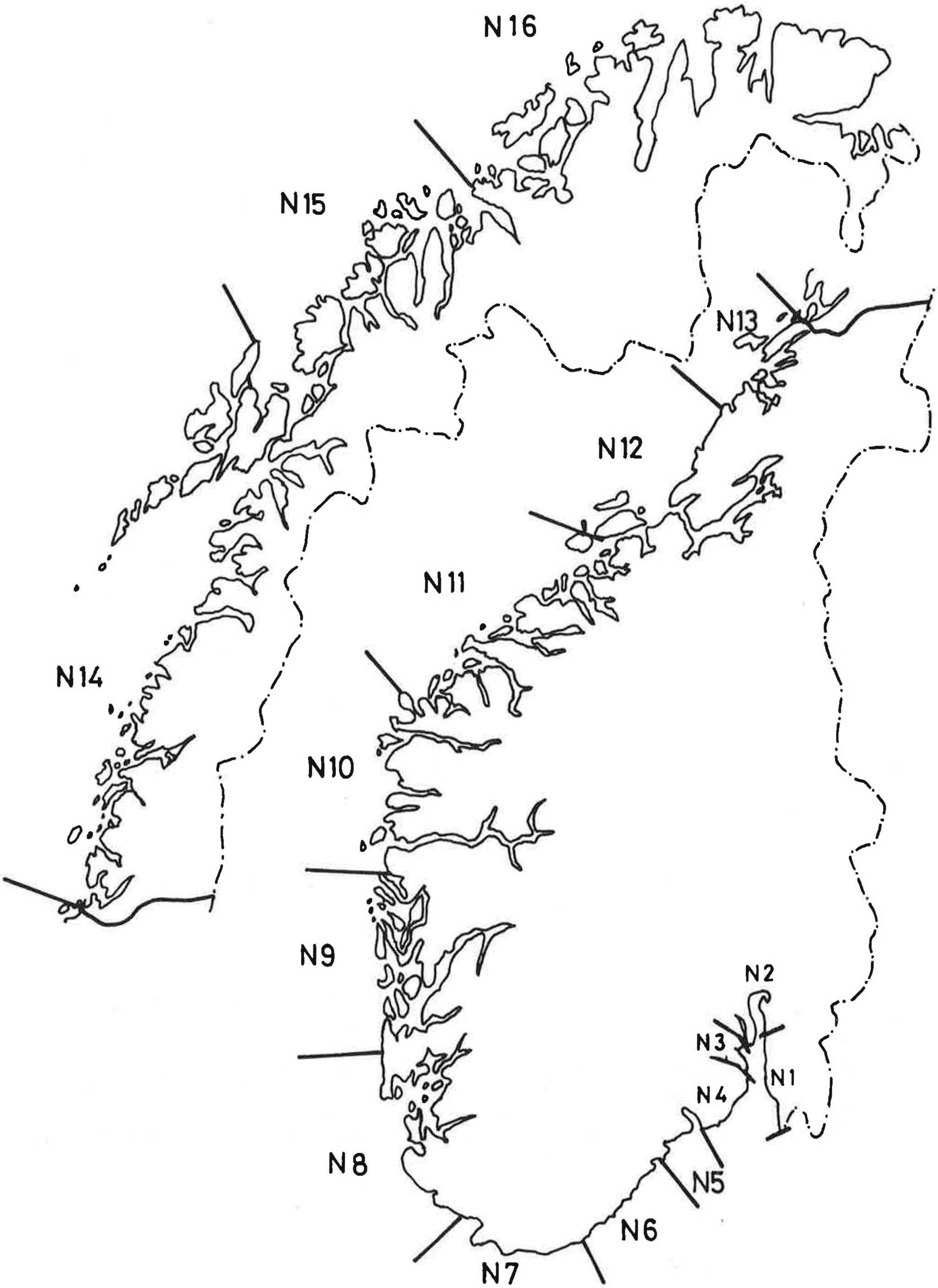

Figure 3. Area divisions for Norway.

INPUTS QUESTIONNAIRE

A. Explanatory Notes

1. Objectives: The purpose of the questionnaire is to provide a basis for an estimate (order of magnitude) of the input of major categories of pollutants to the marine environment in the North Sea, the Oslo Commission area and parts of the ICNAF region. For this purpose the marine environment will be taken to include river estuaries and fjords. Information is called for on all major pathways and on any individual sources which national authorities consider should be specified separately.

2. Inputs which are of concern are via the following pathways or routes.

   (i) River input to the marine environment.
   (ii) Input directly to the marine environment (as distinct from river, dumping or atmosphere), e.g., pipeline discharges, etc., to estuaries and coastal waters.
   (iii) Atmospheric inputs.
   (iv) Dumping.
   (v) Other sources, e.g., incineration at sea.

3. It is suggested that coastlines be divided into sections of convenient size at the discretion of national authorities, so that input figures for the various individual pathways can be given for each section of the coast. However, major estuaries or fjord systems should be dealt with as discrete units.

4. Wherever possible in an estuarine or fjord situation, it is requested that an estimate be provided of the proportion of the input entering the estuary or fjord which actually enters the open sea.

5. It will be noted that in certain cases, e.g., as in the case of dredging of river estuaries, the dumping of such spoil in the open sea is not an input but a transfer and should be included in the estimates of estuarine pollution load reaching the open sea.

6. It will be noted that details of radioactive wastes, e.g., from nuclear power programmes, are not required as these are being dealt with under the auspices of other international bodies. However, details are required of the volume and temperature elevation of power station effluents, whether nuclear or not.

B. Categories of Pollutant and Waste (to apply to pathways 1, 2, 4 and 5 above, whether of domestic, industrial or other origin).

1. Quantities to be given in m^3/day or metric tons per year. These should be average quantities over the most recent available 12-month period, which should be specified. Where there is evidence that the dates thus provided are significantly different to the most recent situation, a note should be provided to this effect.

Provide details of:-

Total flow
Total population contributing to the flow
<u>Per capita</u> water usage
Suspended solids
Total solids
BOD
COD
Total nitrogen
Total phosphorus
Organochlorine compounds, especially pesticides and PCBs
Petroleum waste and tar products
Metals, i.e., lead, cadmium, mercury, zinc, copper, arsenic and chromium
Other substances
Heated effluents (flow and temperature elevation).

2. A map should be provided showing major estuaries and the way in which the coastline has been divided.

3. Information should be provided concerning the degree of treatment of sewage and industrial wastes, especially where data on individual pollutant concentrations and these quantities are not available.

C. Dumping

1. Include industrial wastes, sewage sludges, mining wastes, harbour dredging (see note above) household refuse, etc. Provide information on approved dumping activities over the most recently available twelve-month period in terms of quantities, composition and origin. Details are also required of the position of dumping, whether or not the waste was in a container, and whether the waste is expected to disperse or remain in the immediate vicinity of the area of disposal.

D. Atmospheric Input

Give details of national programmes to determine atmospheric fallout including sampling sites. Wherever possible estimates should be given of the annual input for the individual pollutants specified above.

E. Other Sources

Data appropriate to incineration at sea should include quantities, composition, origin, temperature of incineration and location of vessel conducting incineration. Please include any other known source not already listed.

Replies to be in not later than 31 December 1975.

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Indication of spine colours

Liaison Committee Reports	Red
Reports of Advisory Committee on Marine Pollution	Yellow
Fish Assessment Reports	Grey
Pollution Studies	Green
Others	Black

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