ROYAL COMMISSION
ON
ENVIRONMENTAL POLLUTION

CHAIRMAN: SIR BRIAN FLOWERS

FOURTH REPORT
POLLUTION CONTROL: PROGRESS AND PROBLEMS

Presented to Parliament by Command of Her Majesty
December 1974

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To the Queen's Most Excellent Majesty

MAY IT PLEASE YOUR MAJESTY

We, the undersigned Commissioners, having been appointed "to advise on matters, both national and international, concerning the pollution of the environment; on the adequacy of research in this field; and the future possibilities of danger to the environment";

And to enquire into any such matters referred to us by one of Your Majesty's Secretaries of State or by one of Your Majesty's Ministers, or any other such matters on which we ourselves shall deem it expedient to advise:

HUMBLY SUBMIT TO YOUR MAJESTY THE FOLLOWING REPORT.

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CHAPTER I
INTRODUCTION

Introduction

1. We were appointed on 29 May 1973 as new members of the Royal Commission on Environmental Pollution. The terms of office of members of the Commission as originally appointed, under the chairmanship of Sir Eric (now Lord) Ashby, expired on 20 February 1973. Three of the original members, Mr. Aubrey Buxton, Professor Vero Wynne-Edwards and Lord Zuckerman, were reappointed for a further year and have now retired from the Commission. We wish to record our gratitude for their great contribution to the Commission's work. We regret the premature departure of Mr. George Richardson, who decided to resign because of other commitments. There have been further appointments to the Commission since this Report was prepared and we list in Appendix A the full current membership.

2. Our terms of reference remain: "to advise on matters, both national and international, concerning the pollution of the environment; on the adequacy of research in this field; and the future possibilities of danger to the environment". These terms of reference are wide; as the Commission commented in the First Report(1):

> "We have no specific or restricted task. We are authorised to enquire into any matters on which we think advice is needed, and also to enquire into any issues, which lie within our terms of reference, as may be referred to us by any of Her Majesty's Secretaries of State or Ministers".

This freedom of action brings with it the difficult task of choosing subjects for enquiry in a field in which many bodies, both official and otherwise, are already active. We have started by surveying the whole field of environmental pollution and considering areas most needing our attention. In this we have been greatly helped by officials of the many Government departments and other bodies we have approached for information, and we wish warmly to acknowledge their willing response to our enquiries.

3. This Report, though the fourth to be published by the standing Royal Commission, is the first since the Commission was reconstituted. We thought we should inform the public about the way we see our role in relation to the problems of environmental pollution. We consider this and related matters in this first chapter of the Report. In Chapter II we present information we have obtained from our first survey of the field of environmental pollution. This is primarily a factual statement, though in some places we have suggested action that might be taken. In our review of the pollution field we were assisted by the valuable survey of the state of the natural environment that was published by the Commission in their First Report. Much of that survey remains valid although the Report is now over three years old.

4. In 1972 the Commission, then under the chairmanship of Lord Ashby, initiated a study into training and manpower requirements for professional and technical staff engaged in pollution control. For reasons that are explained later in this Report, we came to the conclusion that it would be impracticable to proceed with the study in the way originally envisaged. We decided that the best course was to suspend further work on it and to publish a brief statement of our findings on the evidence already taken. This statement forms Chapter IV of this Report. In the initial stages of the study, it was necessary to assemble information about the structure for pollution control in this country. We thought this information to be of general interest and we have therefore presented it in Chapter III. Finally, in Chapter V, we report our conclusions from our preliminary review of the field of environmental pollution and the decisions we have reached on our future work programme.

5. The Report covers a wide field and we have not all been able to take part in every enquiry and discussion on which it is based. Thus, it reflects a broad consensus rather than unanimity on point of detail. In view of our changing membership, it has been signed by those of us who were members on 6 June 1974.

The Commission's role

6. Much effort is being directed by Government and other agencies to the control and abatement of pollution. It is usual to find that any aspect of pollution that appears to give cause for particular anxiety is already the subject of active investigation by some official body. New measures to strengthen controls on pollution that have been introduced by successive Governments testify both to the continuing public concern with environmental issues and to the public will to see improvements brought about. Nevertheless, the existence of a standing Royal Commission with such broad terms of reference implies a judgment that pollution will continue to raise issues of such consequence to the nation as to justify an independent "watch dog" body.

7. Our role, as a watch dog body, is to identify aspects of pollution that appear to call for independent enquiry, to study these in depth and to publish our conclusions. We see it as an important part of this work to inform the general public on environmental matters as well as to recommend action by Government and other agencies where we consider that this is needed. Though we are essentially a lay body, we bring a wide range of experience and expertise to the Commission, and we are in a position to take a comprehensive view of the issues raised by pollution.

8. Public awareness and the extensive Government machinery that exists should ensure that effective action is taken to deal with any situation in which pollution is seen to constitute a serious hazard, and we shall not normally need to concern ourselves with immediate problems that demand urgent action. We expect rather to concern ourselves with the principles that relate to pollution control and abatement and to deal with matters which may escape the attention of official bodies having more narrowly defined responsibilities than those of the Commission, but which may nevertheless be of considerable importance for the future protection of the environment.

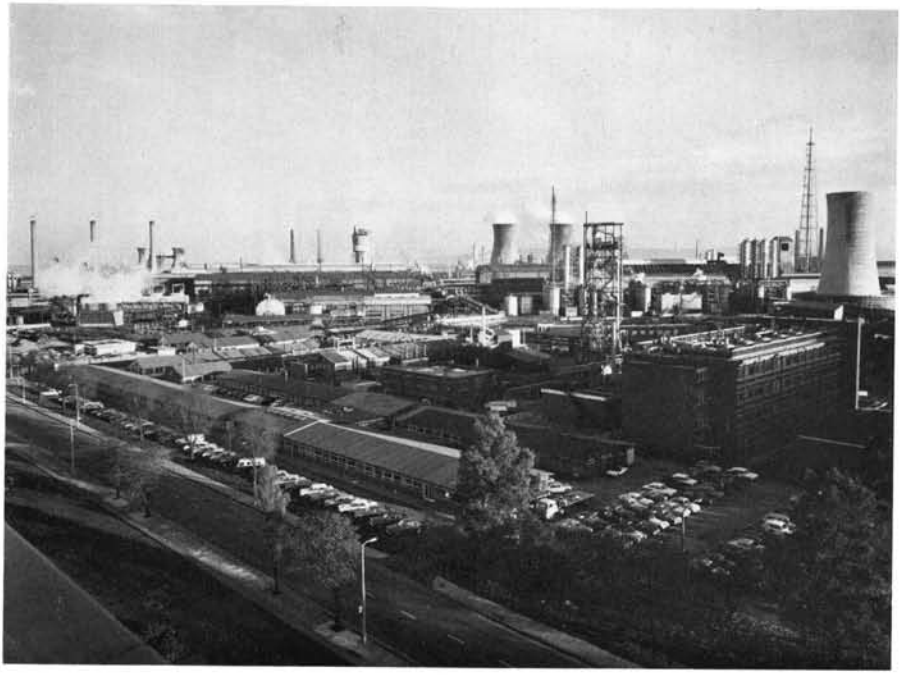


PLATE 1

Chemical works at Billingham before and after significant improvements which involved the closure of old offending plants, their replacement with new units and changes in technology which minimised nuisance from pollution. Reductions in atmospheric pollution over the factory and the surrounding district were as a result dramatic. *Photographs by courtesy of ICI*

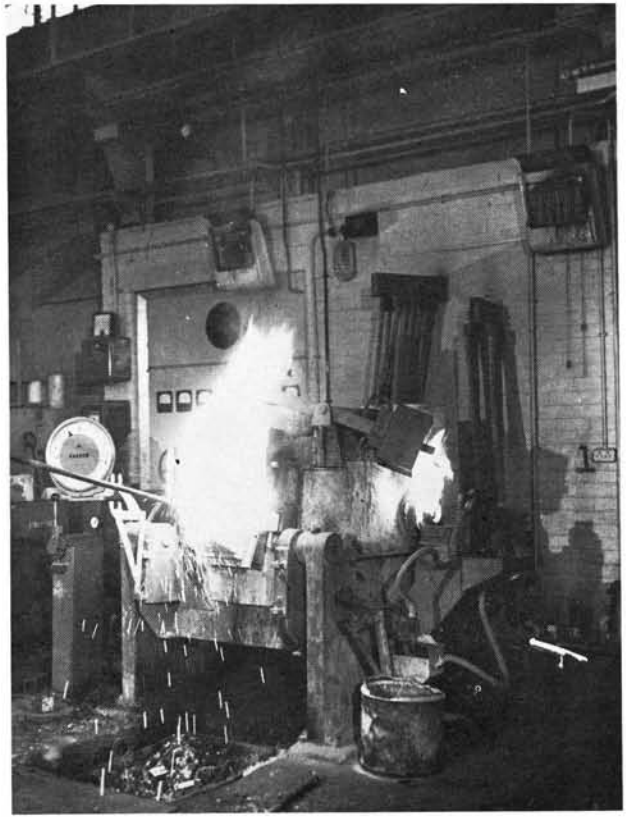


PLATE 2

The reduction in fume obtained with a new process of oxygen-lancing of a steelmaking furnace. *Steel Castings Research and Trade Association*

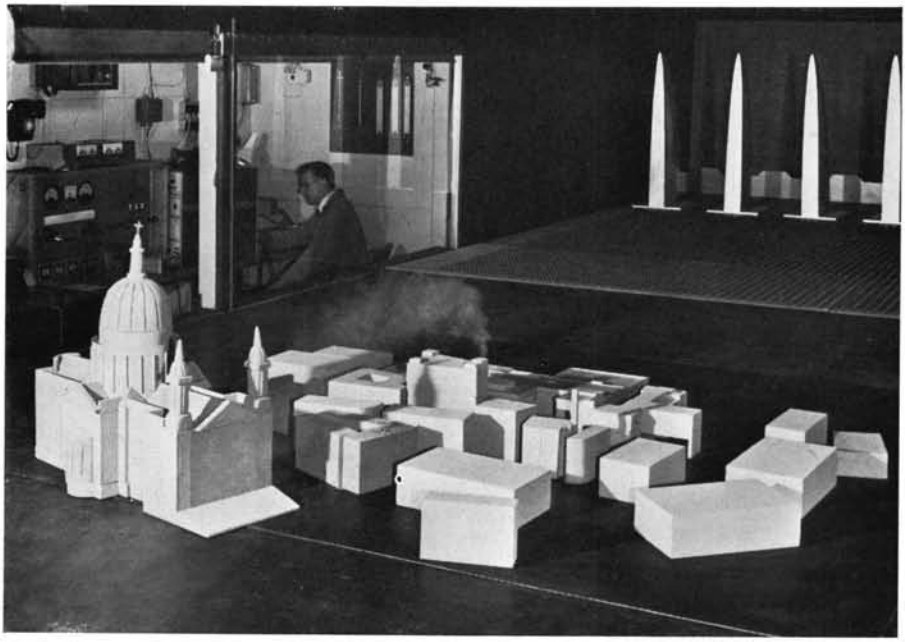


PLATE 3

a. Test on dispersion of pollutants in a built-up area being conducted in a wind-tunnel at the Warren Spring Laboratory. *Crown copyright*

b. Tug spraying a low-toxicity dispersant (stored in drums on deck) in order to treat an oil spill. The sea surface is agitated by means of the slatted wooden frames, developed at the Warren Spring Laboratory. *Photograph by courtesy of BP*

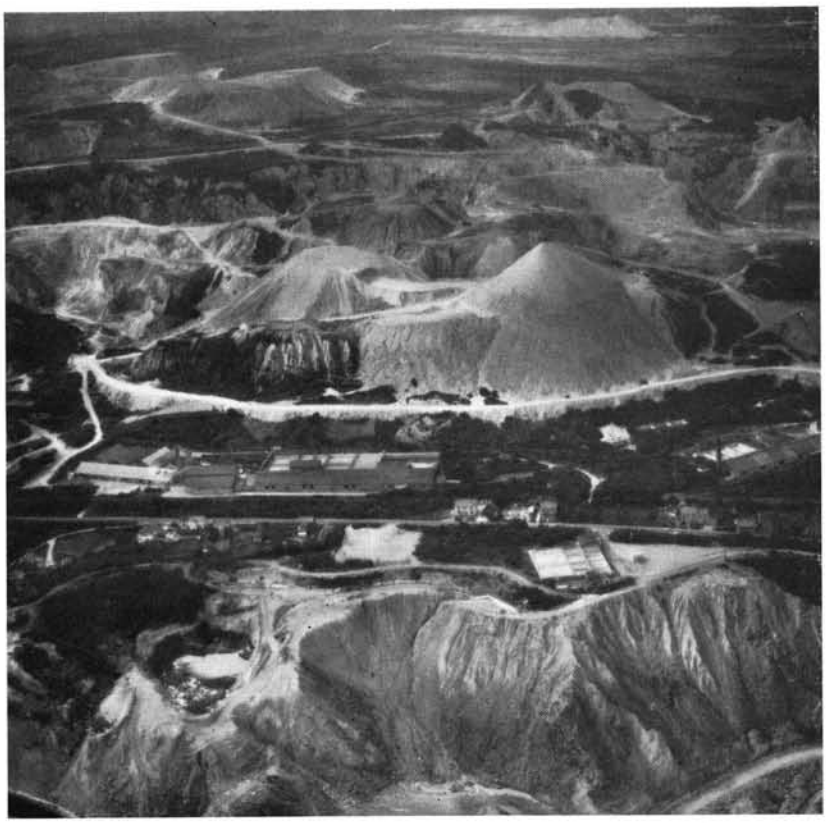


PLATE 4

Wastes from the quarrying of china clay near St. Austell, Cornwall. *Aerofilms*

more than at first seemed necessary and general rules about individual pollutants might be difficult to make because of their interactions with other pollutants in particular environments. Another body of recent work[6,7] has shown that some marine animals and plants naturally synthesise chlorinated hydrocarbons which, by some widely used methods of analysis, could be confused with substances like DDT. This could mean that some of the fears about the ubiquity of man-made substances like DDT might be exaggerated. We would stress that balanced and economical action about pollution depends on research and on having as complete a knowledge as can readily be obtained of such fundamental matters. In this respect we welcome the establishment of information centres where results of international research are collected and made available to Government, industry and public. These are included in the list of bodies given in Appendix B which are able to provide information on various aspects of pollution.

17. A recent development with considerable implications for the environment is the greatly increased cost of oil supplies which is leading to major reappraisal of available sources of energy and of energy use. Nearly all energy conversion results in pollution and many of the topics reviewed in the next chapter are occasioned by energy conversion in various ways. A different pattern of energy conversion will mean that we shall need to concern ourselves with the resulting changes in the pattern of pollution. A change from coal to nuclear energy, for example, would lead to a reduction in sulphur dioxide emissions and in land dereliction arising from coal mining but to an increase in radioactive wastes. The changing economics of energy supply, by discouraging waste, should bring overall environmental benefit. There is also the possibility that it will lead to the further development and greater exploitation of methods of energy conversion that are inherently non-polluting; for example, the use of wind, wave or tidal power.

18. The oil supply situation has resulted in greatly increased emphasis on offshore oil exploration and on the use of nuclear energy. Both developments have environmental implications that concern us. We have already announced our intention to undertake a formal enquiry into radiological safety, with the main emphasis on the problems that might arise in the future with respect to the storage and disposal of radioactive wastes from nuclear stations, the transport of nuclear materials and the siting of nuclear installations. We have also made some preliminary enquiries about the nature and scale of environmental hazards associated with offshore oil exploration, with a view to deciding whether there was a case for more searching investigations. We comment further on these matters in Chapter V of this Report.

19. Concern about environmental pollution is reflected in the steady extension of related legislation. The most significant addition to statutory powers for many years has been provided through the recent Control of Pollution Act. The new legislation represents the evolutionary development of previous controls over a wide field, covering the disposal of wastes on land, pollution of water and air, and noise (though not noise from air or road traffic).

20. We note with satisfaction that the new Act includes provisions to cover the major recommendations previously made by the Commission concerning pollution of estuaries and coastal waters and the disposal of toxic wastes. The Act also makes important provisions in another area of continuing concern to the Commission, namely that of secrecy about industrial emissions and effluents. We fully share the views expressed by the Commission, under the chairmanship of Lord Ashby, on the desirability of full disclosure of the nature and quantities of these wastes; we share also their doubts about the reality of the need for such information to be withheld on grounds of preserving trade secrets.

21. A feature of the Act is the extent to which powers have been reserved to the Secretary of State. Some are clearly appropriate to central government, such as power to intervene in the control of the more difficult or toxic wastes, to impose charges for consents, to regulate the composition of fuels and to restrict or ban the use of dangerous substances. But we hope and expect that those powers that affect publicity about liquid discharges and the extent to which local authorities will be able to collect and publish information about air pollution will be exercised in accordance with the principle that there should be the fullest possible disclosure about wastes discharged to the environment. This principle, advocated in the Commission's Second and Third Reports, has been accepted by successive Governments.

22. The Act provides for the new measures to come into force on dates to be determined by the Secretary of State. We fully recognise that time will be needed before these measures can sensibly be introduced, the more so because of the major reorganisation of local and water authorities. The provisions of the Act will substantially extend the powers and responsibilities of these authorities and we realise that the money and the manpower that they will need to implement these powers will be difficult to find. Nevertheless we are anxious that the new measures should be brought to bear as quickly as possible; expenditure sooner rather than later on the needs of the environment may be wise economics as well as socially desirable. We urge the authorities to bear these needs in mind in their decisions on the allocation of resources.

23. We are concerned that the environment could suffer unduly in the present financial climate, because improvements will often take a long time to realise and because the benefits are usually unquantifiable in economic terms. It will always be tempting to argue, therefore, that action should be deferred in favour of expenditure elsewhere on projects which can be demonstrated to be essential or cost-effective, or which bring shorter-term benefit. Thus, if an estuary has been used as an open sewer and an industrial drain for generations, it may be argued that it does not matter very much if remedial action is delayed by a few more years. We believe, taking account of the risks of serious environmental damage, the sense of responsibility towards the natural environment and the demand of people for better surroundings, that this form of argument should be strongly resisted. At the very least there should be permitted no further deterioration in environmental quality.

24. The additional powers provided by the new legislation will enable controlling authorities to bring about progressively higher standards in the ways and at the pace that they judge to be appropriate to their local circumstances.

This empirical, "best practicable means" approach to the abatement of pollution is traditional in this country; it has served us well and has much to commend it. It can be argued that the alternative approach of setting statutory limits to emissions and effluents is, by contrast, inflexible, and may well be wasteful. It is not our purpose to argue this question here (though we note that the latter approach is used by some other countries within the European Economic Community so that pressures may develop for us to conform). We expect that we shall need to consider this basic question further in the context of a projected enquiry into arrangements for controlling air pollution to which we refer in Chapter V of this Report.

25. The world-wide nature of many environmental problems is reflected in the growing scale of international collaboration to grapple with them. There is, in fact, a somewhat bewildering array of international bodies concerned with various aspects of the environment. An outline of the work of some of these bodies was given in the Commission's Third Report; there have since been two developments that are of particular interest to us.

26. First, membership of the EEC has begun to impinge upon pollution control in this country. The UK is already bound by several directives. Two are concerned with the biodegradability of detergents and three others specify permitted levels and methods of measurement of noise and polluting gases emitted by motor vehicles, and the smoke emitted by diesel-engined vehicles. Further directives have been or will be proposed; some of these are mentioned in Chapter II. In the longer term the UK may be expected to benefit more broadly from the impact of the Community Action Programme on the Environment, adopted by the Council of Ministers in July 1973. The programme is a comprehensive one and its aims are high—to prevent or reduce pollution and nuisances; to husband natural resources and the balance of ecological systems; and to improve the quality of life and working conditions. The programme identifies a number of specific projects that should be completed within two years. Among these are draft recommendations on the implementation of the "polluter pays" principle; a preliminary report on pollution and nuisance caused by energy production; work on the pollution problem in the paper and pulp industry; and a study of the management and storage of radioactive waste.

27. We intend to keep closely in touch with developments in pollution matters within EEC, since these will affect our own studies. There are, for example, close parallels between our own projected enquiry into radiological hazards and the problems of radioactive wastes and the EEC study mentioned above.

28. Secondly, we welcome the progress that has been made with the United Nations Environment Programme (UNEP). Among the actions recommended by the UN Stockholm Conference on the Human Environment was the establishment of a Governing Council of the United Nations Environment Programme to ensure that the impetus gained at Stockholm towards the solution of global and regional environmental problems was maintained. The Council has recently agreed a programme which included proposals for international coordination in the development and provision of environmental monitoring and information systems.

29. These are important developments. There are great difficulties in arriving at agreed international programmes for the environment. There are great differences of view on priorities, especially between industrialised and developing countries. Yet it is only by agreements and concerted action between nations that many of the major environmental problems can be resolved.

CHAPTER II

REVIEW OF RECENT CHANGES IN THE ENVIRONMENT

Introduction

30. The Commission's First Report contained a chapter entitled "The state of the natural environment". This gave a brief survey of the state of environmental pollution at the end of 1970, and allowed the more important items for the Commission's attention to be seen in perspective. Nearly four years have now passed and it seems appropriate that, as a standing Commission, we should once again review the salient facts about the environment in the UK. Much of what follows has been published elsewhere, but in a variety of documents, not all readily available. Moreover, many publications are concerned with only one aspect of pollution whereas our remit enjoins us to consider pollution in all its forms.

31. Although this review was written in the summer of 1974, it was not always possible to obtain statistical information for 1973 because of the inevitable delays in collation and analysis of the data by the Government departments and other bodies concerned. Dramatic changes since the last review are hardly to be expected and in any event there are variations from one year to another caused by external factors such as climate and economic activity. In general, therefore, we did not try to establish numerical trends but sought rather to identify topics that because of changing circumstances and attitudes seem to merit more attention than they are at present receiving.

Population

32. In the First Report it was observed (paragraph 33) that the old problem of pollution had been exacerbated by "the growth of population and the spread of technology". The Commission recognised that an increase in population would compound the adverse effects of material affluence on the environment in the absence of deliberate measures for the control of pollution, especially in certain geographical areas.

33. In July 1971, the Lord President of the Council set up a Population Panel under the chairmanship of Mr. C. R. Ross, "to assess the available evidence about the significance of population growth for both public affairs and private life in this country at present and in prospect". The Panel did not consider the effects on pollution because of the existence of our Commission. We decided therefore that we should look at this question.

34. The Panel published its report in March 1973(8). Two of its main recommendations, that family planning should be incorporated into the National Health Service, and that a senior Minister should be appointed with responsi-

bility for population matters, have been accepted and implemented by the Government. The Minister led the UK delegation to the World Population Conference in Bucharest in August 1974. This was held by the UN which has designated 1974 as World Population Year.

35. The Panel envisaged that there would be a growth in the population of Great Britain from 54 million in 1971 to 64 million early next century, based on current fertility in 1971. Even if fertility were to decline to replacement level (about 2·1 children per family), the age structure of the population is such that numbers will increase to about 61 million in 2011 and would approach stability only slowly thereafter. For population to remain steady over the next 20 years, each woman would have to bear, on average, no more than 1·6 children, which is fewer even than in the 1930s when fertility was unusually low.

36. Thus a moderate increase in population—between 250,000 and 300,000 per year—seems to be probable. Such an overall increase can no doubt be accommodated, but its distribution in particular areas may cause some problems. On the assumption that future demands *per caput* for energy, for water, and for materials, are likely to be greater, waste products are likely to be generated at a faster rate. The capacity of the environment to absorb waste is, however, unaltered. Thus in principle it will be necessary to specify increasingly strict standards on emissions to air and water in order merely to maintain the current position. Unfortunately, since the cost of treatment rises sharply as the last few per cent of impurities are removed from an effluent, there will be an increasing burden on the community. This will be particularly evident in the cleaning of rivers, as the predicted doubling of demand for water between 1970 and 2000 will alter the pattern of flow and reduce the amount available for the dilution of discharges. Some areas of low rainfall and high population density will experience particular difficulties in this respect.

37. Whereas the UK as a whole is self-sufficient in water, we rely on other countries to supply about two-fifths of our food; the net cost in 1973 was about £2,700 million. Since the populations of the food-exporting countries are all rising, frequently faster than their food supplies, the question is posed whether we shall be able to continue to import food on the scale to which we have become accustomed. If not, then the demands on our own agriculture will be much more severe. For an expanding population not only requires more food, but more houses, roads and factories, and so urban areas may be expected to rise from about 9 to between 12 and 14 per cent of the total land area of the country early next century. The character of the countryside may therefore be expected to change, and the practice of agriculture will become yet more intensive, with a corresponding increase in the problems of waste disposal (see paragraphs 86–94).

38. The density of population within these islands is far from uniform, and moreover increases are occurring in the already populous areas where the capacity of the local environment to withstand pollution is under strain. It will be extremely difficult to find sites for noisy or smelly industries, as has been well illustrated by the search in south-east England for a place to build a third London airport. This planning problem will occur with increasing frequency in

the future when land, previously undeveloped, becomes needed for housing although it is not environmentally satisfactory. It is important to realise that the root cause of these conflicts is in many instances the increase of population and its pattern of distribution.

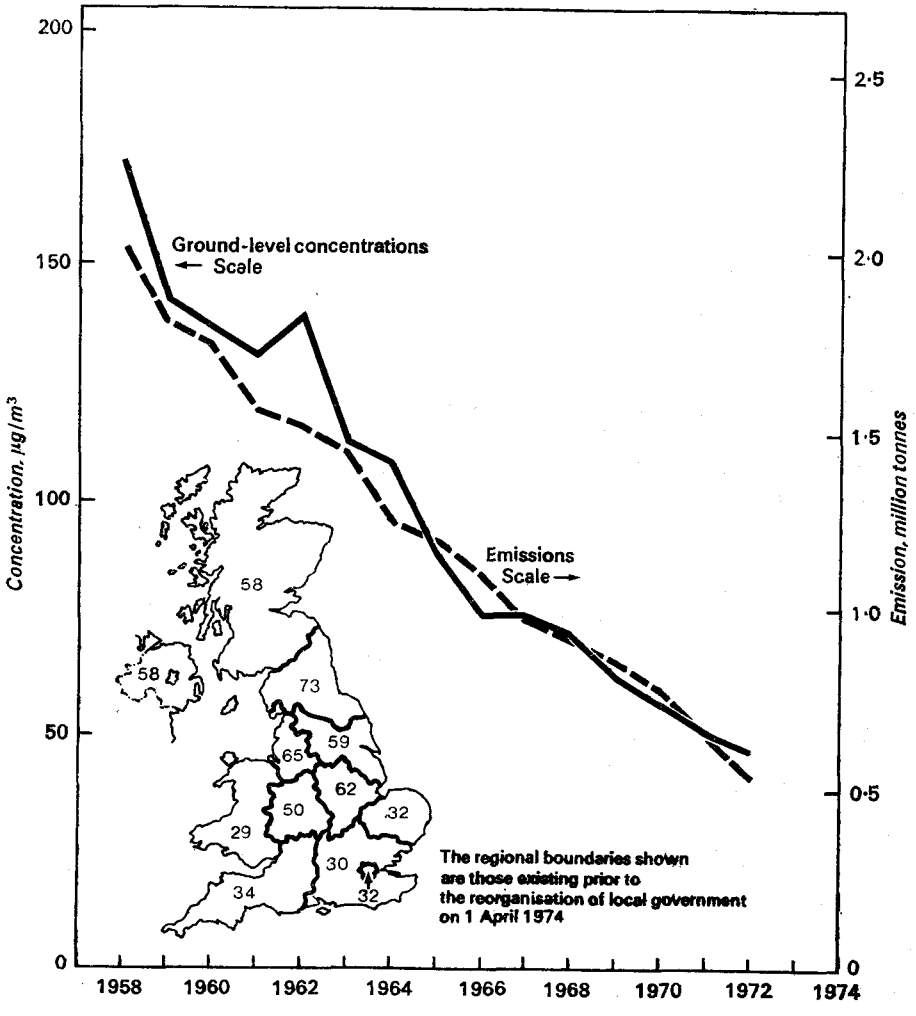
39. Thus although the increase in pollution consequent upon the increase in population may have little effect on health, it will have a substantial effect upon amenity. Considerations of pollution will need to inform policies on the re-distribution of population. They do not yet dictate a policy to contain the total numbers, but they do add force to the argument that a more stable population would be a wise national goal.

Air pollution from stationary sources

40. There is a National Survey of Air Pollution[9], with some 1,200 monitoring stations, which is coordinated by the Warren Spring Laboratory (WSL). At present smoke and sulphur dioxide (SO_2) are the main pollutants being monitored, but starting in 1975 20 of these stations will sample airborne sulphate particles. At 20 sites measurements will be made of a number of elements, including heavy metals, and three sets of equipment will be used to measure oxides of nitrogen, oxidants and hydrocarbons. The Commission's First Report gave smoke and SO_2 emissions and concentrations up to 1968, and these are updated to 1972–73 in Figures 1 and 2, with inset maps showing the urban concentrations in the 12 regions. Both emissions and concentrations of smoke continue to fall; they are barely a quarter of those in 1958–59. In London and the south-east particularly, progress in the elimination of bituminous coal burnt in open fires has been dramatic, and 95 per cent of Greater London is now covered by smoke control orders. It has been worthwhile to clean old buildings of their ancient grime, and the city has, in this respect, become more agreeable for living. Reductions in SO_2 have been less striking. Total emissions have risen slightly but a greater proportion is being dispersed through very tall chimney stacks, and the urban concentrations have fallen by over 40 per cent as a result. The acid gas has a corrosive effect on buildings and structures, but in the absence of smoke its effects on human health are difficult to demonstrate.

41. It is noticeable that although many cities in the north of England, such as Sheffield, have made tremendous advances, there remain others that have barely started to bring in smoke control orders. This is, presumably, because of social preferences and habits and the unwillingness of local authorities to exert sufficient pressure to change them. Major improvements have been made in some areas by industry. Teesside is an example, and Plate 1 shows typical conditions before and after the reconstruction of major works. Part of the "Teesside mist" was due to fine particles produced chemically from ammonia and SO_2 arising from the manufacture of fertiliser; this form of pollution has been virtually eliminated. Progress has also been made with the removal of much of the red fume that was formerly poured out from furnaces making steel by means of oxygen, as may be seen in Plate 2.

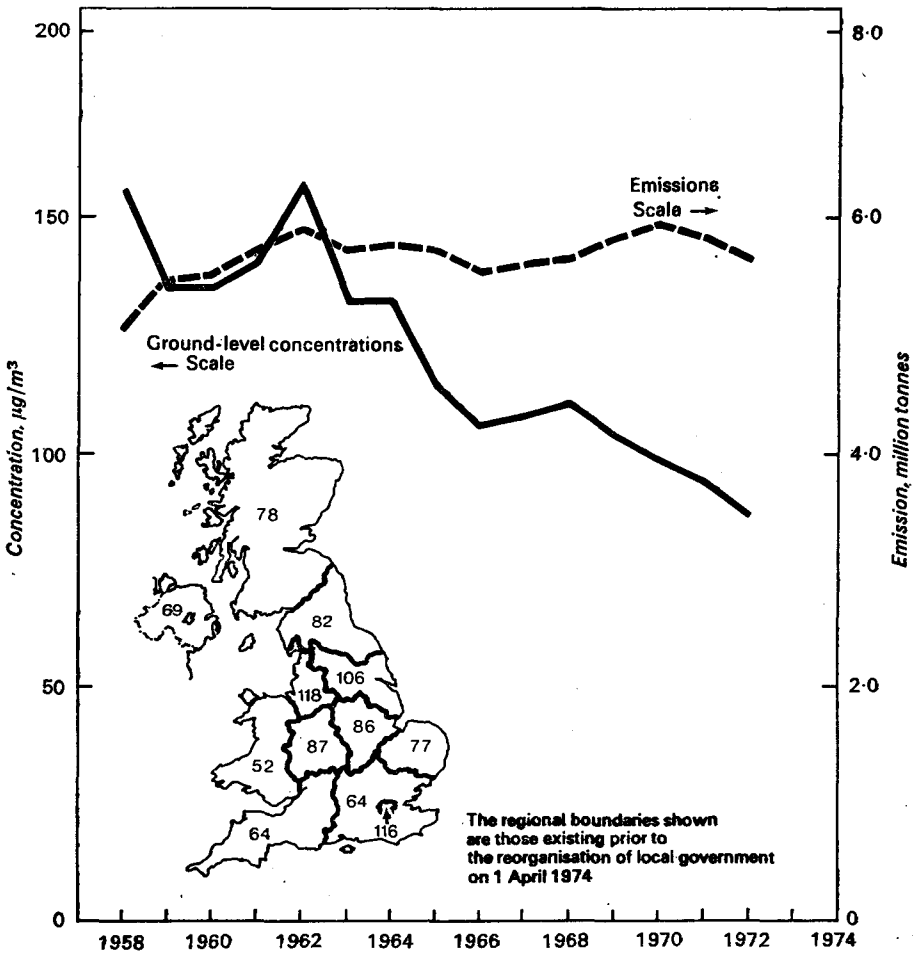
FIGURE 1



Smoke emissions and urban concentrations in the United Kingdom

42. The downward trends in smoke and SO_2 have been encouraged by implementation of the Clean Air Acts and the Alkali &c. Works Regulation Act. Difficulties remain, for instance where the designs of chimneys of office and other buildings have not taken account of the complex patterns of air flow that can result in cities (Plate 3). Another problem is that, in stagnant air conditions, SO_2 concentrations may increase markedly at ground level. A

FIGURE 2



Sulphur dioxide emissions and urban concentrations in the United Kingdom

further problem in some areas is the presence of dust and grit. Some industries, such as electricity and cement, have made substantial progress overall in the reduction of emissions over the last decade. Nevertheless, there are still numerous complaints in some local areas that the nuisance persists, and the National Survey of Air Pollution indicates that very little change in the measured deposition of dust and grit has occurred(10).

43. Epidemiological evidence continues to suggest that smoke and SO_2 interact in both causing and aggravating bronchitis. The great reduction in smoke concentration in the London region has led to a reduction in the number of extra deaths brought about by adverse weather conditions causing the accumulation of air pollutants. The change in the type of air pollution is strikingly illustrated in the table which summarises the conditions in London on three occasions, each in December, when pollution was unusually high:

TABLE 1

Year	*Maximum mean daily concentrations in Central London* $\mu g/m^3$*		*Estimated extra deaths in Greater London*[11]
	Smoke	SO_2	
1952	> 6,000	3,500	4,000
1962	3,000	3,500	750
1972	200	1,200	Nil

During the 1972 incident, hourly concentrations of SO_2 reached 1,700 $\mu g/m^3$ without significant public notice or complaint. The combined effects of smoke and SO_2 contribute also to the numbers suffering from chronic bronchitis. Together with the lowering of concentrations of these pollutants there has probably also been some improvement in sickness absence and mortality from this disease.

44. Air pollutants may adversely affect plants at concentrations that are tolerated by human beings. Gaseous fluorides such as hydrofluoric acid (HF) can cause damage to some susceptible species at airborne concentrations averaged over several months as low as 0·4 $\mu g/m^3$, which is less than is commonly found in industrial areas, but species sensitive to HF tend to be more resistant to the effects of SO_2. There are reports from Scandinavia[12] that the forests there are being adversely affected by SO_2 imported from other parts of Europe in the form of "acid rain". The source is not yet known with certainty, but the Warren Spring Laboratory and other organisations are studying the transport of SO_2 in the atmosphere above the North Sea. The results will be used in a study that the OECD are coordinating. Their published projections forecast a substantial rise in emissions of SO_2 in Western Europe between 1968 and 1980 in the absence of large-scale desulphurisation of fuel oil. The advent of North Sea oil, which is low in sulphur, may reduce this problem at least for the UK and Western Europe. However, in view of the potential economic importance of the effects of SO_2 on vegetation, it is surprising that they are so poorly understood.

* Microgrammes per cubic metre. For SO_2, 2,710 $\mu g/m^3$ at 1 atmosphere and 15°C equals one part per million (1 ppm).

by WSL in six cities[16] showed that concentrations above 10 ppm were exceeded frequently, but that 30 ppm was only exceeded, on average, for a few minutes each day. More recent measurements[17] by the GLC on Putney Bridge gave an average of over 30 ppm during the working day. Such a concentration will induce a blood carboxyhaemoglobin level of from 4 to 8 per cent of total haemoglobin. Such levels are considered undesirable for cardiovascular patients, although they have little observable effect on healthy people and are frequently exceeded by quite moderate smokers.

52. The pressure for higher standards for vehicle exhaust emissions results from an increased awareness of the need to preserve existing standards of amenity and to improve them if possible. This is one facet of the general problem discussed in paragraph 36. Increasing numbers of vehicles mean that each will be subject to progressively more severe (and correspondingly more expensive) controls. The problem is most acute in cities where it is becoming increasingly apparent that it is not possible to cater for their unrestricted use without engineering works on a scale that is socially unacceptable. We may therefore expect that limitations on their use in some urban areas will be imposed in order to safeguard the local environment. This will lead to a reduction not only in their exhaust gases but also of their noise, which many regard as a worse problem. This is discussed in paragraphs 151 and 152.

Waste disposal on land

53. **Industrial and general waste.** Most of the solid waste comes from the mining and extractive industries. It is largely inert material, which is deposited in spoil heaps, adding to an accumulation of several thousand million tonnes. Estimates of the masses generated in 1973 are shown below.

TABLE 2

Masses of solid waste arising in 1973, millions of tonnes

Coal mining	58
Mining other than coal	3
China clay quarrying	22
Other quarrying	27
Domestic and trade refuse	18
Industrial waste	23
Ash and clinker from power stations ..	12
	163

Over the last decade, the quantities of minestone from coal mining have remained nearly constant, the fall of production of coal during that period being matched by greater use of machinery generating more waste than hand-mining. China clay wastes (which are nine times the mass of the marketed product) have approximately doubled (Plate 4) and other quarrying has risen by three-quarters over the same period.

54. The industries concerned are making increasing efforts to dispose of their waste materials so that they may be of further use. This is trebly beneficial, as it reduces local accumulations which are unsightly and sometimes dangerous; it decreases the nation's dependence on primary extraction of non-renewable resources which frequently leaves dereliction in its wake (e.g. extraction of aggregates in England and Wales uses 4,500 acres per annum); and it makes available for constructive use land otherwise covered with unproductive spoil.

55. The major problem is nearly always the economics of transporting an essentially low-value commodity. Thus, although there is a shortage of building sand in south-east England, and an abundance of excellent sand (some ten million tonnes annually) generated from china-clay quarrying in Cornwall, it has been stated that it is not quite economic to move the sand by rail. If a large-scale movement of this type is to be undertaken, then all three parties (the seller, the carrier and the user) must derive some net benefit from the transaction. The amenity-value to the community has not hitherto been considered because none of the parties can count this directly in their analysis. Nevertheless, amenity-value is frequently used by Government as a justification for major and minor items of direct expenditure, and by public bodies who discharge their duties under Section 11 of the Countryside Act 1968. Social benefit subsidies would be particularly relevant to road building and maintenance, which in recent years have consumed more than 40 per cent of all the aggregates used by the construction industry. The DOE have introduced a system of alternative tendering in an effort to promote the greater use of waste materials, but it has had very limited success because of commercial considerations and because contractors are rightly reluctant to use those waste materials that do not comply with British Standard Specifications. We believe that the DOE could usefully examine how they might further encourage the use of waste materials; two matters in particular that merit further investigation are the underwriting by road construction units of the use of suitable waste materials in road construction, and the extension of British Standard Specifications and codes of practice to cover their wider use.

56. **Toxic and dangerous materials.** A number of wastes are poisonous to man or other forms of life, or interfere with natural processes in a deleterious manner. The major sources are industrial. In the Second Report, the Commission drew attention to the urgent need for strict control of the means of disposal of these wastes. Shortly afterwards, interim legislation in the form of the Deposit of Poisonous Wastes Act 1972 was passed. This required companies to notify the local authority (the disposal authority since 1 April 1974) of any noxious wastes for which disposal is needed. A further measure of control is provided for in the Control of Pollution Act, which requires all tips on land to be licensed by the Waste Disposal Authority (WDA) who are required to make a plan for the disposal or reclamation of all waste arising in their area, including toxic and dangerous materials. The existing notification and control procedure has been working reasonably well, with the result that a number of tips have been closed, particularly in the West Midlands; very few prosecutions have been necessary.

PLATE 5

Members of a Royal Navy mine disposal unit carrying away a drum of chemicals of unknown composition washed ashore on the beach at Polperro. *Keystone*

PLATE 6

Litter by the roadside in the outskirts of London. *Fox Photos*

PLATE 7

The reclamation of marshland surrounding Fleetwood Power Station, Lancashire, by means of pulverised fuel ash. *Photographs by courtesy of the CEGB*

PLATE 8

The construction of a section of elevated road in North London brings problems of noise to those who live nearby. *Fox Photos*

57. There is still considerable uncertainty about the amount of wastes being produced. Figures revealed by a recent survey of notifications exclude toxic wastes discharged to estuaries, which caused the Commission such concern in the Third Report. The amounts notifiable for deposit on land probably exceed three million tonnes per year, of which about a quarter are inflammable, another quarter toxic, and perhaps one-fifth acids or alkalis, but many of the wastes are very mixed or of unknown composition. However, this situation should soon improve as WDAs are required to make a survey of all wastes when formulating a plan for their disposal.

58. The DOEs toxic wastes section has recently been expanded and a series of working parties on individual types of difficult waste were set up in October 1973 with industrial representation in order to assess the quantities involved and to advise on modes of disposal or codes of practice. Since 1972 there has also been a substantial research effort into satisfactory methods of landfill, which is still the preferred disposal means for 90 per cent of notified wastes. Of the remainder, more than half is deposited at sea (mostly alkalis, soluble organic materials and sludges from effluent treatment); only about 1 per cent of the total is treated chemically or incinerated. Further restrictions on tipping will encourage the expansion of the chemical waste processing industry. Inevitably, however, the decision to site a treatment plant in a particular area will sometimes arouse intense local opposition on environmental grounds. This conflict is typical of the situation described in paragraph 38. In the absence of a national plan drawn up in consultation with local authorities there is a danger that the location of treatment plants may be based on short-term and parochial considerations.

59. **Advice on disposal problems.** Legislation to require polluting materials to be disposed of properly will succeed only if publicity is given to proposals for enforcement and if good advice is freely available to those who need it. Major firms can afford the services of specialists, but small companies may not be so well served and must generally rely on a local waste disposal contractor being available. Local authorities are the primary source of information, and would usually maintain a list of approved contractors. The DOE can offer some advice and refer enquirers to contractors' trade associations, and they are sponsoring an Industrial Waste Information Bureau at the Hazardous Materials Service (HMS) which has been operating from Harwell since 1970. A regular bulletin is issued to subscribers, who include local authorities, industrial firms and waste disposal contractors, and advice is also available on a consultancy basis. The HMS also provide certain emergency services, such as a chemical databank, a list of specialist personnel, a collection service—primarily for spillages—and a long-stop to the Chem Safe system. The latter has been operated since 1 January 1974 by the Chemical Industries Association to provide technical guidance for the civil emergency services (Plate 5). By contrast with all these provisions, the householder faced with disposal problems is very inadequately served. The Working Group on the Disposal of Awkward Household Wastes has recently reported and we endorse their recommendation that local authorities should take the initiative in providing more advice, and publicity for disposal centres.

60. **Lubricating oil.** If oil is permitted to pass into drains and sewers, it can be a serious pollutant of rivers and a source of trouble in sewage treatment works. Of the total UK annual consumption of 1·1 million tonnes (1971), about 500,000 tonnes of waste oils arise and of these some 370,000 tonnes are suitable for direct recovery. One-third arise from motor vehicles. It is desirable for the waste oils to be used productively, either to be reclaimed or used as a source of heat. Although they are generated in scattered locations, collection in urban areas where most of the oils arise might be economic if producers were willing and able to segregate and store them. The Working Group on the Disposal of Awkward Household Wastes thought that the burden of providing adequate facilities, especially for motorists who change their own oil, should be borne by local authorities. We note, however, that the EEC Commission has put forward a draft directive that would require networks of collection and disposal services to be set up, possibly subsidised from a tax on sales, levied on the "polluter pays principle". We are glad to see this problem commanding a fair amount of attention.

61. **Household refuse.** The mass of refuse collected annually is currently reaching 15 million tonnes. There has been an increase in numbers of households but a static output of weight from each. However, the increase in packaging has meant that volumes have increased by one half in the last ten years. The current composition is shown below.

TABLE 3

Average mass of refuse per household per week, kg (England)

	1973
Cinders, ash and dust	2·2
Vegetable and putrescible ..	2·1
Paper	3·8
Metal	1·0
Rag	0·4
Glass	1·2
Plastics	0·2
Other	0·7
	11·6

Forecasts of the likely composition in the future are not reliable, but it seems likely that, unless there are substantial changes in methods of marketing food and drink, the amounts of plastics and paper will tend to rise and that of cinders and ash will continue to decline.

62. The means of disposal employed is still predominantly landfill, as the table indicates:

TABLE 4
Disposal of household and trade refuse, 1972–3, England*

	%
Tipping	86·3
Incineration.. ..	9·5
Pulverisation ..	3·7
Composting.. ..	0·5
	100·0

About a quarter of the tip sites were not satisfactory—either because they did not conform to the DOE Code of Practice or because danger of leaching made them unacceptable to river authorities. The reorganisation of local government into larger units may be expected to improve the standard of tipping. If it is properly controlled, it can serve a valuable purpose in the reclamation or improvement of land, and from 1961–66 an average of 1,400 acres per year was restored. However, although suitable sites are available in the south of England—e.g. the Bedfordshire brick pits, to which trains are expected to take 300,000 tonnes per annum of London's refuse in 1976—there are shortages elsewhere. Pulverisation is increasing: it reduces the volume of refuse by only one-third, but permits it to be more readily used as landfill.

63. Greater reductions of volume are possible with incineration and pyrolysis. The former is practised fairly widely, but only a small number of furnaces are designed to recover heat from the flue gases, which tend to be very corrosive. As all forms of fuel increase in price, we may expect that the potential of heat from refuse (equivalent to that from six million tonnes of coal per year) will be more widely appreciated. Two recurrent difficulties, namely the need for a year-round market for heat and the unreliability of plant, are avoided if the refuse is converted into products that can be stockpiled and then burnt as needed in conventional furnaces. This is the object of pyrolysis, in which the refuse is heated in the absence of air to produce a combustible gas or oil and a char. Pilot-scale plants are in operation abroad, but only laboratory development has occurred in this country[18]. Recently it has been announced that the British Steel Corporation are studying the possibility of using redundant blast furnaces for this purpose.

64. Remarkably little research and development effort has been deployed in the field of collection and disposal of refuse; only about £400,000† was spent by central government in 1973–74 in comparison with an annual cost to the country of £170 million. A particular lack seems to be the provision of funds to enable novel plant to be tried on a large scale so as to provide operating experience. The need to design systems that can maximise the recovery of useful materials must be borne in mind, and the Control of Pollution Act enjoins waste disposal authorities to do this.

* Figures for Scotland not available.

† We have recently been told that Government expenditure on R and D on waste collection and disposal, including recycling, has been increased and is expected to exceed £1 m in 1974–75.

65. **Litter.** Litter cannot be regarded as an environmental hazard in the way that many pollutants can—although it would be a mistake to suppose that it can never be dangerous. But it is a disfigurement and a nuisance (Plate 6), and has been estimated to cost £50 million a year[19] to clear up. A poll of public opinion[20] commissioned by the Keep Britain Tidy Group* in 1972 revealed that those questioned selected litter in public places far more often than they did dirty rivers and beaches or foul air as the most unpleasant form of pollution. Nevertheless, despite legislation against dropping litter, with increased penalties, and the national and regional campaigns sponsored by the Keep Britain Tidy Group, the problem persists. That dramatic improvements are possible is shown by the example of Singapore, although conditions there are obviously very different. In October 1968 a one-month massive publicity campaign was organised, covering all sections of society and with every possible means of persuasion, to "Keep Singapore Clean". This immediately established very high standards and effected a real change in people's attitudes, especially those of the young. The new anti-litter laws were afterwards administered very strictly, and this was possible because of the new climate of opinion. At present in this country the litter problem is being kept within bounds by a war of attrition; for ultimate success a *blitzkrieg* may be required.

Reclamation of materials†

66. Materials recycling can reduce pollution in several ways. In the first place, if a waste product is removed from the environment it will no longer cause harm to it. For example, heavy metals present in sewage sludge that is applied to land as a fertiliser can damage the crops being grown[21]. There is a loss of amenity when plastics are seen littering beaches, riverbanks and hedgerows (Plate 6). Secondly, primary production can give rise to substantial pollution which is avoided with the use of secondary material. Land dereliction has long been associated with opencast mining for metals. Mercury may be released into surface waters where it is employed as a slimicide in the making of pulp from timber: it is not needed when waste paper is used instead. Thirdly, reuse of materials is frequently less demanding of energy than is the primary process, and the conversion of energy almost always entails some pollution.

67. The reclamation of materials is a large industry, although until recently it was an unglamorous one and often produced backstreet pollution, e.g. from the burning of insulation on copper cables. The table gives an approximate estimate of its importance in 1972.

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* The organisation that came to be known as the Keep Britain Tidy Group was set up by the National Federation of Women's Institutes in 1954. It has the support and encouragement of the DOE.

† Since this chapter was written, a Green Paper, "War on Waste: A Policy for Reclamation" (Cmnd 5727, HMSO, September 1974) has been published, and we are pleased to see that the views there expressed are similar to our own.

TABLE 5

Quantities of materials recovered as a proportion of production or consumption in 1972

	Production/ Consumption	*Recovery*	*Per cent*	*Approx. prices per tonne primary product*	
	Thousands of tonnes			1972	1974 (*April*)
Iron and steel	31,000	20,000	64	£13†	£19†
Aluminium	630	216	34	£240	£350
Copper	650	250	38	£430	£1,350
Lead	350	230	66	£120	£300
Tin	18	5	28	£1,500	£3,900
Glass	2,400	500	21	£5†	£8†
Paper	7,100	1,900	26	£11†	£25†
Rubber	450	75‡	15	£118–£211	£340

Much of the reclamation is reused within the industry itself; almost all the cullet (waste glass) used in glass manufacture, for example, is obtained in this way. Those industrial wastes that can be easily kept separate are normally reused already. Any major increase in materials recycling must be concentrated on domestic refuse, from which at present only 1½ per cent by weight is salvaged. Continuing price increases would improve the economics of reclamation of many materials.

68. **Metals.** At least 90 per cent of potentially recoverable ferrous scrap is already reused, but technical developments in the steel industry may make the poorer grades less saleable in the long term. At present there are 900,000 tonnes of tin cans in domestic refuse, and only a small proportion is recovered for melting to make cast iron; de-tinning is a possibility but is currently only practised on process scrap. This could increase in the future if refuse is sorted at recycling centres, as the magnetic properties of iron make it easy to extract. Among non-ferrous metals, copper and aluminium are often found together. They can be separated mechanically by a new process developed at the WSL, and the recent rises in raw materials prices have improved the economics of the process. The laboratory have also demonstrated that a number of non-ferrous metals may be satisfactorily recovered from effluent sludges by means of chemical treatment.

69. **Glass.** The main constituents of glass are limestone, sand and soda-ash which is made from brine. All are plentiful and are mined in the UK. However, the Glass Manufacturers' Federation have announced[22] that they intend to make greater use of cullet in the future; this will save some energy in the manufacturing process. Reuse of glass containers is probably a more satisfactory

† UK scrap/waste prices.

‡ This yields only 25,000 tonnes of reclaimed rubber.

long-term aim, but at present the vast assortment of shapes and sizes makes sorting impractical, except for some beverage containers. The change from imperial to metric sizes provides an opportunity for the British Standards Institution to draw up specifications for a limited range of standard reusable glass containers. This could be expanded gradually, and would greatly facilitate the reuse of glass containers, provided that adequate publicity were given to the new standards. This is but one example of the general need for packaging to be designed from the outset with a view to its eventual reclamation or reuse.

70. **Paper.** This is potentially the most fruitful area for increased reclamation of materials from refuse. It has been estimated by the Joint Waste Paper Advisory Council that some 69 per cent of current consumption is economically recoverable. In practice, only 26 per cent is recovered compared with 43 per cent in the Netherlands. Nearly all of this comes from the paper industry itself, and from trade premises by way of merchants; barely one-seventh comes from the one-third of local authorities who were collecting paper in 1974. In 1972, a total of three million tonnes of waste paper was not reclaimed, and had to be replaced with imported paper or virgin pulp at a cost of £240 million*. A report(23) by Pira† for the Department of Industry indicates that the long-term future of waste paper as a raw material is excellent. Using existing technology, UK manufacturers of paper and board could increase their usage of waste paper from 44 per cent to 58 per cent, and this would absorb a further 670,000 tonnes per annum, or nearly twice the amount now being collected by local authorities.

71. Local authorities are often hesitant to begin paper salvage because of uncertainties about future demand. Their confidence was badly shaken by the recession of 1971–72. Although the Pira report indicates that such a situation is unlikely to occur, a stabilising mechanism for the market, supported by the Government, may be a necessary precondition to stimulation of greater activity. A price-support system, such as was used for agriculture, might usefully be considered for other materials. The Department of Industry are currently appraising a scheme for the purchase and storage of excess stocks of waste paper put forward by the British Paper and Board Industries Federation. While we cannot comment on this particular proposal, we consider that some form of Government participation is justified by the potential benefits to the nation as a whole.

72. **Other materials.** Plastics can be recycled and the potential supply is one-third of the annual consumption in the UK of 1·5 million tonnes(24). Several companies, some assisted by the National Research Development Corporation, are being set up to do this. Usually a mixture of plastics is pulverised or granulated, and then heated, sometimes with another material, and pressed into the required shape. At the moment the major source of raw material is industry, which can provide wastes of uniform composition. Polymers such as PVC may disrupt some processes; it is almost impossible to segregate them from the present jumble of plastics in domestic refuse.

* Total imports were 6m tonnes at a cost of £484 million.

† The research association for the paper and board, printing and packaging industries.

73. Straw is another material that could be better utilised than at present. Of 9 million tonnes produced annually, 3½ million tonnes is burnt in a period of a few weeks. It often causes damage to wildlife and hedgerows and it gives rise to more atmospheric pollution than the 14 million tonnes of coal still burnt each year in domestic fireplaces. It might be made into paper-making pulp but, apart from organisational problems, there are severe technical difficulties with storage and with water supply, which is already critical in the east of the country where most of the surplus straw arises. Another possibility, as yet uneconomic, is its conversion to an ingredient in animal feedstuffs.

74. Reclamation of materials should not be pursued in isolation from the effort to make more efficient use of energy. This consideration should inform decisions on whether some kind of Government assistance should be given to aid processes that are currently not economic. The saving of energy leads as a rule to a reduction in air pollution. We therefore hope that the Advisory Council on Energy Conservation, which has recently been set up under the chairmanship of Sir William Hawthorne, will take this factor into account when it examines the possibilities in this field. Air pollution considerations could perhaps make a difference to the case for making use of the waste heat from power stations, where two-thirds of the energy in the fuel is at present dissipated in towers or cooling water. In several overseas countries district heating is widely practised, and there may be great potential in using the waste heat for agriculture or horticulture, such as growing tomatoes in greenhouses[25].

75. **Separation of materials.** Reclamation of materials is much more difficult if a mixture has to be separated. The best solution is for the householder to do this, and several surveys have demonstrated great willingness of people to cooperate[26,27]. There may, however, be problems of storage and handling whose solution would require some development work. We recommend that the DOE's Standing Committee on Research into Refuse Collection, Storage and Disposal give this some attention, as it does not appear from their first report (March 1973) that any such work is taking place. A second approach is to rely upon mechanical separation equipment to process straight refuse. Full-scale systems are in operation both in the US and in Europe, and, although they are mostly subsidised and have imperfections, they are yielding valuable operating experience. The most promising appears to be the "dry" system in Madison, Wisconsin, in which refuse is pulverised and then air-classified. Not only can paper be separated from other materials, but some grading of the waste paper can also be accomplished. Some work along these lines is taking place in the UK at the WSL, but the real need is for large-scale plant to be built so that the practical problems of operation and marketing of the products can be investigated. The Department of Industry, which can provide loans to industry for new plant and which is interested in reclamation, cannot themselves assist local authorities in this way because the latter come under the DOE. Recently, however, a joint committee has been set up to promote liaison between these two departments, and it is planning the creation of a Waste Management Advisory Council with strong industrial representation. We hope that this will enable large-scale experimental plant to be commissioned.

Land dereliction

76. As discussed in paragraph 11, we decided that we should review the state of land dereliction and progress in its elimination. An initial difficulty arises in defining those areas that are derelict. In the past the DOE have used a very narrow definition, namely, "land so damaged by industrial or other development that it is incapable of beneficial use without treatment". They excluded land being actively used as a tip, previous workings now fairly well blended into the landscape, and urban sites in the process of redevelopment. On this basis, the total derelict area in England was 97,000 acres at the end of 1971. The "Countryside in 1970" Conference adopted a much wider definition, retaining tips and dilapidated buildings, and including subsided and war-damaged land and any neglected or under-utilised areas; under this definition the total may be as high as 250,000 acres.

77. On 1 April 1974 the DOE widened the scope of its survey in England to include all active tips and mineral workings. Disused or abandoned railway land is now listed separately. The regular survey will no longer be annual, as it was from 1964 to 1971, but it should be a much more realistic measure than previously of the extent of dereliction and of progress in its elimination.

78. The Town and Country Planning Act 1947 brought tipping and mineral working under planning control. A General Development Order permitted certain existing operations to continue, but from 1948 most operations required specific permission and have been subject to planning conditions governing, amongst other things, their after-treatment and restoration. In recent years it has sometimes appeared that the present planning controls over mineral working are inadequate to achieve the desired results. For example, local authorities would like to be able to vary conditions in the light of changed circumstances without the present day compensation liabilities. In August 1972 the Government appointed a Committee on Minerals Planning Control under Sir Roger Stevens to look into the subject. The Committee is expected to report towards the end of 1974. Another body, the Advisory Committee on Aggregates, was appointed at the same time under Sir Ralph Verney. It has already issued a preliminary report which identifies some of the main constituents of the problem of the supply of aggregates for the construction industry.

79. Responsibility for restoring derelict land can be assumed by either counties or districts. In England much of the initiative has come from counties in the north and north-west, many of whom have set up specialist reclamation teams. Some districts, and former county boroughs like Stoke, have been active. Grants are available from central government funds to cover the majority of the loss incurred by the local authority at the following rates:

TABLE 6

	%
Development areas	85
Intermediate areas	75
National parks and areas of outstanding national beauty	
Derelict land clearance areas	
Elsewhere	50

In addition, part of the local authority contribution will be covered by rate support grant, so that the central government share may be up to 95 per cent.

80. To expedite this work the DOE set up in April 1970 a Central Group for Derelict Land Reclamation "to keep under continuous review the progress of derelict land clearance in England; to identify obstacles in the way of progress and to advise Ministers on how these can be removed". The areas of derelict land reclaimed during the last five years are shown in the following table:

TABLE 7

Acres of derelict land reclaimed in Great Britain

	England	*Wales*	*Scotland*	*Total*
1969	2,504	799	301	3,604
1970	3,645	827	329	4,801
1971	4,792	1,049	732	6,573
1972	5,360	985	414	6,759
1973	n.a.	1,560	622	n.a.

Plate 7 shows a recent example where a waste material has been used to reclaim marshland.

81. The acreages, although still small, are growing fast enough for the Central Group to estimate in their first report (July 1972) that most of the inherited dereliction in the worst affected areas would be restored by 1981. Adopting the fairly narrow DOE definition of derelict land, this prediction may well prove correct, but there will remain, at a rough estimate, 150,000 acres which are derelict according to the wider definition referred to in paragraph 76. Moreover, substantial areas of land are becoming newly derelict each year.

82. Open-cast metal mining on a huge scale in mountainous areas has been considered recently. It would cause immense destruction and would require correspondingly great works of restoration. The implications of such an activity were discussed by the "Commission on Mining and the Environment" under the chairmanship of Lord Zuckerman, set up by a consortium of mining companies, who reported in 1972.

83. For a limited period, between February 1972 and September 1973, "Operation Eyesore" enabled local authorities in assisted areas to provide employment and to effect a number of improvements in the appearance of neglected or unsightly land and to remove eyesores. Many buildings were cleaned and waste lands were cleared of rubbish and grassed. Over £45 million was paid from public funds. The scheme was remarkably effective, but, the original objective having been attained, it was deemed to be too costly to continue—normal expenditure on derelict land is only £12 million per annum. We would, however, urge that reconsideration be given to its reinstatement on a continuing basis, perhaps on a reduced scale.

84. **Wales and Scotland.** The situation here is broadly similar to that described above for England. The main difference is the existence of Derelict Land Units in Cardiff (since 1966) and Edinburgh (since 1970) which have executive as well as advisory functions. They stimulate local authorities to activity, provide advice and technical assistance, and pay the Government grants. They also conduct surveys of derelict land in Wales and Scotland, and the estimates of areas are as follows:

TABLE 8

Acres of derelict land in Wales and Scotland

	Wales	*Scotland*
Year of survey..	1969	1972
Total area derelict	19,000 acres	37,000 acres
Area justifying treatment ..	13,200 acres	25,000 acres

The Welsh unit are now mounting a new survey with more uniform definitions, and this suggests that the area derelict is twice that previously recorded (allowing for what has been reclaimed since 1969).

85. **Possible future action.** We would not wish to anticipate the recommendations of the Stevens and Verney committees, but we hope that they will be considered in the context of a general programme for the improvement of the environment. It would be of little value, for example, to reclaim land for housing if the local noise from aircraft was intolerably loud. Consideration might, however, be given to a survey of attitudes to dereliction set within the broader context of environmental pollution. This might show the economic penalties associated with the presence of derelict land, which could deter local investment, depress property values and encourage migration to other areas. Such information would be helpful in any cost-benefit analysis of the economic and social costs of rehabilitation projects which might not otherwise appear warranted on economic grounds alone. We note that the reclamation of derelict land in Wales and Scotland benefits from the respective Derelict Land Units which can provide for an exchange of information between districts and can prevent wasteful duplication of effort. We hope that the different administrative arrangements in England will nevertheless achieve the same goals.

Pollution from animal husbandry

86. The First Report drew attention to the rapid increase in the numbers of animals since 1946 and to the dangers of allowing their manure, particularly when diluted with water, to seep into drains and streams and cause pollution. It was concluded that farmers might need economic incentives to use the manure on the land; recent increases in the price of chemical fertilisers have already provided them. The more general problem of intensive agriculture was mentioned in paragraph 37; as population expands and available land diminishes we may expect that animal husbandry will also become more intensive and more specialised, so that the capacity of our farms to sustain growth in output without impairment of their ecological stability will increasingly be called into question.

87. **Cattle.** There are 14 million cattle in the UK, about half being dairy herd* and half kept for beef. They usually spend the winter months indoors or in covered yards, and during this time their manure and the wash water may cause pollution if it is allowed to run into watercourses, or if it is spread directly on land which is not able to absorb it. The manurial values, especially nitrogen, will be more effectively conserved if the manure is stored during the winter and spread in springtime. Some farms have no proper facilities for storage and so a continuing effort must be exerted to improve the position. A fundamental difficulty remains that much of the country's dairy herd is now in the west, and it is not economic to transport the manure, of which water forms a large proportion, across to the arable land in the eastern counties.

88. **Pigs.** Most of our nine million pigs are kept permanently indoors in intensive units. Some of these are on small sites so that special arrangements have to be made to dispose of their manure. The recent tendency for pig-rearing to move eastwards into arable areas where feed and bedding are readily available should help here. A difficult problem arises on some soils when high rates of pig manure are applied, because the copper added to their feed with the intention of improving feed conversion can subsequently damage the crops that are grown on the fertilised land. The disposal on land of sewage sludge contaminated by heavy metals can cause similar problems.

89. Traditionally, waste food has been used on a large scale after cooking as swill for pigs. This represents an excellent reuse of materials, as food on refuse dumps attracts scavenging animals and birds and increases the danger of disease being spread unless there is a very high standard of tip management. However, the swill may also carry a risk of disease to the pigs, especially if it contains meat or comes from abroad on ships or aircraft. There are regulations governing the preparation and feeding of swill. Collectors and processors of waste food have to be licensed annually and the requirements for the licence have been considerably tightened from 1 July 1974. Specially constructed centralised units for processing waste food would mean that pig-keepers would probably have to pay more for their swill and there might be considerable objection. These issues require further examination.

* Only about three million are cows in milk.

90. **Poultry.** In 1973 there were 144 million fowls in Britain. Of these, 58 million are broiler chickens which are kept almost exclusively at very high densities on deep litter which is increasingly composed of sawdust and wood shavings. Almost all their manure is returned to land with the shavings, which are broken down by bacteria, using nitrogenous compounds in the manure. The 52 million laying birds produce annually some 2·5 million tonnes of manure, of which 25 per cent is dry matter. This has been used as fertiliser, but an increasing proportion (now about 7 per cent) is being dried to 90 per cent dry matter and used as a cattle feed ingredient. The drying process is potentially lucrative because of the soaring costs of imported cattle feed, and, although a distasteful idea to some, it represents an environmentally sound reuse of materials, provided that adequate supervision is available to ensure that there is no health hazard to the cattle. The smells that can arise are very disagreeable and we are concerned that adequate means of combatting them should be employed in order to avoid adverse public reaction.

91. Use of chicken manure for anaerobic digestion to generate methane gas is not likely to be a viable process in this country. The capital equipment is expensive and requires careful supervision to ensure that the reaction proceeds under optimum conditions. Moreover the manure requires extensive dilution first, and then this large volume of dilute sludge has to be kept at around 35°C for up to 30 days in order to give satisfactory yields of methane. This is a much more attractive proposition in a tropical country than here.

92. **Planning and agriculture.** Agricultural buildings under 465 square metres do not require planning permission*, but buildings above this size do. Since 1 March 1973 there is no longer a requirement for planning authorities to consult with the MAFF Advisory Service, although their advice may still be sought in particular cases, and general guidelines have been published by the DOE. Thus there is a danger that planners with little experience of the countryside may not fully appreciate the effluent problems of modern intensive farming on small sites. The difficulty has been compounded by the reorganisation of local government on 1 April 1974 because rural districts have been subsumed in many instances into districts that are predominantly urban.

93. Animals and their products tend to smell, and when they are kept intensively or processed on an industrial scale, there may be a serious loss of amenity. With increasing pressure to develop land for housing purposes, there is thus a conflict with the need to preserve space around these activities. They are very necessary, but they are not desirable as neighbours.

94. **Technical progress.** The last three years have seen a vast expansion of research and development effort on the subject of farm wastes. The Agricultural Research Council and MAFF have sponsored a number of major projects, some of which are expected to continue, and the Agricultural Development and Advisory Service of MAFF have undertaken a major campaign of farmer education. We welcome this progress and hope that the detailed scientific investigations will not prevent a more fundamental examination of whether it would be possible to ensure that the wastes are generated close to where they can be used.

* Provided the building otherwise falls within the exempted categories (Class VI) of the General Development Order 1973 (S.I. 1973/31).

We also welcome the increased attention being paid to farm waste management in agricultural colleges. These developments have already led to a substantial drop in the numbers of agricultural pollution incidents, most of which are the result of mismanagement, and augur well for the future.

TABLE 9

Actions taken by river authorities against farmers (England and Wales)

	Warnings	*Prosecutions*
1972	555	148
1973	278	69

Pesticides and toxic chemicals

95. **Pesticides.** In the First Report the Commission said that they were convinced that, in place of the existing voluntary scheme, mandatory control of the agricultural and similar uses of all pesticides was desirable and, eventually, inevitable; they also emphasised the importance of a continuing appraisal of all pesticide use in the UK and said that they proposed to review progress on the phased replacement of the more persistent pesticides by less persistent alternatives. Since then, a survey of the non-agricultural uses of pesticides in Great Britain has been completed by the Department of the Environment and we have had informal exchanges of views with the Advisory Committee on Pesticides and Other Toxic Chemicals (which keeps under review all uses of pesticides) both on the question of controls and on the progress that has been achieved in phasing out the more persistent pesticides.

96. In the agricultural and horticultural area progress in reducing the use of the more persistent organochlorine insecticides in Great Britain has continued with a drop in estimated tonneage from 365 in 1966–68 to 250 in 1970–72*. The mean concentrations of the residues of the three main organochlorine pesticides found in human fat—BHC, dieldrin and DDT—have continued to decline([28]).

97. Our discussions with the Advisory Committee on Pesticides have to some extent modified the views expressed above. With the evident cooperation of the agrochemical industry and the continuing downward trend in the agricultural use of organochlorine compounds, to replace the existing voluntary system of control (the Pesticides Safety Precautions Scheme) with a statutory one does not appear to be justified at present. We are, however, conscious that the use of a voluntary system in the UK may encourage its adoption in other countries where it would not work so well.

98. In the non-agricultural field, however, the picture is more disturbing. For instance, in the period 1971–72 the annual quantity of dieldrin used in Great Britain, mainly by industry for mothproofing and wood preserving, was estimated to be 22 tonnes, which is greater than the amount used in agriculture

* Figures based on Pesticide Usage Surveys conducted by MAFF.

and horticulture. And due to a world shortage of a less persistent alternative (gamma-BHC) the figure for 1973 is likely to be more than double this. In general, we are concerned about the apparent lack of reliable information on the use of all biocides outside agriculture, the amounts used and the extent of their escape to the environment. We believe that there should be adequate oversight of their use and that Codes of Practice (which should provide for adequate labelling), where they are appropriate and do not already exist, should be drawn up and promulgated.

99. **Toxic chemicals.** Each year many new chemicals are introduced or manufactured in large quantity. Some of these are relatively harmless, but some are indisputably toxic and many more have effects that are largely unknown. It has been demonstrated on a number of occasions that the damaging effect of one pollutant chemical can be much enhanced if a second is also present, although sometimes the one may act as a partial antidote for the other. Since the medical evidence on the effects in low concentrations of well-known elements such as lead acting alone is not yet clear, reasoned judgement of the potential risks from possible interactive combinations of pollutant chemicals is not feasible.

100. The risks that can arise from chemicals were recently highlighted by the discovery that vinyl chloride could cause cancer experimentally in animals and had caused cancer in men who had been exposed to high concentrations in the air in the course of their work. Vinyl chloride is used to make polyvinyl chloride, a plastic which is used for many purposes, including food wrappings, water piping and bottles for beverages. Minute amounts of vinyl chloride are found as a contaminant of the finished product and pass from it into food and drink. Vinyl chloride itself has been used as a propellant for hair sprays and insecticides and has been detected in concentrations of the order of 0·1 ppm in the air immediately outside factories. All these amounts are tiny in comparison with those encountered in industry. Concentrations of the order of 50 ppm in air have been common and they have risen on occasions to 1,000 ppm when autoclaves were cleaned. The cancers that have been produced are an unusual type which normally affects only one or two people a year in the whole of Britain*. It would therefore have been possible to detect a hazard to the health of the general public without great difficulty if one had been produced and we can be confident that no serious damage has been done. The position would have been different, however, if any of the commoner cancers had been caused, such as cancer of the lung or stomach. In this case, the risk might not have been detected for many years, by which time the environment would have been materially polluted.

101. In the UK, the existing situation is that there are advisory committees to screen chemicals intended for use in food and drugs and for agricultural purposes. The Health and Safety at Work Act 1974 extends screening procedures to substances intended for use in the work place, and procedures exist for assessing the effect of chemicals discharged to water. There is at present no general power to prevent or control the use of chemicals that may have a deleterious effect on the environment, but reserve powers are provided in

* The tumour, or angiosarcoma, arises in the blood vessels of the liver.

Section 94 of the Control of Pollution Act. The Secretary of State will be able to make regulations to prohibit or restrict the importation, use or supply of any substance in order to prevent damage to man, animals or plants, or any form of pollution. This "long-stop" provision is intended to catch chemicals that slip through the existing or planned screening network. Enabling legislation of similar form is currently being prepared in a number of overseas countries, notably Canada, Sweden and the USA. Two countries, Japan and Switzerland, have gone further and require all new commercial chemicals to be subjected to biotoxicity and bioaccumulation tests and the results submitted to the Government before marketing is permitted.

102. The Commission suggested in the Second Report that an "early warning" system should be devised for this country, with the intention of forestalling damage to the environment from new chemicals. It was argued that certain classes of chemical should be treated with suspicion, and that there should be sustained monitoring of their impact on the environment as they were brought into use. The Commission also suggested a data bank containing information that would allow chemical structure to be correlated with environmental effects. The Commission invited The Royal Society to consider this idea in more detail. In April 1973 the Royal Society's British National Committee on Problems of the Environment held a discussion meeting([29]), and we are grateful to them for their response. In general, the idea of a data bank was supported, and the consensus was that it should be selective and utilise existing systems rather than begin anew. We endorsed these views and they have been adopted by DOE who have engaged consultants, the United Kingdom Chemical Information Service, to design and develop a national data bank. The national bank will be included in international data bank networks now being planned at the global level (the International Register of Potentially Toxic Chemicals of the UN Environment Programme (UNEP)) and European level (European Chemicals Data and Information Networks of the EEC). These may be seen as a specialised development of the International Referral System for Sources of Environmental Information which the UK has firmly supported and worked for since the Stockholm Conference and which was approved by the Governing Council of UNEP in Nairobi in March 1974. In effect, therefore, the UNEP International Registry of Potentially Toxic Chemical Compounds and its regional equivalents will be data networks made up of existing and newly-formed chemical data files in which network partners agree to hold information in a common format, in order to make it more readily available to users.

103. However, the data bank is only one part of the problem, and the need to foresee the effects of new chemicals remains. When a preventive system of screening is being drawn up, it is necessary to know what kind of questions to ask, and it is desirable for the questions and the answers to be internationally acceptable. A number of international bodies are currently giving this subject their attention, notably the OECD through its Sector Group on Unintended Occurrence of Chemicals in the Environment. A one-year study programme was agreed in April 1974 which will make an international survey of information needed to evaluate adequately the potential environmental effects of chemicals. The principal UK contribution is to be on effects other than biological toxicity

and will presumably include atmospheric chemistry and climatic changes. One example of such an effect was mentioned in paragraph 14, namely the action of freons on the ozone layer.

Pollution of inland waters

104. Since the First Report, the review of the state of cleanliness of inland rivers has been put on a more formal basis and the results of surveys in 1970 and in 1972 have been published[30,31]. The rivers are classified on the basis of their content of dissolved oxygen into four grades: unpolluted (1), doubtful (2), poor (3) and grossly polluted (4), and are tabulated by mileage. All stretches of rivers with a summer flow of at least a million gallons a day are included: in effect, this means that most significant rivers and tributaries are included to within a few miles of their source. In Scotland, a similar survey was published in 1972[32], but although four grades are again used, the definitions are not identical. (In subsequent surveys in Scotland, the criteria used for England and Wales will be employed.) The figures are reproduced below.

TABLE 10

Non-tidal rivers: comparison of mileages by chemical classification
(England and Wales)

Class	1958		1970		1972		*Changes*†, 1970–72
	Miles	%	*Miles*	%	*Miles*	%	*miles*
1	14,603	72·9	17,000	76·2	17,279	77·4	+254
2	2,865	14·3	3,290	14·7	3,267	14·7	− 13
3	1,279	6·4	1,071	4·8	939	4·2	−118
4	1,278	6·4	952	4·3	832	3·7	−123
Total	20,025	100·0	22,313*	100·0	22,317‡	100·0	

(Scotland)

Class	1968	
	Miles	%
1	2,473	77·8
2	442	12·9
3	167	5·2
4	99	3·1
Total	3,181§	100·0

* Larger total than 1958 because of greater accuracy of survey.

† Some minor adjustments have taken place between surveys of quality and mileage; this column records actual change in quality.

‡ There were also 1,545 miles of canals, of which 78 miles (5·1 per cent) were in Class IV (6·7 per cent in 1970).

§ Some 1,600 miles of rivers are not within purification board areas; of these not more than 1 per cent are believed to be in Classes III and IV.

FIGURE 3

Sketch map showing, hesvily dellneated, the continuous stretches of British rivers classified as poor (class 3) or grossly polluted (cless 4) in the 1972 survey[31,32]. The markings for England and Wales are updated from the maps issued with the 1970 survey[30].

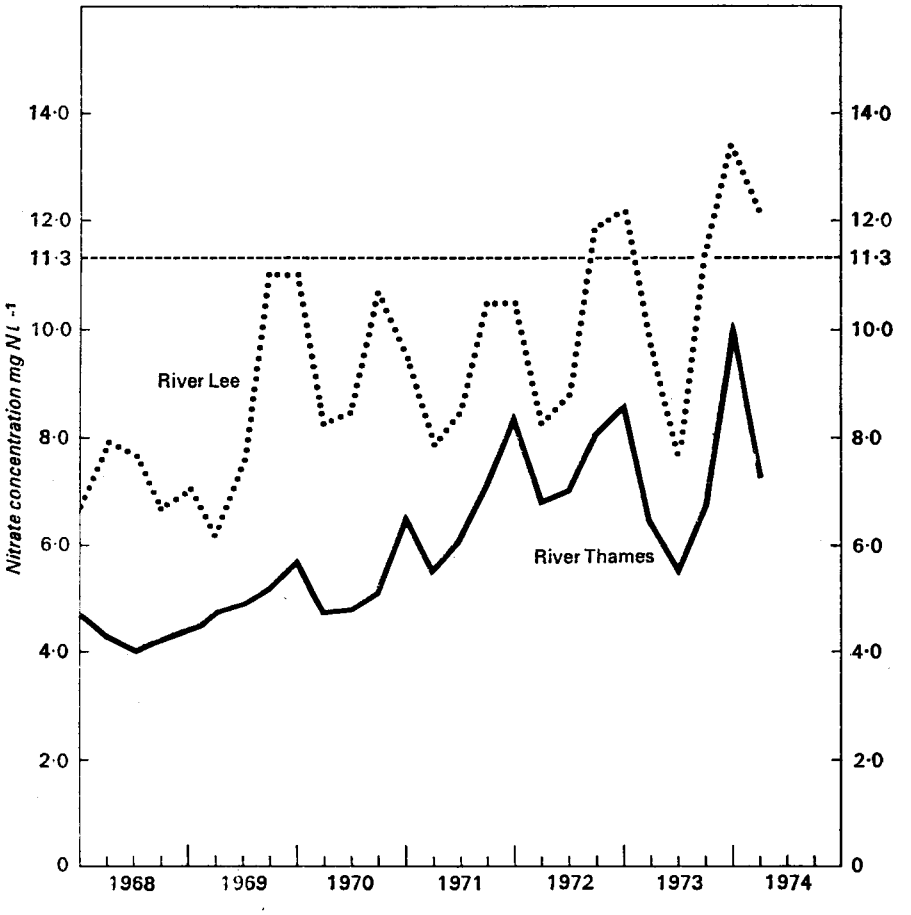
105. These figures show that, overall, advances are being made in the quality of rivers, but the more accurate data assembled in recent years do not yet span a sufficient period of time to establish clear trends, or to allow us to judge whether the present rate of improvement is satisfactory. Between 1970 and 1972 major improvements were made, for example, in the condition of some rivers in the former Trent and Devon River Authority areas, but in England and Wales as a whole, for every seven miles of river improved, one mile has deteriorated. In Scotland, although only 6 per cent of rivers overall are poor or grossly polluted, this figure rises to 20 per cent in the areas of the four river purification boards with the greatest concentration of population. Thus the general pattern is not very clear from the tables alone and Figure 3 has been drawn to show where the Class 3 and 4 rivers are located. This figure is based on the maps issued with the 1970 survey results; revisions made in the 1972 survey have been incorporated.

106. The surveys are carried out in terms of mileages. As the reports themselves acknowledge, this introduces a basic distortion of the true degree of pollution since it is often in the lower reaches of rivers, with their larger flows, that the worst pollution occurs. The table shows that only 7·9 per cent of non-tidal rivers were of poor quality or grossly polluted, but it is probable that the percentage volumes of polluted water would have been much higher. Measurement by length is a yardstick that is both relatively easy to determine and to understand. But we suggest that it is not necessarily the best criterion of the condition of our rivers. The value of the surveys would be improved if the percentage lengths in the four classifications could be broken down to show the broad ranges of volume of flow (based on summer norms) in which they occur. One million gallons a day is rather a small river and would not provide much by way of an amenity. By way of comparison, the Cam at Cambridge has a mean summer flow of 30 million gallons per day and the Thames at Teddington, 630 million gallons a day.

107. A recent report by the Water Resources Board(33) estimated that, by the turn of the century, a further 10 million cubic metres of water per day will be needed for public water supply. There is no absolute shortage, but rather a problem of distribution from the wetter regions in the west to the drier areas in the east of the country. The Board believed that if the quality of some rivers, notably the Trent, were improved sufficiently they could carry water suitable as a source for public supply to the points of heavy demand in their lower reaches. This would avoid the need for abstraction high upstream with the heavy building and maintenance costs of lengthy pipe lines. Successive Governments have accepted the need for a general improvement in the quality of our rivers. For a river not needed as a source of potable water, the benefits of cleansing will be greater if there is a general environmental improvement in the area embracing air, land and water.

108. **Nitrates.** The nitrate concentration of rivers was reviewed in paragraph 57 of the First Report: we have noted some discussion of the problem recently(34) and therefore return to it in more detail. Nitrates present in rivers can arise from several natural sources, and they are a normal component of a well-oxidised sewage works effluent. In some lowland rivers of the south-east, con-

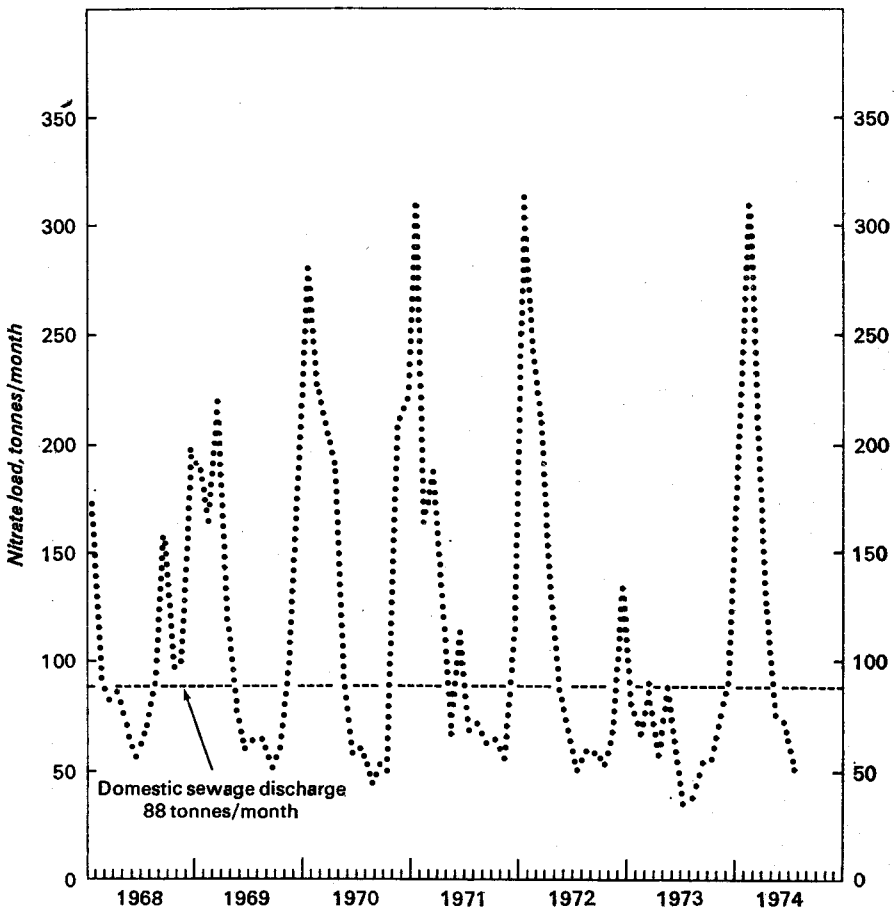
FIGURE 4



Nitrate concentrations in River Lee and River Thames
Quarterly averages

centrations have risen steeply during the last three years, as may be seen in Figure 4. The main reason for concern has been the danger to bottle-fed infants, who can contract infantile methaemoglobinaemia (the "blue-baby" disease) by drinking water containing high levels of nitrates. Current WHO standards recommend that water should not be used for public supply if nitrate concentrations exceed 22·6 parts per million (measured as nitrogen), and half this concentration is regarded as a desirable upper limit. For short periods early in 1974, the nitrate concentrations of the River Thames and River Lee both rose above 11·3 ppm and the Metropolitan Water Board (now the Thames Water Authority) ceased abstraction and relied upon reservoirs for public supply. Because of the increasing demand for water in the south-east, provision of low nitrate water may become rather expensive. There is also evidence that nitro-

FIGURE 5



Nitrate loads in River Lee at Lee Valley Road
Monthly averages

samines can be produced in the body through the action of bacteria on nitrates. These form nitrites and hence, with amines, nitrosamines, some of which are known to be powerful carcinogens. Whether this is an actual risk to man remains to be seen.

109. The immediate causes of the rise in nitrate levels are largely climatic—mild winters which favour the breakdown of organic matter in the soil and the recent pattern of low rainfall, with low river flows to dilute the steady load from sewage treatment works. The nitrate load in the River Lee is shown on a monthly basis in Figure 5. It is clear that there is a very wide seasonal variation, with the greatest amount entering the river in the winter. Thus domestic sewage, which imparts a nearly constant load throughout the year, and inorganic nitrogen

fertilisers, which are seldom applied before March, can hardly be responsible for the recent seasonal increases. The close correlation of nitrogen tonnage with river flow strongly suggests that natural run-off from the land and from urbanised areas is the main source of nitrates. There is little that can be done to control these diffuse sources, but a start has been made to reduce the nitrate content of the sewage effluent at Rye Meads which serves several large towns. The aeration of some sections of the activated sludge treatment is reduced and bacteria that can reduce the nitrates to nitrogen can then flourish. Although some 80 per cent of the nitrogen is thus removed from the sewage effluent at no additional cost, the nitrate from the diffuse sources which is much the greater load in wintertime is unaffected. This could only be removed (at considerable expense) when the water is extracted from the river and treated for public supply. However, at present the nitrogen balance in the river is not well understood, as the estimated total potential load from all known sources far exceeds the amount actually observed. There is therefore an urgent need for more research into the processes of denitrification that occur naturally before large amounts of money are invested in particular technological solutions.

Pollution of estuaries and tidal waters

110. The Commission studied the problems of estuaries in some detail in the Third Report, and they also commissioned a study of the particular problems of four heavily polluted ones, the Tees, Mersey, Humber and Clyde. This was published in February 1973([36]). We have ourselves visited the Tyne estuary and seen evidence of progress in the cleaning of this river. In the paragraphs that follow, we review briefly the current state of pollution of the major estuaries and tidal rivers and note what is being done to improve them.

111. The DOE survey of tidal rivers in 1972 revealed that there had been very little progress since 1970, but that some lengths that were of doubtful quality in 1958 had recovered from pollution by the 1970s:

TABLE 11

Tidal rivers: comparison of mileages by chemical classification (England and Wales)

Class	1958		1970		1972		*Change, 1970–72 miles*
	Miles	%	*Miles*	%	*Miles*	%	
1	720	40·7	862	48·1	880	49·4	+18
2	580	32·8	419	23·4	414	23·2	− 5
3	250	14·1	301	16·8	253	14·2	− 3
4	220	12·4	209	11·7	236	13·2	−10
Total	1,770	100·0	1,791	100·0	1,783	100·0	

(See notes to Table 10 on page 34)

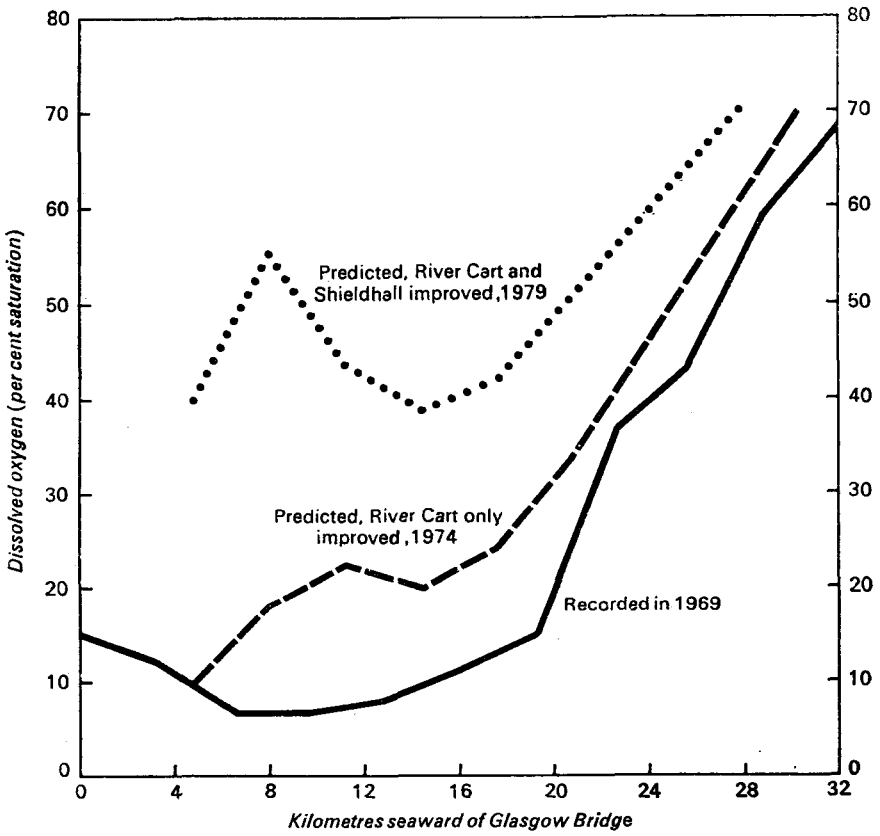
In Scotland, the only major polluted estuary is the Clyde, although parts of the Forth are also of poor quality.

112. The reorganisation of water authorities in England and Wales on 1 April 1974 has simplified the administrative arrangements for control, and only two estuaries—the Humber and Severn—are now the joint responsibility of more than one water authority. Negotiations are taking place to set up appropriate machinery for coordination. The old river authorities had made arrangements to work together, and a Tidal Waters Order for the Severn had actually been submitted in March 1974. This would have permitted all discharges, including pre-1960 ones, to be subject to control, but it has recently been overtaken by the Control of Pollution Act which, when the relevant part of the Act is brought into force, will provide water authorities generally with such powers.

113. Domestic sewage and industrial effluents are the twin causes of pollution in all estuaries, although sometimes the former dominates, as in the Tyne and Thames, and sometimes the latter, as in the Tees. Thus a plan for cleaning an estuary must embrace both sectors. The responsibility for industrial effluents generally lies with industry, and the new Act will be of assistance both in controlling direct discharges and in regulating what is put into public sewers. The water authorities on the other hand have inherited the responsibilities for collecting and treating domestic sewage from the multitude of municipal corporations and sewerage boards, and they will have to meet the cost of the necessary capital works. At present there are unusually severe restrictions imposed by the Government on what may be spent. As certain measures to provide water supply and sewerage to new housing are clearly essential, the various programmes to remove raw sewage from tidal rivers, which cannot be used as a source of mains water, have been delayed. This may be expected also to cause delay in the control of industrial discharges, as the moral position of a water authority that is attempting to dictate stiff consent conditions to an industrial firm will not be a strong one if it is itself permitting grossly polluting domestic discharges. Conversely, if domestic discharges are being improved then it is reasonable to expect industry to treat its effluents to a good standard. Thus on the Tees, although domestic sewage accounts for only a small fraction of the total oxygen demand of the river, several new sewerage schemes and treatment plants are in operation or under construction, and the two major industries, ICI and British Steel, have undertaken to halve the amount of polluting matter discharged by 1975–76 from the 1971–72 level.

114. Decisions on what standards of sewage treatment to specify for new works and where they should discharge, and on consent conditions for industrial effluents, must be made on a rational basis. One technique that may enable this to be done involves the preparation of a mathematical model of the river or estuary. Simple models allow the "sag" curve of dissolved oxygen to be predicted for any given pattern of polluting discharges. Figure 6 shows the improvement that is expected to occur on the Clyde, for example, when the sewage treatment works at Shieldhall provides secondary treatment. It is a necessary condition for the passage of migratory fish that there should be an adequate reserve of dissolved oxygen to counter any sudden pollution load. More advanced models permit the estimation of ammonia, which can be toxic to fish, and of heavy metals and persistent organic chemicals which are retained in

FIGURE 6



Predicted effects of reducing pollution loads on dissolved-oxygen levels in the Clyde Estuary

bottom muds and sediments and therefore may take some years to flush away. We are pleased to note that most industrialised estuaries have such models either in use already as a management tool or in preparation: the one notable exception is the Humber. The model for the Tees is also being used for a major university research project sponsored by the DOE on the feasibility of controlling industrial discharges by the levying of payments at appropriate levels. It was recommended in the Commission's Third Report that the Government should examine the case for such a charging system.

115. Our concern is that the cleaning of estuaries has so far been allotted such a low priority by the Government. There seems not to be the sense of commitment to a timetable that has been manifest, for example, in the clearance of derelict land in Scotland, where a 15-year programme was shortened to ten years on the instructions of the Secretary of State[37]. The scale of the problem

of our polluted estuaries is such that substantial progress is hardly possible without a long-term programme of Government encouragement and support. The Thames is still classed as poor despite the efforts of the PLA and GLC to clean it, and to advertise the fact with fishing contests. However, between 1972 and 1975, new works at Beckton and improvements elsewhere will have halved the oxygen demand and brought long stretches up into Class 2. The rivers flowing into the Humber carry an immense load of pollution, and some of them are getting worse. The Tyne in some parts is an open sewer, and in warm weather the stench can be intolerable. No salmon run to Glasgow, although the city's coat of arms reminds us that they did so once.

116. The state of cleanliness of our beaches is often unsatisfactory. While there is general agreement that the medical hazard to bathers is negligible, even in those resorts where raw sewage is discharged above low water level, the aesthetic objections to the practice are general. Long sea outfalls have been the subject of extensive research, and they are often the most satisfactory way of disposing of domestic sewage. Toxic discharges from industry are another matter, and water authorities should not adopt the easy solution of removing pollutants from estuaries by the expedient of pushing them round the corner.

Pollution of the high seas

117. Whereas in the First Report the Commission observed that some "isolated and stagnant basins within largely land-locked seas" were showing major changes due to pollution, a number of reports are now appearing that suggest that plastic refuse and oil residues are present all along some oceanic shipping routes, and that local concentrations of heavy metals in the waters off industrialised countries may be affecting marine life. Some people have expressed concern that the major oceans might be seriously disturbed by man's activities.

118. Since the First Report, a number of conferences have been convened by the Intergovernmental Maritime Consultative Organisation (IMCO) and by individual governments in order to formulate conventions to control what may find its way into the sea, either by accident or by design. These are described below, but it is important to remember that the IMCO conventions affecting ships do not generally come into force until they have been ratified by at least 15 countries, representing half the world tonnage of merchant shipping. This process can cause delays of several years, although a number of states, including the UK, have implemented conventions for their own ships even before they are in force internationally. Moreover, up to now it has always been an accepted principle that, where a vessel discharges oil on the high seas, in contravention of treaty provisions, discipline will be administered by the state in which the vessel is registered, rather than by the one whose coastline or fisheries may be affected by the discharges. The coastal state has therefore only been able to control discharges from foreign vessels in its own territorial waters.

119. An outline of the international agreements and proposals relating to the prevention of pollution of the high seas was given in Appendix B to the Commission's Third Report. Since then there have been several further international agreements. In September 1972, the United Kingdom implemented a recom-

mendation by IMCO about routeing schemes to separate opposing streams of sea traffic(38). The schemes affected included those in the Dover Strait and its approaches, as well as ones in other parts of the world. The effect was to make the right-hand side obligatory for UK shipping in the Dover Strait instead of advisory, which it had been since 1967. This was a further step in reducing the likelihood of collisions at sea, among the consequences of which could be serious oil pollution. Since then other countries have also implemented this recommendation.

120. The expected world-wide convention on the prevention of marine pollution by dumping of wastes and other matter at sea was concluded in London in November 1972. On similar lines to the earlier Oslo Convention, which had been negotiated between countries with North East Atlantic and North Sea seaboards, the London Convention was a concerted attack on marine pollution, not only by preventing uncontrolled dumping at sea but by drawing attention to all sources of pollution of the marine environment. The Dumping at Sea Act 1974, which enables the Government to ratify the Oslo and London Conventions, came into operation on 27 June 1974.

121. Another new piece of legislation is the Merchant Shipping Act 1974, which among other things enables the UK to implement the 1971 amendments (described in Appendix B to the Third Report) to the 1954 IMCO Convention for the Prevention of the Pollution of the Sea by Oil.

122. In October 1973 an international conference convened by IMCO met in London and concluded a new International Convention for the Prevention of Pollution from Ships 1973. The new instrument aims to reduce substantially the amounts of oil and other noxious substances, including refuse, that are discharged at sea from ships and rigs*. No oil discharges at all, except from very small ships, may be made in certain relatively enclosed seas like the Baltic and Mediterranean. Most of the ships comprising the 15 per cent of world tanker tonnage not practising the "load-on-top" system† are to be adapted to use it. New tankers over 70,000 tonnes deadweight will require separate ballast tanks, and the subdivision and damage stability regulations are tightened so that less oil will be lost in the event of collision or stranding. There are also provisions on the discharge of sewage and refuse in coastal waters.

123. Under this convention (which has been signed but not yet been ratified by the UK), a coastal state is empowered to punish violations by foreign vessels within its jurisdiction so that, whilst this is construed by the UK as limited to territorial waters for the time being, it is possible that this jurisdiction for the purposes of pollution control may be widened as a result of the UN Conference on the Law of the Sea which opened this summer at Caracus. This could well

* However, discharges of oil or minerals arising from exploitation of mineral resources of the sea bed are not covered.

† Under this system, the water used for tank washing and for ballasting dirty cargo tanks is collected in slop tanks where the water is allowed to separate from the residual oil before discharge. The new cargo of oil is then loaded on top of the residual oil retained in the slop tanks. To prevent explosions, an inert gas atmosphere is needed in the tanks being washed.

be of extreme importance for the UK in view of the very large numbers of foreign vessels that pass along sea routes off our shores.

124. A further step forward was achieved when a convention for the prevention of pollution of the seas arising from land based sources was signed in Paris in June 1974 by the countries with North-East Atlantic and North Sea seaboards, as well as countries with rivers flowing into these seas. Under its terms, the contracting parties undertake to eliminate pollution of the seas up to the freshwater limit through the discharge of specially noxious substances such as organohalogen compounds, mercury, cadmium and persistent synthetic materials, oils and hydrocarbons and to limit pollution through the discharge of other less noxious or less persistent substances.

125. **North Sea oil.** Although pollution of our coasts by oil spills is now almost a routine occurrence, and derives mainly from the transport of oil by sea, offshore exploration and production from UK coastal waters raises a completely new possibility of environmental pollution. We have therefore decided to review briefly the various risks and what is being done to contain them. We have had some informal talks with representatives from the Department of Energy, and we have visited north-east Scotland in order to see something of the work at first hand. No release of oil, however small, is permitted under the Prevention of Oil Pollution Act 1971; despite extensive exploration, there is no evidence that any significant amount of oil has yet escaped, and it would have been easily visible had it done so.

126. The worst oil release so far occasioned by offshore oil operations occurred in the Santa Barbara Channel off California. The loss of oil was probably about 10,000 tonnes, although some estimates have put the figure as high as 100,000 tonnes. In the North Sea the geological formations are different, so that this particular type of release is less likely; moreover, higher standards of care are exercised here, both by the Government and by the oil companies. The oil is, however, to be taken from unusually deep and stormy seas, which will make additional demands on men and equipment. There are therefore other dangers of oil pollution for some areas of the UK and of neighbouring countries.

127. The biggest spillage of oil to affect this country arose through the *Torrey Canyon* disaster in 1967. The tanker contained about 117,000 tonnes of crude oil when it went aground. All of this oil was lost, but some volatilised before it could reach a shore and by good luck with the winds a great part of the oil was carried to the Bay of Biscay where it was either sunk or dispersed. About 13,000 tonnes of oil reached Britain and about 20,000 tonnes reached France and the Channel Islands and, since the parts of the oil most toxic to marine life had evaporated before they could come ashore, the main damage was that done to amenities by the oil and to marine life by the detergents used to clear away the oil. This and other past disasters are described in Table 12 (for which we are indebted to Dr. Molly Spooner and Mr. David Moulder) which shows that the consequences of an oil spill depend on many factors, including the weather conditions, the type of oil, where it is spilt, how it is treated, the time it takes to reach land and the kind of shore on which it is stranded.

128. It might be thought that oil released in the North Sea oilfield could not come ashore, but there is little reason to accept this view. In the *Torrey Canyon* disaster the most extensive fouling of beaches occurred in Brittany and the Channel Islands. The oil, as water in oil emulsion, a persistent "chocolate mousse", had been 24 days on the surface of the sea before being stranded and had travelled about 230 miles altogether and covered a distance of 130 miles. These distances are greater than those that separate the coast of Scotland from the North Sea oilfields. It is, for example, only about 100 miles from the Forties Field to Peterhead, and 160 miles to the coast of Norway.

129. There are at least four ways in which a major oil spill can occur—blowout from a well, rupture of an oil storage tank, fracture of a pipeline, and an accident involving an oil tanker. Elaborate precautions are taken by the companies against blowouts, and these precautions are approved in advance, and their observance is monitored during drilling, by Government inspectors. In the unlikely but conceivable situation in which the blowout occurs too quickly for the blowout preventers to be operated, it may be necessary to drill an intersecting well* to seal off the leaking one, and perhaps 1,000–2,000 tonnes of oil might escape each day for several months. The escaping oil and gas would normally be set alight (if it were not already on fire) in order to obviate the possibility of an explosion. If the well was a production one, then the oil would be led to the surface through the riser and would burn readily and cause little marine pollution. However, the relatively light riser used for exploration wells would soon fail, and it is not clear how readily oil would burn that had come up through 100–200 metres of seawater. There would probably be substantial marine pollution in this instance, and the burning oil would inevitably hamper the drilling of an intersecting well.

130. Marine storage tanks and oil platforms are designed, of course, to withstand huge surface waves, and in most designs the oil tanks are well below the keel of even the biggest ships. However, in certain circumstances they could suffer great damage if struck by a ship such as a supertanker, and this might rupture one or more of the many cells, each containing some 10,000–15,000 tonnes of oil, into which they are subdivided. The zone around each installation prohibited to general navigation has a radius of 500 metres, far smaller than the distance required by a supertanker to make a substantial change of course or to stop. The chances of a collision are currently being assessed by the Department of Energy. A further hazard to a production platform arises from the plant used to separate the oil from gas and other products. There is a remote chance that a failure in a high pressure gas line could cause an explosion, and this might in turn set off a chain of events that would cause a big oil spill.

131. Pipeline fractures present less of a hazard than might be supposed, as pumping would be stopped as soon as the reduction in pressure was detected. The oil will normally contain gas dissolved under pressure. If this is lower than the external water pressure, i.e. the water depth exceeds about 90 metres, then a few thousand tonnes of oil may escape under gravity; if the water is shallower,

* The two wells do not actually have to intersect, but the second well must strike the reservoir rock within 10–20 metres of the first.

TABLE 12
Summary of spills and their effects

Name Date Location	*Type of pollutants and quantity*	*Economic effects*
1. *Torrey Canyon* Tanker March 1967 W. English Channel and Bay of Biscay 9–10°C	Kuwait crude oil 117,000 tons spilt 12,000 tons detergent and 3,000 tons "craie de Champagne" used "Mousse" 80 per cent water-in-oil	Cost of cleanup French fish market upset by rumour Minor effect on shell fisheries
2. Santa Barbara Oil well blowout January 1969 onwards California coast Temperate	Crude oil 10,000–110,000 tons Wide estimates of loss Some low-toxic dispersants used "Mousse" 50 per cent water-in-oil	Cost of cleanup including pleasure boats Some effects on tourist trade Fishery effort temporarily reduced, no long-term effect
3. *Tampico Maru* Tanker March 1957 Baja California, Mexico	Dark diesel oil 8,000 tons In small cove emulsified by surf Oil droplets in water	(Site remote from human activity)
4. West Falmouth Oil barge September 1969 Buzzards Bay, Massachusetts, USA	No. 2 fuel oil 41 per cent aromatic 600–700 tons Emulsified oil-in-water	Cost of cleanup
5. Anacortes Oil barge leak April 1971 Puget Sound, USA Temperate	No. 2 diesel oil 750 tons Dispersed by surface currents, calm Not obviously emulsified	Cost of cleanup
6. *Arrow* Tanker February 1970 Chedabucto Bay, Nova Scotia 0°C	Bunker C oil 10,000 tons spilled 6,500 tons offloaded from sunken hull "Mousse" 30–50 per cent water-in-oil	Cost of offloading and cleanup Local fishing and fish processing only temporarily hindered
7. Tarut Bay Pipeline break April 1970 Saudi Arabia 25°C	Light Arabian crude 14,000 tons Low-toxic dispersant used at sea	Temporary stoppage of important local food source from fish traps Boat fishery unaffected
8. Hong Kong Land storage tank November 1973 20°C	Marine diesel 40 per cent aromatic 3,000 tons at once, 1,000 tons slowly Emulsifiers used in main channel, not near fish farm	Serious damage to floating fish farms—kills or tainting Restarting delayed General fisheries unaffected

TABLE 12
Summary of spills and their effects (continued)

	Effects at sea	*Effects near shore*	*Effects on shore*	*Effects on seabirds and mammals*
1.	*Torrey Canyon* Extreme surface phytoplankton, pilchards, eggs and young killed. Other zooplankton not detectably affected Fish not tainted	Excessive use of toxic detergents caused kills. Some crabs and lobsters tainted, market temporarily closed French oyster beds saved	Some smothering by "mousse". Detergents killed herbivores on rocks; excess algal growth Imbalance lasting from two to six years	10,000–40,000 birds killed, serious particularly to auks and at French breeding colonies
2.	Santa Barbara No effect of oil on plankton or fisheries noted Oil on seabed naturally sunken by clays	Oil caught in kelp beds No kill in aquarium water taken from under oil + dispersant in harbour	Some smothering Damage by steam cleanup Some delayed effects but not for certain attributable to oil	3,000–4,000 birds killed, migrants absent No proven effects by oil on mammals
3.	*Tampico Maru* Fish probably left the area	Kill of herbivores, pismo clams and abalones, causing very heavy growth of kelp Recovery seven years at least	Oil confined to small cove, extreme kill, probably by very aromatic oil	
4.	West Falmouth Persistance and spread of oil in sediments	Nearly 100 per cent kill in fairly restricted area Shellfish beds seriously affected	Penetration of tidal river and marsh mud Heavy plant and animal mortality	
5.	Anacortes Strong currents	No observable mortality subtidally	Locally high kill of shore fishes and epi- and in-fauna Oil persisted in clays and in tissues Repopulation rapid	Several thousand birds killed
6.	*Arrow* Particles of oil traced 250 km Uptake by zooplankton Particles of oil in copepod faeces	Closure of non-commercial clam bed	Smothering of algae Fauna not seriously affected Oil very persistent at high water level	*ca.* 7,000 birds killed Some seal deaths
7.	Tarut Bay No fish tainting in the Bay	Fish traps badly oiled; shrimp and fish catch reduced and inedible for several weeks	Mangroves partly damaged Great reduction, but not complete loss of fauna Rapid recovery and disappearance of oil	Not migrant season
8.	Hong Kong Zooplankton killed but soon replenished Temporary tainting of fish	Recruitment of some fish stocks affected locally Sea urchins gonads affected	Oil persisted in sands which became anaerobic Poor flushing Meio and macro fauna killed	Very few birds in area Pigs in stys close to high water died

then some of the gas will come out of solution, expand, and expel additional oil from the pipe. Pipelines are normally buried along their entire length but this cannot be done in rocky areas and, in others, movements of the sea bed may expose a previously buried section, although regular inspections are made. An uncovered portion of pipe may be subject to damage from fishing gear over its long expected life. Prevention of coastal damage from an oil spill caused by a leaking pipeline close inshore or crossing an estuary would in addition be more difficult than from one out to sea.

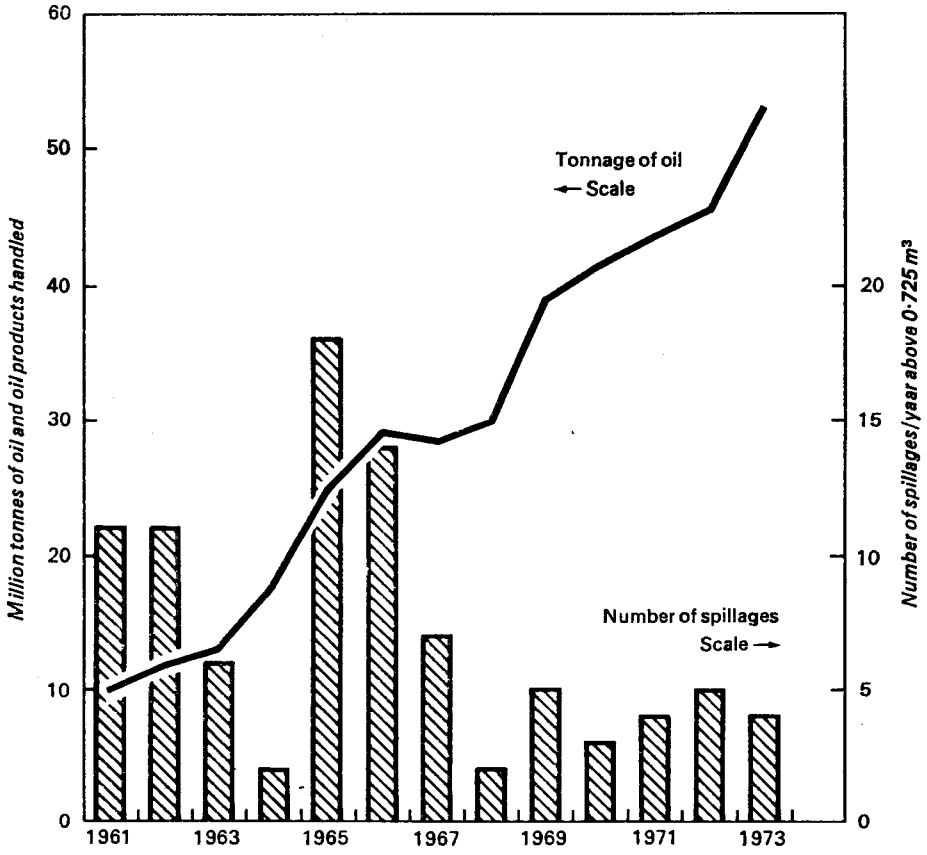
132. The greatest risk of a major release of oil, especially close to shore, appears still to be from a serious accident to a tanker, either by stranding or collision. Although much of the oil will be brought ashore by pipeline, tankers of up to 300,000 tonnes deadweight will ply from Sullom Voe in the Shetlands and for some of the more remote oilfields, single-buoy moorings are being considered that will enable tankers to load from a marine storage installation. Thus, a problem we have lived with for many years will continue, though different regions of the United Kingdom will be at risk. There may be a case for insistence on tankers being fitted with equipment to make them more manoeuvrable and on unusually high standards of operational competence.

133. There are particular risks of oil pollution at shore installations where oil is loaded, unloaded and refined, and where small spills and seepages can have a cumulative effect. High standards can certainly be achieved in the handling of oil. Thus, in the four years 1966 to 1969, 127 million tonnes of oil and oil products were handled at Milford Haven with a spillage of only 550 tonnes. The numbers of severe spillages have declined over the years as is shown in Figure 7. However, it is projected that up to 200 million tonnes of North Sea oil will be landed in one year in the 1980s, so that these standards may need to be bettered.

134. The danger from an oil spill depends very much upon particular circumstances, to judge from past experience (see Table 12), but there are generally two kinds of effect. The first depends upon the physical properties of the oil. It can cause a great loss of amenity on beaches, and much trouble and expense in cleaning operations. A large volume of drifting oil in the North Sea may present a serious hazard to some colonies of seabirds, which can be coated and become immobilised, and may die in large numbers. Birds particularly affected are those that stay mainly on the water surface such as auks—guillemots, black guillemots, little auks, puffins and razorbills. The danger is greater in winter, when the birds stay close to shore and the oil is more viscous; the Shetlands are frequently subject to fogs at this season which impede the navigation of tankers and the dispersal of any oil spilled. Further south, such as in the Firth of Forth, oil spills would be damaging to sea ducks, eider ducks, scoters and goldeneyes. In general, the number of dead birds that are found ashore is only a small fraction of the total kill.

135. The second effect of the oil is its chemical toxicity. This can be significant but is often exaggerated. Only certain fractions of the oil, notably low boiling point aromatic hydrocarbons, are toxic to marine life or taint fish. Although the most toxic of these compounds are also the most volatile, and would mostly evaporate within a few days, they tend also to be the most soluble

FIGURE 7



Oil tonnage and number of spillages at Milford Haven, 1961-1973

in seawater and thus will be responsible for the major damage to marine life in the waters under an oil spill. Here, total hydrocarbon concentrations of some 0·02 ppm have been measured, away from the immediate time and place of the spill. This is at least an order of magnitude greater than the level measured[39] in unpolluted water west of the Shetlands, but it is only one-fiftieth of the level needed to produce noticeable effects on the feeding of copepods* and long-term lethal effects. It is therefore not possible to imagine that even a major spillage of oil over the oilfields could affect submarine life appreciably: any local losses in the planktonic communities would be quickly repaired.

* Copepods are crustaceans and are some of the most abundant animals in the seas and oceans. Most of them are small: a mature specimen of the most common copepod in the North Sea, *Calanus finmarchicus*, being about 3 mm long. They are the most important herbivores in the food web of the North Sea.

136. Hydrocarbons occur naturally in the open sea but there is insufficient knowledge of the processes involved to estimate how their concentration may have been affected by oil pollution. Sediments on the sea bed even in unpolluted regions contain hydrocarbons to the extent of about 100 ppm (dry weight). If oil spills find their way into these deposits these could become anaerobic and temporarily unable to support their natural populations of animals. However, recovery begins well before the hydrocarbon levels return to normal, and it is unlikely that the great mass of marine fauna and flora can have been generally affected by man's use of oil. We would urge, however, that more research should be done on naturally produced hydrocarbons, on the metabolism of hydrocarbons by plants and animals and on the fate of natural and other hydrocarbons in sediments.

137. During the last few years, considerable improvements have occurred in the methods of clearing oil slicks. These have resulted from work by oil companies and by the Government, largely at the Warren Spring Laboratory (Plate 3). There are new devices for corralling the oil and the detergents for dispersing it into the sea are now much less toxic; stockpiles of these are maintained at a number of coastal depots. The system was demonstrated by "Operation Bowman" which took place in May 1974 off Aberdeen; however, there is still some uncertainty on how effective the treatment methods are in the really rough conditions that are to be expected in the North Sea in winter. These conditions are also the ones most likely to cause the relatively light North Sea oil to form a persistent mousse for which high mixing energy is a precondition. Knowledge of evaporation rates is important where an oil spill is being treated and decisions on the method of treatment are made in advance as far as possible. In plans to deal with spills, particular care is being taken to protect regions of special importance to fish culture (such as are found off Norway and Scotland), fish spawning and bird life.

138. **Carbon dioxide.** The burning of fossil fuels on a large scale has led to an increase in the level of carbon dioxide (CO_2) in the atmosphere. At present the concentration is just over 320 ppm and it is increasing at about 0·7 ppm per year. Only about half of the output from burning fuel remains in the atmosphere; the remainder is probably taken up by the oceans. Although ultimately the CO_2 will be harmlessly distributed throughout the deep waters of the oceans, there have been discussions among scientists over whether concentrations in surface waters could reach high levels and cause damage as more and more fuel is burnt. Equilibrium is quickly reached with respect to CO_2 between the atmosphere and the surface waters—i.e. approximately the top 70 metres—but it is not known with certainty how rapidly gas dissolving in the sea will find its way into the deeper waters.

139. It has been argued[40] that if fossil fuels continue to be burnt at the prodigal rate that extrapolation of our recent history suggests, there could be a period early in the next century when the increase of CO_2 in the surface waters could cause these waters to become so much more acid that calcium carbonate deposits will dissolve. It has also been suggested that the change in acidity could adversely affect plants and animals, particularly those that lay down calcareous skeletons, such as shellfish. We do not know enough about the

circulation of waters in the oceans, about the solubility of calcium compounds in sea water, or about the effects of raised levels of CO_2 on marine plants and animals to make confident predictions on this subject. Our enquiries indicate, however, that even assuming an extremely rapid use of fossil fuels, there is no danger of CO_2 having large effects on the solubility of calcium carbonate in the tropical and subtropical waters which make up the majority of the ocean surface; the coral reefs of the world, therefore, will not dissolve. We cannot rule out the possibility of appreciable changes in acidity and in the solubility of calcium carbonate in temperate and colder waters such as those that surround Britain[41–43]. If, however, some of the extensive sea bed deposits of calcareous material, which is particularly abundant in the western end of the English Channel, were to dissolve this would help to maintain calcium carbonate at saturation level and diminish the acidity change. In any event, the effects would not be serious.

Heavy metals

140. **Lead.** Lead has always been widespread in the environment in soil and water; it is absorbed by plants and animals and is a natural constituent of the body. It has, however, no known biological function in man and there is no evidence of a homoeostatic mechanism for maintaining the amount in the body at an optimum level. The body-burden is, therefore, directly dependent on the quantity absorbed. Centuries of industrial use have helped to disperse lead throughout the world and have created situations in which individuals have, at times, been exposed to amounts large enough to produce poisoning. Most cases have occurred in people who were exposed to lead in the course of their work, but a substantial number have also occurred in the general population. Sufferers have included people who have habitually drunk soft water that had been allowed to stand overnight in lead pipes. Some children with "pica" chew and eat non-food materials coated with high lead paints and there have also been reports of poisoning from ingestion of lead-containing eye cosmetics that were commonly used by Asian families.

141. The circumstances in which poisoning has occurred are now well understood and have, for the most part, been brought under control. There remains, however, the possibility that lesser amounts that do not produce overt poisoning could undermine health in a more subtle way—particularly perhaps in children—and that such effects might be contributed to by motor vehicle exhausts, or by the ingestion of dust by people living in the neighbourhood of lead works. The evidence has been summarised by the Central Unit on Environmental Pollution in a recent report[44] and has been reviewed by individuals who do not always reach the same conclusions[45]. That this should be so is not, perhaps, surprising in view of the variety of inconsistent figures that have been published, due (at least in part) to the technical difficulty of measuring minute amounts of lead in body tissues and the use of different methods of analysis.

142. There is, however, general agreement that there is no immediate cause for alarm. The greater part of the lead content of the body is due to the ingestion of lead with food and there is evidence that this has not changed materially

over the last 25 years. The amount of lead in the blood is not much higher in townsmen than in countrymen, and is well below the level at which poisoning is known to occur. What is disputed is the extent to which the inhalation of town air, containing an average of 1–3 μg of lead per m^3, contributes to the amount of lead in the body and whether blood levels intermediate between those that are now common (say 15–35 μg per 100 ml) and those that are regarded as undesirable in industry (about 80 μg per 100 ml) have any effect on health. One effect has been demonstrated at levels intermediate between these two, namely, the partial inhibition of an enzyme (δ-aminolaevulinic acid dehydratase) which is involved in the formation of haemoglobin: but this has not been correlated with any significant disease. Children, it is thought, would be likely to be affected at lower levels than adults and there has been much concern about the possibility that these intermediate levels might damage intellectual development. It is, therefore, reassuring that in a recent study([46]) of school children who lived in the neighbourhood of a lead works, no relationship was found between blood level and general intelligence, reading ability, or behaviour disorder, despite the fact that 20 per cent of them had blood levels ranging from 40 to 65 μg per 100 ml. Indeed, those who had lived near the works since two years of age or younger performed on average rather better than those who had lived elsewhere.

143. Regulations requiring the amount of lead in petrol to be progressively reduced are being implemented in the USA and Germany. In the UK the oil crisis led to some deferment in the original programme for a phased reduction in lead content, but the maximum permitted level is to be reduced from 0·64 to 0·55 g/litre on 1 November 1974. The EEC Commission have recently proposed a draft directive to reduce the maximum level to 0·4 g/litre in 1976 and, for regular grade petrol, to 0·15 g/litre in 1978. New engines can easily be designed to run on lead-free petrol by means of a simple modification, but it would not be feasible to convert the large numbers of existing engines. Lead-free petrol of octane numbers corresponding to those of the current market would possibly cost some 2–3 per cent more, and substantial capital would be required to provide the additional refinery capacity. A cheaper alternative might be to fit lead traps on car exhausts. It should be remembered, however, that the removal of lead from petrol will modify the character of the other combustion products of petrol and care would have to be taken to ensure that the removal of one pollutant did not result in an increase of others that might have more serious effects.

144. More research is needed to establish the extent to which the lead from motor exhausts gets into the body, and to determine whether continued exposure to amounts of lead that are insufficient to cause the classical symptoms of lead poisoning has any long-term deleterious effects on health. More research is also needed to characterise critical groups in the population who absorb unusually large amounts from air, water, or any other source. In the meantime we are satisfied that there is no need for emergency action. We shall keep the situation under review and, if at any time it seems necessary to do so, will undertake a special study.

145. **Cadmium and mercury.** Several other metals, notably cadmium and mercury, are also known to cause great injury to man if they accumulate to a substantial amount. Like lead these metals are not known to have any biological function in man. The sufferings of Japanese people who were poisoned by industrial discharges of cadmium at Toyama, and of mercury at Niigata and Minamata, are now well known. There were also outbreaks of mercury poisoning more recently in Iraq and Nigeria when a number of people ate bread made from wheat that had been treated with alkyl mercury as a fungicide. As a result, there has been widespread international anxiety that similar pollution incidents may be possible elsewhere.

146. In 1973, Government reports on surveys of cadmium and mercury in food were published. The latter broadly confirmed the earlier mercury report, some of whose findings were included in the Commission's Third Report (Tables 20, 21). The reports conclude that the population as a whole is clearly not receiving an undue dose of either metal. However, inshore fish from the Thames and Mersey estuaries, and Morecambe Bay, contain high levels of mercury (of the order of 0·5 ppm), and brown crab meat, especially from the south Devon coast, is rich in cadmium (means: 21 ppm from Devon, 6·5 ppm overall). Thus certain individuals with unusual diets may be receiving a good deal more than the average daily dose of 16–32 μg of cadmium and 5–10 μg of mercury. Provisional tolerable daily doses of 60–70 μg and 40 μg respectively have been proposed for a 70 kg man by the 16th FAO/WHO Expert Committee on Food Additives* and provisionally by WHO, which are less than a tenth of the amount that is estimated to have been associated with the development of symptoms in the Japanese incidents.

147. Two difficult issues remain. First, certain critical groups of people may have unusually high intakes of heavy metals, and these reports record no attempts to identify and study such groups. Children in particular, whose intake of food in relation to their weight may be twice that of an adult, may be nearer to the limits than the averages suggest, as may people exposed to airborne cadmium who are residents in the neighbourhood of cadmium works or who smoke cigarettes. This is in contrast to the successful use of the critical group technique to monitor exposure to radioactivity by consideration of particular individuals unusually affected. We consider that a critical group technique should be adopted whenever possible in the monitoring of pollutants, not least because it may ease the problems of maintaining very low average levels in the population at large.

148. Secondly, there is no clear evidence of the effect of heavy metals in amounts too small to cause the gross symptoms that have been seen in Japan and in workers who have been specifically exposed because of their occupation. More information is needed both to determine the long-term effect of intermediate exposures and to quantify the effect of the interaction of different

* The Committee considered that it was more realistic to control the intake of metals which accumulated in the body on a weekly basis rather than a daily basis and provisionally recommended tolerable weekly intakes of 400 to 500 μg for cadmium and 300 μg for mercury, of which not more than 200 μg should be in the form of methyl mercury.

metals, which may even, on occasion, be beneficial. To judge by animal experiments, the relatively high content of selenium in tuna fish might, for example, afford some protection against the toxic effects of mercury in fish that have been exposed to industrial mercury wastes.

Noise

149. There are four main classes of noise: from traffic, from aircraft, from the neighbourhood and within the workplace. Medically, the last is by far the most serious, with at least 600,000 people possibly suffering progressive loss of hearing as a result of their work. A recently-published Code of Practice(47) should, if enforced, achieve a substantial improvement here. Two working groups of the Noise Advisory Council (NAC) have studied the problem of local noise, and the recommendations made by one of them in their report on the workings of the Noise Abatement Act of 1960 have been largely embodied in the Control of Pollution Act. These will empower local authorities to designate noise abatement zones within which they will be able to require existing noise levels to be held steady and thereafter reduced if possible. There will also be controls on building and demolition sites, and a more rapid procedure for dealing with nuisances.

150. The outlook for the next ten years, particularly in respect of traffic and aircraft noise, has been the concern of another working panel of the NAC under Professor E. J. Richards. Their report has now been published(48) and we have discussed it with the Chairman and some members of the Panel. We are in general agreement with their findings and recommendations, and endorse in particular their support for the development of a quiet commercial road vehicle and the flight-testing of retrofit equipment to quieten aircraft engines.

151. Traffic noise is by far the more widespread of the two sources and over eight million people were subjected in 1970 to levels that exceeded the NACs absolute limit of acceptability around residential developments of L_{10}70dB(A). (This means that the noise exceeded 70dB(A) for 10 per cent of the 18-hour day from 6.00 a.m. to midnight). If traffic growth continues unabated, then this number will increase to 29 million by 1980. This would mean that half the total population would be subjected to traffic noise so great that, if it were from a new or improved road (Plate 8), a sound insulation grant would normally be payable under the Noise Insulation Regulations 1973. Such a situation would clearly be intolerable.

152. The NAC panel observed that traffic noise from heavy goods vehicles was especially high in the UK because of "historical and geographical" reasons. These have led to "the largest commercial vehicle population in Europe" and consequently road traffic bears by far the greatest proportion of the goods transported. The Panel took the view that the increased use of railways or other forms of transport such as canals should be studied in depth, with a view to a reduction in pollution generally, including noise.

153. A comparison with West Germany shows that a different distribution of freight traffic between road, rail and waterway may not be incompatible with a prosperous industrial society. This pattern is reflected in the relative capital

TABLE 13

Distribution of freight transport by mode, 1972[49]

	Great Britain		*West Germany*	
	Million tonne-km	%	*Million tonne-km*	%
Road	88,600	65·5	88,300	40·5
Rail	23,400	17·3	66,600	30·6
Inland waterway ..	200*	0·15	44,000	20·2
Coastal shipping ..	20,000	14·8	—	—
Pipeline	3,000	2·2	19,000	8·7
	135,200		217,900	

expenditures incurred on the different transport infrastructures in the two countries over the last decade or so. The determination of the optimum balance of freight transport between various modes clearly requires the study of many issues with which we are not concerned. We suspect, however, that the problem of rapidly increasing traffic noise, much of which is from heavy goods vehicles, will require for its solution a fundamental change in transport strategy.

154. Aircraft noise affects fewer people (in the UK about 2½ million, of whom the vast majority live near Heathrow) than does traffic noise, but it is much more penetrating. It is also unusual as a pollutant in that the major source is from overseas, so that actions against it need to be on an international scale. So far, the desire to develop the aircraft and air transport industries has prevented any major reductions in permitted noise levels, although in fairness we should point out that the wide-bodied aircraft now coming into service are not only quieter in absolute terms than their predecessors, but also carry more passengers so that the number of flights need not be so great. Nevertheless, unilateral action is being taken in a number of countries to encourage aircraft to be quieter[50]. Pilots can improve the noise on approach by deferring the lowering of landing gear or by using a two-angle glide path; they already have to use noise abatement procedures when taking off. Airlines can fit their noisy jets with hush-kits. A circular[51] to all airlines last December from DTI asked about their willingness to fit these devices and their plans to retire some aircraft early. We hope that this presages the imposition of progressively lower noise limits for, until this is done, it is rather unlikely that sufficient action will be forthcoming.

Radioactivity

155. Radioactivity is an unusually dangerous and insidious form of pollution, especially for man, who is more vulnerable than any other animal or plant.

* British Waterways Board waterways freight transport only.

There is no physical sense with which it can be recognised, so that monitoring by means of instruments is essential in all situations in which a hazard from radioactivity is a possibility. Some radioactive materials decay only very slowly into inert elements and they must therefore be isolated for immensely long periods. Radioactivity can not only injure or kill the living, but it can induce genetic changes in chromosomes, and thus in principle can cause babies in subsequent generations to be born with defects or malformations.

156. It must be said that these potential hazards have stimulated an immense amount of research and development, and that great care is taken that neither workers in the nuclear industry nor the general public should receive an undue dose of radiation. Indeed, so much attention is paid to the health of nuclear workers that their morbidity and mortality compare very favourably with those of workers in similar trades not involving radioactivity. At present, however, nuclear power accounts for barely 10 per cent of the UK generating capacity, and much less in most other countries. In the future this may not be so. With rapidly increasing prices for fossil fuels, and an increasing awareness of the pollution they can cause—land dereliction, oil spills and massive emissions of SO_2 for example—nuclear power stations look attractive and plans are being made for expansion of the industry. In the early days of motor cars, their hazards were appreciated by Parliament, and they had to be preceded by a man on foot carrying a red flag. Nowadays there is no man with a red flag and they kill about 7,000 people per year in Britain alone. This appears to be regarded as a tolerable price for the convenience they offer. While it would not be reasonable to press the analogy too far, and no one has yet suggested any relaxation of safety standards in the nuclear industry, we are reminded that a potentially dangerous technical development may be well safeguarded when it is first introduced, but that more casual attitudes may develop when it becomes a dominant feature of industrial society.

157. The nuclear fuel cycle gives rise to radioactivity at various stages, of which the principal ones are routine emissions from nuclear power stations and reprocessing plants, and the generation of waste materials. The routine emissions are mainly to water and are carefully monitored to ensure that they are below the permitted discharges, the results being published annually. The limits are designed to ensure that the radiation doses, both to the whole population and to "critical groups" of particular individuals, are below the limits set by the International Commission for Radiological Protection. Examples of the "critical groups" are those who drink Thames water, which contains tritium discharged from Harwell, and some Cumbrian fishermen and South Wales laverbread* eaters, who are affected by discharges from Windscale. The doses of radiation received by these groups are well below the safety levels, and *a fortiori*, the doses received by the rest of the population are even less significant. The control is exercised by virtue of the Radioactive Substances Act 1960, which provides for a system of authorisation, with inspectors. Advice is available from the National Radiological Protection Board, set up in October 1970 by virtue of the Radiological Protection Act 1970.

*** Laverbread is a delicacy made from seaweed, some of which comes from the coast of Cumbria.**

158. Nuclear reactors not only generate vast amounts of radioactivity during their active life, but they remain intensely radioactive afterwards, and the problems of decommissioning a large power reactor have never been experienced. Waste materials are of two kinds—contaminated and highly radioactive. Contaminated materials, such as rubber gloves, are often stored in special vaults adjacent to nuclear reactors, or buried in trenches at Drigg in Cumberland. High-level wastes are liquids that remain hot because of their radioactivity; they are kept in special cooled stainless-steel tanks at Windscale. In the US, some of the tanks used for this purpose have leaked badly, but none of the UK tanks have done so. Nevertheless, it is considered desirable that these wastes should be solidified for greater long-term safety, and research on glassification is taking place at Harwell. Various alternative solutions to the problem of dealing with these wastes, which must be safeguarded at least for centuries and perhaps for millions of years (if certain trans-uranic elements are not otherwise reduced to insignificant levels), have been proposed.

159. Having considered these problems, and having had informal discussions with many of the bodies concerned with nuclear power generation and its control, we have concluded that we should undertake a special study of radioactivity and publish our findings. The reason for this, and our main lines of enquiry, are given in Chapter V.

CHAPTER III

THE STRUCTURE FOR POLLUTION CONTROL IN THE UNITED KINGDOM

Introduction

160. In connection with the study of training and manpower requirements for pollution control staff, the Commission assembled information on the structure that has been established in this country for controlling pollution. We felt that this information would be of general interest and, accordingly, we present it in this chapter. Much responsibility for the control and abatement of pollution rests with industry, but our present concern is with those official bodies having statutory responsibilities in the field.

161. The system of control has evolved gradually over a period of more than a century, being modified from time to time to meet changing circumstances arising from industrial expansion and from redistribution and growth of population. In England and Wales, major modifications resulted earlier this year from the reorganisation of local government and of the water authorities. The recently enacted Control of Pollution Act will bring about further changes and give added responsibilities to various authorities concerned with pollution control. The accession of the United Kingdom to the EEC, and the consequent gradual harmonisation of approach to environmental problems with other member countries, will lead to new requirements that may call for changes in our system of control.

162. The organisation for pollution control is divided between Government departments, local authorities and water authorities. We describe the responsibilities for pollution control in these three areas in the following sections of this chapter.

Responsibilities of Government departments

163. The responsibilities of Government departments for the control of different forms of pollution are summarised in Table 14. In this table we have included not only the divisions of departments that have direct control responsibilities but also those that have mainly a research or advisory role, since divisions in this latter category also play an indirect part in the control of pollution. In these instances, however, the numbers of staff employed are less relevant to our purpose and the corresponding column in the table has been left blank. Where staff numbers have been included in Table 14, they relate only to the professional and technical staff employed and not to administrative and clerical staff.

164. At central government level, most pollution problems are the responsibility of the Department of the Environment (DOE) in conjunction, as appropriate, with the Scottish and Welsh Offices. The DOE is concerned with air pollution, freshwater pollution, refuse disposal, radioactive wastes, oil on

TABLE 14

Pollution control responsibilities of Government departments

Type of pollution	*Govt. dept.*	*Division*	*Responsibilities*	*Staff in 1972*	*Remarks*
Air pollution	DOE	HM Alkali and Clean Air Inspectorate	Air pollution from registered works.† Advice to local authorities on processes and operations outside the scope of the Alkali Acts	35	England and Wales are divided into 15 districts, each with a district inspector. Additionally, there are 16 inspectors allocated to 13 of the 15 districts
	SDD	HM Industrial Pollution Inspectorate for Scotland	For air pollution has the same responsibilities as the Alkali Inspectorate, but also has some additional responsibilities as described below	7	Scotland is divided into three units, each with a senior inspector and an inspector
	DOE	Directorate of Vehicle Engineering and Inspection (also operates in Scotland)	Air pollution (smoke) from road vehicles	5	There are five HQ staff. The remaining staff are concerned with all aspects of vehicle testing and safety. Smoke control is only a minor part of their total duties
	DI	Warren Spring Laboratory (Air Pollution Division)	Co-ordinating centre for the National Survey of Air Pollution. Surveys of pollution from traffic, aircraft, etc. Long-range trans-frontier pollution. Odours. Development of measuring techniques		Work relates more to monitoring and research rather than the direct control of pollution
Freshwater pollution	DOE	Directorate General Water Engineering (DGWE)	Overseeing of sewage disposal schemes. Technical advice to local and water authorities	70	The staff figure is the total professional staff complement of the Division. Pollution control is only part of their duties
	SDD	Engineering Division		16	
	SDD	HM Industrial Pollution Inspectorate for Scotland	Advice on the control of water pollution		See under air pollution

† Includes radioactive emissions from nuclear installations.

TABLE 14—continued

Type of pollution	*Govt. dept.*	*Division*	*Responsibilities*	*Staff in 1972*	*Remarks*
Pollution from agricultural chemicals	MAFF / DAFS	Safety, Pesticides and Infestation Divisions	Control of pesticides and advice on disposal of farm wastes		Technical advice is obtained from the MAFF Plant Pathology Laboratory and Pest Infestation Control Laboratory, the DAFS Agricultural Scientific Services and the MAFF/DAFS Agricultural Development and Advisory Service (ADAS)
Marine pollution	MAFF / DAFS	Fisheries Division	Discharges at sea outside territorial waters		Technical advice is obtained from the MAFF Fisheries Laboratories at Lowestoft and Burnham and the MAFF Marine Laboratory at Torry. No technical staff are engaged on this full-time. These laboratories also monitor pollution of the sea (both chemical and biological monitoring)
	DOT	Marine Division	Oil pollution at sea		Control is the responsibility of the Marine Survey Service, the staff of which is mainly concerned with other duties. The Warren Spring Laboratory is engaged on research on methods of dealing with oil pollution and gives technical advice
	D of Energy	Petroleum Production Inspectorate	Pollution from drilling operations	3	The number of staff will expand to meet the demands of oil exploration in the North Sea

TABLE 14—continued

Type of pollution	*Govt. dept.*	*Division*	*Responsibilities*	*Staff in 1972*	*Remarks*
Radioactivity*	DOE	DGWE Radiochemical Division	Advice on the Radioactive Substances Act 1960, monitoring the effectiveness of the controls	5	Included in total complement figure for DGWE given under water pollution
	MAFF	Fisheries Division (Fisheries Radiobiological Laboratory)	Monitoring discharges of radioactive effluent into inland and coastal waters	33	All staff have some pollution control responsibilities, but this varies considerably
	D of Energy	Nuclear Installations Inspectorate	Safety of nuclear power plants, fuel processing plant, etc.	67	
	SDD	HM Industrial Pollution Inspectorate for Scotland	Control of pollution arising from the use of radioactive substances (with assistance from Fisheries Radiobiological Laboratory)		See under air pollution for numbers and organisation
Toxic waste disposal	DOE	DGWE Toxic Wastes Division	Advice on methods of disposal of toxic wastes, monitoring and collating information	6	Included in total complement figure for DGWE given under water pollution
	SDD	HM Industrial Pollution Inspectorate for Scotland	Advice on the disposal of toxic wastes		See under air pollution for numbers and organisation
Refuse disposal	DOE	DGWE Public Cleansing Division	Advice on methods of refuse disposal, refuse collection and street cleaning	5	Included in total complement figure for DGWE given under water pollution
	SDD	Engineering Division			See under water pollution for numbers

* The National Radiological Protection Board provides information, advice and services in connection with radiological protection.

TABLE 14—continued

Type of pollution	*Govt. dept.*	*Division*	*Responsibilities*	*Staff in 1972*	*Remarks*
Noise	DOE	Directorate of Vehicle Engineering and Inspection (operating also in Scotland)	Noise from road vehicles	4	There are four HQ staff. The remaining staff are concerned with vehicle testing. Noise is only a minor part of their total duties
	DOT	Civil Aviation Division	Aircraft noise		DOT concerned with policy on aircraft noise. Technical work carried out by Civil Aviation Authority

DAFS: Department of Agriculture and Fisheries for Scotland
DI: Department of Industry
DOE: Department of the Environment
DOT: Department of Trade
MAFF: Ministry of Agriculture, Fisheries and Food
SDD: Scottish Development Department

beaches and noise other than aircraft noise. The Secretary of State for the Environment also has a general coordinating role on pollution matters as a whole, which is exercised through a Central Unit on Environmental Pollution within his department. As will be seen from the table, however, direct responsibility for several aspects of pollution rests with other departments. Thus, the Department of Trade (DOT) is responsible for the control of oil pollution at sea and aircraft noise; the Ministry of Agriculture, Fisheries and Food (MAFF) and, in Scotland, the Department of Agriculture and Fisheries for Scotland (DAFS) are responsible for the control of agricultural chemicals such as pesticides, and for the protection of fisheries from pollution. The activities referred to in the table relate to the control of pollution in the open environment; pollution arising within factories is the responsibility of the Department of Employment (DE) and is controlled by HM Factory Inspectorate. In addition to the departments listed in the table, certain others have an indirect interest in pollution control. These include, in particular, the Department of Health and Social Security and the Scottish Home and Health Department which are directly concerned with health and medical aspects of pollution.

165. Generally, the responsibility for exercising controls on pollution rests with local and water authorities. The concern at central government level is with the legislative framework for controls and with providing advice and guidance to the authorities on pollution control aspects of their work. In a few areas, however, the responsibility for control rests solely with central government organisations. This applies to the control of pollution caused by agricultural chemicals; the control of pollution from radioactive materials; the control of aircraft noise; and the control of emissions to air from industries registered under the Alkali Acts. With regard to the latter, registered industries are those using processes that cause particularly noxious or offensive emissions or that are technically difficult to control. These include, for example, chemical, cement and brick works and thermal power stations. Emissions from other industrial processes or from domestic premises are the responsibility of local authorities.

Responsibilities of local authorities

166. The structure of local government in England and Wales (excluding Greater London) was reorganised with effect from 1 April 1974. There are now six metropolitan counties and 39 counties in England and a further eight counties in Wales, each comprising about five or six districts. These form the upper and lower tiers of government. In Scotland the reorganisation will take effect on 16 May 1975, when nine regional and three island councils will replace the existing counties. The regions will comprise a second tier of districts as in England and Wales, but the islands will not be subdivided. In Northern Ireland there are 26 district councils.

167. The responsibilities of local government in the field of pollution are shown in Table 15. There are considerable differences in different parts of the country in the allocation of responsibilities between county and district authorities. The counties are responsible for the disposal of solid and toxic wastes in

TABLE 15

Area	ENGLAND			WALES	SCOTLAND (from 16th May 1975)		NORTHERN IRELAND
	Greater London	*Metropolitan Counties*	*Counties*	*Welsh Counties*	*Scottish Mainland*	*Scottish Islands*	
Upper tier	GLC	6 Met. C.	39 County C.	8 County C.	9 Regional Councils	3 Island C.	N. Ireland Office
Lower tier	32 London Boroughs	36 District C.	296 District C.	37 District C.	51 District C.		26 District C.
SOLID							
Refuse collection ..	London B.	District C.	District C.	District C.	District C.	Island C.	District C.
Refuse disposal ..	GLC	Met. C.C.	County C.	District C.	District C.	Island C.	District C.
Toxic wastes	GLC	Met. C.C.	County C.	District C.	District C.	Island C.	District C.
LIQUID							
Sewage collection ..	London B.	District C.	District C.	District C.	District C.	Island C.	NI Min. of Develop.
Sewage disposal ..	9 Regional Water Authorities			Welsh National Water Development Authority	Regional C.	Island C.	NI Min. of Develop.
Water pollution ..	9 Regional Water Authorities				River Purification Boards		NI Min. of Develop.
AIR							
Registered works ..	HM Alkali and Clean Air Inspectorate			HM Alkali and Clean Air Insp.	HM Industrial Pollution Inspectorate for Scotland†		Alkali Inspectorate (Min. of Develop.)
Non-registered works and domestic	London B.	District C.	District C.	District C.	District C.	Island C.	Min. of Develop.
NOISE							
Aircraft	Department of Trade			Dept. of Trade	Department of Trade		Department of Trade
Traffic	Met. Police*	Local police	Local police	Local police	Local police	Local police	None
Neighbourhood ..	London B.	District C.	District C.	District C.	District C.	Island C.	None
RADIOACTIVITY ..	Central Government Departments			Central Government Depart.	Central Government Departments		NI Min. of Develop.

* Area differs slightly.

† Have wider responsibilities (see Table 14).

England and of sewage in Scotland. At district level, public health inspectors are responsible for dealing with air pollution arising from non-registered works or domestic sources, and with noise nuisances.

Responsibilities of water authorities

England and Wales

168. On 1 April 1974, nine regional water authorities for England and the Welsh National Water Development Authority took over all the responsibilities of the former river authorities and the sewage disposal functions formerly carried out by the local authorities. In addition, although less relevant in the present context, they assumed overall responsibility for water supply. Under arrangements made by the DOE and the Welsh Office for the first few years, the divisional structure of water authorities is based on the existing river authorities as rivers divisions, on the existing statutory water undertakers as water supply divisions and on the 88 newly formed divisions for sewage disposal.

169. The main tasks of water authorities in implementing their statutory responsibilities for the control of water pollution (which will be extended through the Control of Pollution Act to include discharges to tidal stretches of rivers, estuaries and the coastal sea) are the giving, and subsequent supervision, of consents to discharge pollutants. This involves the systematic inspection, monitoring, sampling, chemical analysis and biological surveys of water in watercourses and of discharges to surface waters or to underground strata. This work forms a variable proportion (10–30 per cent) of the total activities of river authorities depending upon the extent of pollution in their regions.

170. The 88 sewage disposal divisions of the water authorities replace the 1,364 local authorities and 27 joint sewage authorities previously responsible for treatment and disposal of domestic sewage and the trade effluents which by agreement are discharged into sewers by industry. Responsibility for the sewers themselves remains with local authorities as agents for the water authorities.

Scotland

171. In Scotland the river purification boards have responsibilities for the control of pollution broadly similar to the rivers divisions of the water authorities in England and Wales. Under the original proposals for the reorganisation of local government in Scotland, the river purification boards were to have been abolished and their responsibilities taken over by the local authorities. The Commission referred to these proposals in the Third Report (paragraphs 113–18) and expressed the view that the advantage of retaining the river purification boards would outweigh other advantages of integrated control under local government. We are therefore glad that under the Local Government (Scotland) Act 1973, river purification boards are to be established from 16 May 1975 over the whole mainland, although the island councils will be the river purification authorities for their areas. The boards' responsibilities will be similar to those of the water authorities in England and Wales, except that they are not to take over responsibility for sewage disposal.

Sea Fisheries Committees

172. Sea fisheries committees have the power to make and to enforce byelaws prohibiting or regulating the deposit or discharge within the three-mile limit of territorial waters of any solid or liquid substance deterimental to sea fish or sea fishing. These byelaws do not apply when consents to discharge have been issued by water authorities, although water authorities are required to have special regard to the interests of sea fisheries and therefore to consult the committees before issuing a consent.

CHAPTER IV

THE TRAINING AND MANPOWER REQUIREMENTS FOR POLLUTION CONTROL STAFF

Introduction

173. We have referred in paragraph 4 of this Report to the study of training and manpower requirements for pollution control staff which was initiated by the Commission in 1972. It was evident that to proceed with the study as first conceived we should need to institute thorough enquiries into the pollution control responsibilities of local and river authorities, and this during a time when these authorities would be fully committed to planning the major reorganisations which took effect on 1 April 1974. In some important respects the arrangements which would be the subject of our enquiries were destined to change as a consequence of reorganisation. Thus the transfer of responsibility for sewage disposal to regional water authorities (in England and Wales) and the new responsibility for solid waste disposal at county council level (in England) would call for changes in structure and staffing and would no doubt lead to the early review of training requirements. It appeared to us that we should hinder rather than help if we were to press our own enquiries during a time when the bodies formally responsible for these matters were actively investigating them. We confirmed our view about the difficulties that continuation of the study would create by informal consultation with appropriate local authority associations and with the National Water Council.

174. We concluded that it would be wrong to attempt to proceed further with the study at the present time. The time was at once too early and too late; too early, that is, for the new situation arising from reorganisation to be assessed, and too late for the study to contribute usefully to thinking and planning for that reorganisation. We decided to suspend work on the study and to publish a brief report on the limited investigations that had already been made. In the circumstances we are not in a position to draw conclusions on some of the important questions that were implicit in the study as first defined; our conclusions are necessarily more general and more tentative. Nevertheless, we hope that they will be helpful. Our report is presented in this chapter.

Scope of the investigation

175. The study was undertaken because of the Commission's concern about the need to ensure that the training of pollution control staff matched their responsibilities, and that appropriately qualified staff were available in sufficient numbers. The intended scope of the investigation was as follows:

(a) A review of the qualifications, training and certification desirable for the professional and technical staff responsible for controlling pollution.

(b) An estimate of future manpower needs for such staff.

(c) A review of existing courses, both full-time and part-time, for those wishing to take up a career in the field of pollution control at or above higher technician level.

176. With regard to (a) and (b) above, it was envisaged that enquiries would need to be made of central government, local and river (now water) authorities, industry and the professional institutions having members engaged on pollution control work. At the time when the study was suspended evidence had been obtained from Government departments and the professional institutions and a first approach had been made to river authorities. However, no evidence had been taken from local authorities or industry. The review of existing courses was undertaken for the Commission by the University Grants Committee, the Department of Education and Science and the Scottish Education Department. We wish to record our gratitude to these bodies for their work on the Commission's behalf.

Structure for pollution control and overall staffing needs

177. Consideration of training and manpower needs should logically begin with an assessment of structure. We have presented in the previous chapter information on the present structure that was obtained in connection with the study. There appear to us to be some general grounds for supposing that changes will be called for in the future and we have discussed this matter briefly in paragraphs 229–232 of this Report. Nevertheless, a new structure has been created as a result of the reorganisation of local and water authorities and a period of settling down is evidently necessary before further substantial changes could be contemplated or the need for them properly assessed. In the circumstances we have taken the present structure as largely given in considering the findings from the study.

178. Whatever the structure, the demand for higher environmental standards will certainly lead to the need for more, and often better qualified, staff to control pollution. It will also mean higher costs, though these costs will generally still be small in proportion to total expenditures by the bodies concerned, whether these are controlling authorities or industry. We consider it highly important that in the present financial climate action to abate pollution should continue to be given priority. Postponement may appear an attractive and ready means of economy, but it would often be a false economy, leading to more difficult problems and higher costs in the long run.

179. The staffing implications of advances in dealing with pollution may be seen in relation to the recently enacted Control of Pollution Act. In the explanatory memorandum accompanying the Bill it was estimated that the new functions of local authorities, water authorities and river purification authorities would require eventually some 500 to 800 additional staff. This estimate is necessarily a very rough one, and not all these additional staff would be in the professional or technical categories that are our concern. On the other hand, the estimate does not include additional staff in these categories who may be needed in

industry. Probably the best that can be said at present is that the new legislation will call for the recruitment eventually of several hundred additional professional and technical staff. It is important that the introduction of improved environmental standards should not be hindered by a lack of manpower. Comment is made later on the staff situation as regards public health inspectors and sewage works staff, but we have been unable to make any general appraisal of the numbers and types of staff who will be needed. Such appraisals will no doubt be undertaken by the National Water Council and the Local Government Training Board in the areas that are their respective concern. The position, however, should be seen as a whole, and we recommend that the Department of the Environment should take the lead, in collaboration with other interested parties, in assembling an overall picture of staff requirements for pollution control work within central government, local authorities, water authorities and industry.

180. In assessing staff requirements for pollution control work it seems useful to distinguish between three categories of staff and related qualifications, as follows:

(a) Graduate and professional (with a university degree or corporate membership of appropriate professional institution).

(b) Technician engineer (with Higher National Certificate or Diploma).

(c) Technician (with Ordinary National Certificate or City and Guilds Certificates).

The first category will include laboratory scientists, senior inspecting staff and staff in a managerial capacity concerned with directing work on pollution control within agreed policy, and with contributing to policy formulation. The second category covers inspecting staff concerned to ensure that prescribed standards of control are enforced, and some technical staff in laboratories. The third category covers a range of supporting staff, for example, staff responsible for the operation and servicing of measuring apparatus.

Manpower requirements and organisation

Government departments

181. The organisation of pollution control functions at central government level is given in Table 14 (Chapter III). To obtain details about how these responsibilities were carried out, a questionnaire was sent to each of the sub-units of the departments involved. The information given in the table is largely derived from the answers to the questionnaire. An analysis of the returns showed that the types of staff employed by Government departments for pollution control could broadly speaking be divided into the following three classes:

(a) Staff recruited in their mid-30s who are professionally qualified engineers, chemists, etc., and who must have had several years industrial or field experience to carry out their responsibilities. Examples are the alkali inspectors and the various engineering and chemical inspectors employed by the Government.

(b) Staff with qualifications in science or engineering ranging from GCE "O" level to PhD who are recruited straight from school, college or university to work in Government research laboratories.

(c) Staff who have pollution control responsibilities "attached" to their work for administrative convenience and who are taught to exercise their extra responsibilities by on-the-job training. Examples are the marine survey officers of the Department of Trade, who are naval architects, marine engineers, etc., who have been given responsibilities for the control of oil pollution.

182. The qualifications and experience of the staff employed by Government departments to carry out their pollution control functions appeared generally appropriate to the work. For none of the classes listed above was any serious recruitment problem apparent; staff with the requisite qualifications and experience were available in the numbers required. In fact there has been no pronounced shortage of technically qualified people in recent years, due mainly to the increased numbers being produced as a result of the massive investment in the provision of higher educational facilities in the early 1960s. Another factor is the cut back in industrial recruitment of graduates in the 1960s. But we are by no means sure that this satisfactory recruitment position will continue and this is one reason for our recommendation in paragraph 179 that an overall review of future staff needs should be undertaken.

Local authorities

183. The responsibilities of local authorities for the control of pollution are outlined in Table 15 (Chapter III). At district council level the main burden of pollution control work falls on the public health inspectors (PHIs) who are responsible for controlling some forms of air pollution and neighbourhood noise. The pollution control tasks of PHIs generally amount to no more than about 10 per cent of their work as they are concerned with a wide range of other matters such as food hygiene, rodent control, slum clearance, etc.

184. Evidence given by the Association of Public Health Inspectors (APHI) early in 1973 referred to a shortage of PHIs. They estimated that there were about 5,900 posts in England and Wales of which about 460 were vacant. We understand that the position has substantially worsened since reorganisation and that the overall shortage may now exceed 20 per cent. According to the APHI there is a 27 per cent deficiency in the number of PHIs in the London area. The difficulties created by these shortages will be exacerbated by the extra tasks that the Control of Pollution Act will impose on PHIs.

185. We have no ready answer to the problem of the shortage of PHIs. Recruitment of staff in any field depends on salary, career prospects, status and job opportunities elsewhere. It may be that in the past PHIs have not enjoyed the status they deserve because of a narrow public view of their work as being concerned with drains and sanitation, and that this has done much to dissuade potential recruits. The creation in the new district councils of the post of Chief Environmental Health Officer (CEHO) should enhance the status and career

prospects of PHIs, and we welcome this development. A recent analysis of recruitment to CEHO posts shows that in a large majority of cases the CEHO has chief officer status and that almost invariably the posts have been filled by PHIs. At the same time, we note that CEHOs will be concerned with questions of policy over a wide field, and that the Diploma of the Public Health Inspectors Education Board, which is an essential requirement for PHIs, is unlikely to be an adequate qualification for these duties. We return to this point later in this report.

186. The need for CEHO posts has arisen from the transfer of medical officers of health (MOHs), who were formerly employed by local authorities, to the reorganised National Health Service; in many local authorities the PHIs previously came under the overall direction of the MOH. However, the transfer of the MOH raises problems, since it is essential that adequate medical advice should be readily available to the PHIs if they are to carry out all the duties expected of them. We are therefore concerned that satisfactory liaison arrangements are made between the local authorities and the National Health Service.

187. The responsibilities of PHIs with regard to both air pollution and noise will be increased by the provisions of the Control of Pollution Act. Other measures being taken to counteract noise, by giving sound insulation grants and by paying compensation in certain instances, will add further to their work. We are concerned about whether the span of expertise required of PHIs has become too large. We understand that specialisation on particular duties is already the general practice in the major cities and we note that the formation of larger authorities through reorganisation should make it feasible for the practice to be extended, so that more staff may specialise on pollution control. We recommend that local authority associations and other bodies concerned should consider the desirability of this development.

188. As a result of reorganisation, county councils in England are responsible for the disposal of all types of solid wastes (in Wales and Scotland this is a district council responsibility). We are in favour of giving the responsibility to the larger authorities and we are pleased to note that the Control of Pollution Act places on these authorities the duty of making a survey of all waste arising in their areas and of making long-term plans for its disposal. The responsibilities acquired under the Act will call for more staff, particularly if an increased emphasis is given (as we believe it should be) to the reclamation of materials.

189. The arrangements to be made by the new authorities for the disposal of solid wastes had still to be finalised at the time we were assessing the findings from the study. We were unable, therefore, to consider the organisation for waste disposal or the types of staff employed. We regard it as essential, however, that the disposal authorities should be able to call on staff with sufficient expertise to be able to decide whether any danger would result from the deposit of toxic materials at particular sites. We are aware that the disposal authorities will be under a statutory obligation to consult the appropriate water authority before issuing a disposal licence, and that water authorities will have specialist staff able to assess the risk of pollution. Nevertheless, we do not think it would be desirable to rely solely on this consultation, if only because there are bound to be occasions when liaison is not completely effective.

190. In order to ensure the safe disposal of toxic wastes, licensing authorities will need to be able to call upon a wide range of experience and scientific knowledge. We had this requirement particularly in mind in our recommendation, in paragraph 179, that the DOE should take the lead in reviewing staff needs. We believe it is important to arrive at clear guidelines on the nature of the specialist teams that should be established. We suspect that it may not be feasible for the smaller authorities to establish teams with the necessary range of skills, and we see scope here for collaboration between authorities and the pooling of knowledge and expertise. The local authorities should also have access when necessary to specialist advisory services within the DOE or elsewhere, but consideration should be given to whether the present facilities are adequate, and whether they are adequately used.

TABLE 16

River authority staff engaged on pollution control

(From data supplied by the Local Government Training Board)

Age distribution	*Number of staff employed in:*	
	Water quality inspectorate	*Water quality laboratories*
−20	3	26
20–29	112	145
30–39	93	47
40–49	54	31
50–59	41	9
60+	9	6
Total	312*	264†
Qualifications		
ONC/OND	7	27
HNC/HND	18	27
University Degree	26	55
Institute of Water Pollution Control	141	18
Royal Institute of Chemistry	25	62
Public Health Inspectors Education Board	18	—
Other qualifications	14	22
Total number of qualifications	249	211

* Includes eight personnel employed by local authorities.

† Includes 25 personnel employed by local authorities.

Water authorities

191. The organisation and pollution control responsibilities of the water authorities are broadly described in paragraphs 168–171. As far as the work of the river authority divisions is concerned, we believe that the qualifications of the staff are generally appropriate to their responsibilities. Information on the qualifications, numbers and age distribution of river authority staff employed on pollution control is given in Table 16. This does not reveal any obvious deficiencies, but additional staff will presumably be required in view of the extended responsibilities that water authorities will acquire through the Control of Pollution Act, which will bring discharges to tidal waters under control.

192. We are less satisfied with the staffing position in the sewage disposal divisions of the water authorities. Table 17 gives the qualifications, numbers and age distribution of pollution control staff employed by the sewage disposal authorities before the transfer of responsibility from local government to the

TABLE 17

Pollution control staff employed by sewage disposal authorities
(From data supplied by the Local Government Training Board)

Age distribution	*Main drainage effluent control*	*Sewage works operation*	*Sewage works pollution control*
−20	1	3	56
20–29	40	44	254
30–39	24	85	128
40–49	13	131	53
50–59	9	113	39
60+	5	50	18
Total	92	426	548
Qualifications			
ONC/OND	3	12	66
HNC/HND	5	12	57
University Degree	9	4	32
Institute of Water Pollution Control	36	79	213
Royal Institute of Chemistry	16	12	67
Engineering Institutions	3	9	1
City and Guilds Institute	4	18	15
Other qualifications	—	10	5
Total number of qualifications	76	156	456

water authorities. Apart from the fact that the number of technical staff employed seems small in relation to the 1,400 sewage disposal authorities, the table shows there is a large number of unqualified staff engaged in the operation of sewage treatment works, and in this sector the age structure suggests that within ten years about one-third of the staff now employed will have reached retiring age. It seems likely that with the transfer of responsibility to the water authorities there will be some movement of staff between the river authority divisions and the sewage disposal divisions. This should improve the level of expertise within the sewage divisions but will still leave an overall deficiency of qualified staff in the younger age groups.

193. The Working Party on Sewage Disposal (the Jeger Committee) also referred to the lack of suitably qualified and properly trained personnel in sewage works. Evidence presented to us by the Institute of Water Pollution Control referred to the fact that since the Working Party reported in 1970 there had been no progress in carrying out the Working Party's recommendations concerning qualifications for sewage works staff. The Institute made the point that the price to be paid for the involvement of untrained or inadequately trained personnel is frequently the poor performance of the sewage plant. We refer in paragraph 199 to the training requirements of sewage works staff.

Training

194. One of the factors that led the Commission to undertake the study was the wish to look into the training courses that were being taken by people intending to embark upon careers in pollution control. There were some grounds for thinking that current concern with environmental problems might have led to a proliferation of broadly based environmental science courses, designed to give an understanding of the range and multi-disciplinary nature of these problems. While fully accepting that such courses make a valuable contribution to general understanding, the Commission's view is that they do not provide a suitable foundation for people who are to be employed on scientific and technical work in the field of pollution control. We consider that the best basis for this work is a specialist degree in a relevant basic discipline; this will provide the theoretical background to which further knowledge, acquired by practical experience and from post-experience courses, may best be added. Our views on this matter were supported by nearly all the professional institutions that commented on it in their evidence.

195. The particular basic discipline and the level of knowledge required varies, of course, with the type of job. Many disciplines, e.g. chemistry, biology, mechanical engineering, geology, play an important part in pollution control. Some jobs require more specialist knowledge; thus, public health inspectors must have a diploma which is awarded by the Public Health Inspectors Education Board. The diploma is also accepted in Scotland for the post of sanitary inspector, although Scottish sanitary inspectors normally take an examination set by the Royal Sanitary Association of Scotland. For some posts in the water pollution field the diploma awarded by the Institute of Water Pollution Control is required. We refer to these qualifications in more detail in the next section.

196. At the Commission's request the University Grants Committee, the Department of Education and Science and the Scottish Education Department made a survey of the existing courses at universities and polytechnics in environmental studies that were relevant to pollution control. An examination of the results of this survey showed that there were very few generalised environmental science courses. On the whole, courses with an environmental content were grounded in basic disciplines with optional additions on aspects of pollution control during one year of a course. We think this is a sensible approach, since such additions should give some insight into practical problems and help to prepare and qualify students for certain types of work.

197. Given that the primary qualification is in a basic discipline, further training should follow. Post-graduate courses, short courses on specific aspects of pollution control organised by universities and technical colleges, and symposia and conferences organised by professional institutions, all play a part in this further training and in keeping staff abreast of developments. Because of the specialised nature of pollution control work, post-graduate and post-experience courses run by educational establishments are not readily available outside the big centres of population. For this reason we welcome the initiative of the Open University in planning to introduce next year a post-experience course in "Environmental Control and Public Health". Conferences and symposia run by professional institutions present less of a problem because it should be possible to release staff for short periods to attend them even if they are some distance away. We think that staff should be encouraged to undertake appropriate training and that staff complements should allow for this.

Professional institutions

198. The institutions that submitted evidence to the Commission are listed in Appendix C. Most of them award qualifications that would be relevant and useful in the field of pollution control, and in some cases possession of these qualifications is an essential requirement. The two most important in this respect are the Public Health Inspector's Diploma and the Diploma of the Institute of Water Pollution Control (IWPC).

199. In reviewing the education and training of staff in water pollution, the Working Party on Sewage Disposal (the Jeger Committee) commented that it was difficult to over-emphasise the importance of the IWPC Diploma. They suggested that block release courses should be organised at a small number of centres to assist students to prepare for the diploma examination. The Jeger Committee further recommended that managers of sewage-treatment works serving a total population equivalent exceeding 15,000 should be required to hold the diploma or a university degree (or equivalent) in science or engineering. All the evidence offered to us supported the value of the diploma and we have no hesitation in endorsing these recommendations.

200. While we see the value of these diplomas for the education and training of higher technicians engaged in the day-to-day operation of pollution control, and of the technicians needed for routine work, we do not think they provide a suitable qualification for policy makers in the higher levels of the new organisations for pollution control.

201. We have considered offers made to us by the Institution of Chemical Engineers to set up a "board" to examine qualifications and experience of policy makers in pollution control, and a proposal by the Royal Institute of Chemistry for a "Post-graduate Endorsement Diploma in Pollution Monitoring and Control". These possibilities (and others) would be realised if a single professional Diploma in Pollution Control were offered as an additional qualification for professionally qualified scientists and engineers. It would need to cover academic and practical training, together with experience in a position of responsibility.

202. The setting up of a suitable scheme could be undertaken by the institutions in the Council of Engineering Institutions and the Council of Scientific and Technical Institutions. It would need an examination, probably in sections, to cover separate areas such as monitoring and control, design, operation, biological surveys, etc., as appropriate for the aerial, aquatic and land environments. Exemptions should be available for approved university qualifications at first degree or post-graduate level.

203. The aim of the diploma should be to ensure that it became recognised as the professional qualification in at least one area of pollution control. It might in the course of time become a statutory requirement for duties in administering environment protection legislation, possibly similar to the professional qualifications required for public analysts for the Food and Drugs Act 1955 or doctors, pharmacists and others for the Medicines Act of 1968.

Summary of conclusions and recommendations

204. We were unable to complete the study as originally envisaged because of the timing of our enquiries in relation to the reorganisation of local and water authorities (paragraphs 173–174).

205. Nevertheless, we think it would be useful to assemble an overall picture of requirements for professional and technical staff for pollution control work within central government, local authorities, water authorities and industry. We recommend that the DOE should initiate this work in collaboration with other appropriate bodies (paragraph 179).

206. It is important to ensure that satisfactory arrangements are made for liaison between local authorities and the National Health Service (paragraph 186).

207. We recommend that consideration should be given by local authority associations and other institutions concerned to the desirability of further specialisation by public health inspectors to enable more staff to concentrate on pollution control work (paragraph 187).

208. We are particularly concerned about the new structures for waste disposal at county council level. We recommend that the DOE should take the lead with the institutions concerned to arrive at guidelines for structure and staffing of the specialist teams, and to consider the back-up facilities that are needed (paragraphs 188–190).

209. We are concerned about the staffing position for sewage disposal. We endorse the recommendations of the Jeger Committee regarding the qualifications that should be held by the managers of sewage treatment works (paragraphs 192–193 and 199).

210. We consider that an honours degree in a relevant basic discipline provides the best academic basis for a career in pollution control. We were glad to find from our survey of courses that, on the whole, courses with an environmental content were grounded in basic disciplines with optional additions on aspects of pollution control (paragraphs 194–196).

211. We stress the importance of further training, and that staff should be encouraged to undertake it (paragraph 197).

212. We have considered the desirability of establishing a professional Diploma in Pollution Control as an additional qualification for professionally qualified scientists and engineers. We recommend that this matter should be considered further by the institutions in the Council of Engineering Institutions and the Council of Scientific and Technical Institutions.

CHAPTER V

CONCLUSIONS AND PROGRAMME OF WORK

Introduction

213. In this chapter we report our conclusions from our review of the current state of environmental pollution and the decisions we have reached on our future work programme. We have taken account not only of our own findings but those expressed by the Commission, then under the chairmanship of Lord Ashby, in their First Report. In Chapter IV of that Report they identified two classes of problem: those already receiving attention from other bodies and those to which they considered further attention needed to be given. As a convenient approach to describing our conclusions we propose first to review progress made in these latter areas; then to return to some of the matters raised in Chapter II; and finally to raise certain additional matters that appear to us to call for comment.

Problems identified in the First Report as requiring further attention

214. There were six of these. One of them, pollution of estuaries, was the subject of a major study by the Commission and was dealt with in their Third Report. The main recommendations in that Report that called for action by the Government have been incorporated in the Control of Pollution Act.

215. We continue to be concerned about the condition of many of our estuaries, and are anxious to see action taken to improve them. We have already commented in paragraph 113 on the effect of financial restrictions; this is bound to delay programmes for sewage treatment schemes and this delay will weaken the position of the water authorities in seeking to impose stricter controls on industrial discharges. In our discussions on these matters we have given some thought to whether, in the present financial climate, there would be virtue in concentrating available resources to some extent on a particular estuary, although we realise that this approach would probably only be tenable if it could be adopted without imposing significant further delay on schemes elsewhere. It appeared to us that to bring about an early and dramatic improvement in the condition of one of the grossly polluted estuaries would be very valuable in providing an example of what can be achieved. The essential requirements would be that plans for dealing with the pollution are already well advanced and that they could be implemented reasonably quickly. We have not been able to investigate this idea in detail, though during our visit to the Tyne we formed the view that that estuary might well qualify for such priority treatment. We noted that the major source of pollution of the Tyne is sewage, that work on intercepting sewers and treatment works has started and could be completed within a few years, and that much is already being done through reclamation and landscaping to make the banks of the estuary attractive. We recognise,

however, that we have been unable to familiarise ourselves to the same extent with the situation in other estuaries. We have invited the Department of the Environment to consider the matter further in consultation with the water authorities.

216. Another of the problems identified in the Third Report was that of the qualifications and training of staff engaged on pollution control. The study of this subject that the Commission initiated is reported in the previous chapter and our recommendations are summarised at the end of that chapter. We discuss the position in the remaining four problem areas below.

Economic considerations

217. Much importance was attached in the Third Report to the need for economic studies in order to provide a basis for decision-making about pollution and its abatement. The Commission regarded existing information in this area as being seriously deficient and recommended that the Government should take steps to improve the situation.

218. Some progress has been made. We note, for example, that in 1971 the Programmes Analysis Unit made estimates of the costs attributable to air pollution which were intended to update the figures given in the 1954 Beaver Report. However, these estimates have been sharply criticised and it does not appear that there is yet any generally agreed set of figures on overall costs even in this area which has been more extensively studied than others and which would appear to be relatively amenable to analysis. The Department of the Environment have recently been paying increased attention to the economics of pollution and they have commissioned a number of studies at universities during the last two years. These have concentrated on specific topics, mainly in the field of water pollution. We welcome this initiative, and hope that efforts will be continued to expand the numbers of economists working in this area. In some instances a good approach may be to consider costs and benefits at the margin, so that the economic effects of changes in pollution standards may be appreciated before decisions are taken, rather than to attempt to tabulate overall costs. In spite of what has been done, we remain concerned about the adequacy of the resources currently devoted to the study of economic aspects of pollution and especially of its social costs and of the social benefits that can be derived from its amelioration.

Monitoring

219. Monitoring of pollutants in the environment is essential to provide the factual basis for decisions on standards and controls. In previous reports, the Commission drew attention to the need for careful design of monitoring systems and for uniformity of techniques and units of measurement, preferably agreed on an international basis. We therefore welcome the report on monitoring which was published by the DOE Central Unit on Environmental Pollution[52] earlier this year and which should lead to the development of a comprehensive, unified and flexible system. We would stress the need for critical appraisal of the

monitoring scheme. Collecting data at random could be very costly indeed and not necessarily useful. We suggest that a valuable discipline is to attempt to formulate some of the questions which the measurements yielded by the scheme are required to answer. We have noted earlier in this Report that statistics appear to be lacking or misleading in some areas at present; thus, volumes of toxic or dangerous wastes, the true acreage of derelict land and the extent to which our major rivers are polluted.

Pesticides and other biocides

220. Our preliminary findings on this problem are set out in paragraphs 97 and 98 of Chapter II. It appears that the present system of voluntary control over agricultural and horticultural usage has been effective in bringing about a substantial reduction in the use of the more persistent organochlorine pesticides. However, the position on the non-agricultural usage of pesticides is less satisfactory. We welcome the DOE survey of this problem([53]) and, arising from this, we hope to see the introduction of appropriate control arrangements and codes of practice in this area. While there appear to be no grounds at present for us to investigate these matters further, we propose to keep in touch with the Advisory Committee about future trends in the use of pesticides.

Radioactive waste

221. The disposal of radioactive waste was identified in the First Report as a matter that called for enquiry, bearing in mind that this country among others was moving into an era of greatly increased use of nuclear energy for generating electrical power. We have decided that this is an appropriate field for us to investigate, and we have already announced the terms of an enquiry that is now in progress. Our decision does not imply that we are critical of current arrangements. It reflects simply our view that now, when we are on the threshold of substantial expansion in the use of nuclear power, is the right time for a thorough examination of the environmental issues that this expansion will raise. We believe it is important that the public should be as fully informed as possible about these issues. Technical and organisational arrangements that provide adequate environmental safeguards at the present level of use of nuclear power may not be adequate for the future.

222. We shall consider the organisation for radiological safety in this country with particular reference to three main areas. The first is the disposal of radioactive waste materials, especially the products of fuel element reprocessing. The second is the transport and storage of nuclear materials, especially plutonium; this is potentially extremely dangerous because of its radiotoxicity and it is vital that it should be safeguarded at all stages of its life. The third is the environmental consequences of hypothetical reactor accidents and the criteria proposed for siting nuclear installations.

Other matters requiring attention

223. Under this heading we comment further on three matters referred to in Chapter II which appear to us to give particular grounds for concern.

224. **Noise.** As a result of our preliminary enquiries on this subject, we have been struck by the generally deteriorating situation, particularly with respect to road traffic noise. In their report, the Noise Advisory Council Panel foresaw the possibility, given expected growth in the volume of traffic, that by 1980 some 29 million people in urban populations could be exposed to residential noise levels above the accepted limit. The Panel saw a partial solution to the problem through recognition of the need to take noise into account in road planning and in traffic management schemes, but they noted that necessary steps to quieten vehicles were likely to be inhibited by the need for general EEC agreement. We are dismayed by the potential conflict between the pressing need to reduce vehicle noise in this country and the noise limits currently specified in the EEC directive. We strongly support the Panel's suggestion that the UK should urge reductions in these limits. We agree with the Panel about the need for determined Government action to reduce noise, and we generally welcome the proposals they have made to that end. We propose to keep in touch with developments and with the Council.

225. **Toxic chemicals.** We have referred in paragraphs 14 and 99–103 to this subject and to the views previously expressed by the Commission about the need for an early warning system on the effect of new chemicals on the environment. We are aware that extensive arrangements already exist in Government and industry for screening new products from the viewpoint of their possible hazard to health, safety or the environment. The use of chemicals in food, drugs and water supplies and for certain agricultural, industrial and domestic purposes is subject to supervision and often control by Government departments through arrangements that harness both official expertise and independent advice. New legislation provides a comprehensive framework of controls over discharges and emissions, including the disposal of toxic wastes. Moreover, under the Control of Pollution Act, the Secretary of State for the Environment has reserve powers to take action to deal with any hazardous substance that might escape the screening procedures.

226. The protection of the environment against possible hazards from new chemicals is essentially an international problem, and we welcome the consideration that is being given to it within OECD and other international bodies and to which the DOE and the Department of Industry are contributing. Nevertheless, we remain concerned about the problem. We are conscious on the one hand of the pace of technological advance, the rapidity with which these advances are exploited in the development of new products, and the scale of their manufacture; and, on the other hand, that the effects of some substances on the environment may be extremely subtle, indirect and long-term in character, so that potential hazards may be undetected until serious damage has been done. We have already referred in paragraph 14 to a particular example, namely the possible hazards to the ozone layer from freons. Some risks are inevitable if mankind is to benefit from technological innovation, but there is a need for

great caution before new substances are introduced into the environment on a massive scale and this should be reflected in thorough scientific assessments in order to minimise the risks. We intend to make specific enquiries about the freon problem, as we shall about any particular matter where there appears to be a risk of a major threat to the environment. We propose also to keep in touch with developments arising from international studies of the general problem.

227. **Offshore oil exploration.** We were concerned about the environmental implications of oil exploration at sea, especially with regard to oil pollution. Accordingly, we have had some informal discussions on this matter with officials of the Department of Energy and with one of the oil companies, and we have visited an oil exploration rig in the North Sea and a production platform yard. As a result of our enquiries, we have been reassured by the safeguards that are being taken against the risk of oil pollution and by the arrangements that have been made to deal with accidental spills that could occur. We note, however, that because of the arrangements for landing oil from the North Sea, the risk of serious pollution is likely to be concentrated in the area of the Shetlands where there is a hazard to wild life, particularly to the very large numbers of sea birds, and where the difficulties of applying clean-up measures will be greatest. There is a need for great care and vigilance in landing operations, and the need for exceptional precautions against accidents should be considered. Because of the great increase in the cost of oil, such precautions are likely to be justified on economic as well as environmental grounds.

228. While we have gained some understanding of oil exploration and the attendant risks we have not been able to look at the process, and the problems, of exploitation to the same extent. Oil production platforms are novel structures in terms of their vast size and the extreme conditions they will need to withstand in the North Sea, and in our view great efforts should be made to establist their structural integrity. From our enquiries about the pollution hazard arising from offshore oil we have concluded that there is no need at present for us to pursue the matter further, but we are bound to keep an anxious eye on it because the development is so new. We have been influenced in reaching this conclusion by the fact that a detailed examination is now being undertaken by the Central Unit on Environmental Pollution within DOE in conjunction with other departments concerned. We welcome this investigation and propose to keep in touch with its progress.

Organisational issues

229. In the course of our deliberations we have given some thought to general questions of organisation for pollution control, and especially to the question whether control should be exercised centrally or locally. Central control appears essential when the hazards involved are potentially so serious as to call for very strict and uniform controls. For example, we fully accept the need for central control in relation to radiological hazards. In other areas, where pollution raises technical issues of a highly specialised nature, it will be easier to ensure that the necessary expertise is available with centralised organisation. On the other hand,

it may be argued that the abatement of pollution generally raises issues which require for their rational resolution the balancing of one set of local interests against another. This suggests that wherever possible pollution control should be a local responsibility; this need not preclude support from central bodies which could issue guidelines or specify standards as appropriate and be available to give expert assistance and advice in particularly difficult cases.

230. Other factors will affect the balance between local and central pollution control. Increasingly strict controls will be needed to deal with pollution, and their application to secure environmentally optimum solutions may call for a more comprehensive approach than is feasible under present arrangements. For example, the emission of sulphur dioxide from a power station may be greatly reduced by installing scrubbing equipment, but this could result in the discharge of acid effluent to a river. There is a choice, but it is not clear that coordination between existing organisations can be relied upon to ensure that the best choice is made.

231. There is another reason for supposing that there may be a need for more comprehensive local expertise on pollution matters. We have given some consideration to pollution problems in relation to planning. The Planning Acts impose upon local authorities the responsibility for planning administration, including the control of development. In preparing development plans local authorities are required to take account of their environmental effects. Proposals to undertake the development of a power station, a refinery, a petro-chemical plant, a steel plant, etc., or a combination of such projects, create pollution hazards which are very specialised and complex as well as being highly sensitive to public reaction. Although local authorities can turn to various bodies for advice, it may be difficult for them to obtain advice that adequately takes account of local circumstances, such as topography, climatic conditions, etc.

232. We have made no considered study of these organisational issues. However, one issue, that of central or local control, is highlighted by present arrangements for the control of air pollution, where responsibility is divided between the Alkali and Clean Air Inspectorate and the public health inspectors acting within local authorities. We were, therefore, particularly pleased to undertake at the invitation of the Secretary of State a review of these arrangements. The terms of reference of the review, which is now in progress, are as follows: "To review the efficacy of methods of control of air pollution from domestic and industrial sources, to consider the relationship between the relevant authorities and to make recommendations". We were asked to report if possible within 12 months.

Acknowledgements

233. Finally, we wish to record our gratitude to the many individuals and organisations we have consulted; their information and help have been invaluable.

234. We must also express our warm appreciation for the work of our small secretariat on whom the preparation of this Report has placed a considerable burden. In particular, we would like to acknowledge our indebtedness to our Secretary, Mr. L. F. Rutterford; our Assistant Secretary, Mr. D. J. MacVicar; and our scientific assistant Dr. G. R. G. Lewison who was responsible for researching a great deal of the background material on which Chapter II was based.

ALL OF WHICH WE HUMBLY SUBMIT FOR YOUR MAJESTY'S GRACIOUS CONSIDERATION.

BRIAN FLOWERS (*Chairman*)
SHIRLEY ANGLESEY
RALPH VERNEY
RICHARD DOLL
FREDERICK WARNER
ERIC DENTON
DEREK BOWETT
TONY CHANDLER
FRANK CHAPPLE
JOHN COLLINGWOOD
TERENCE CONRAN
RONALD NICOLL

L. F. RUTTERFORD (*Secretary*)
D. J. MACVICAR (*Assistant Secretary*)

September 1974

APPENDIX A

LIST OF CURRENT MEMBERS OF THE COMMISSION

Chairman
SIR BRIAN FLOWERS, MA, DSC, FINSTP, FRS
Rector of Imperial College of Science and Technology

THE MARCHIONESS OF ANGLESEY
Vice-Chairman of the Civic Trust for Wales

DR. D. W. BOWETT, LLB, MA
President of Queens' College, Cambridge

PROFESSOR T. J. CHANDLER, MSC, PHD
Professor of Geography, University of Manchester

F. J. CHAPPLE, ESQ.
General Secretary and General President designate of the Electrical, Electronic, Telecommunication and Plumbing Union

DR. J. G. COLLINGWOOD, BSC, CENG, FICHEME
A director of Unilever
Fellow of University College, London

T. O. CONRAN, ESQ.
Designer
Chairman of Habitat

PROFESSOR E. J. DENTON, CBE, SCD, FRS
Royal Society Research Professor, Bristol University and Marine Biological Association, Plymouth
Fellow of University College, London

PROFESSOR SIR RICHARD DOLL, OBE, DM, MD, DSC, FRCP, FRS
Regius Professor of Medicine, University of Oxford

PROFESSOR PATRICIA J. LINDOP, MB, PHD, DSC, MRCP
Professor of Radiation Biology, University of London, Medical College of St. Bartholomew's Hospital

Appendix A

PROFESSOR J. M. MITCHISON, SC D, FRSE, FIBIOL
Professor of Zoology, University of Edinburgh

PROFESSOR R. E. NICOLL, MSC, FRICS, FRTPI
Professor of Urban and Regional Planning, Strathclyde University

PROFESSOR T. R. E. SOUTHWOOD, PHD, DSC, ARCS
Professor of Zoology and Applied Entomology, University of London
Head of Department of Zoology and Applied Entomology and Director of Field Station, Imperial College of Science and Technology

P. P. STREETEN, ESQ., MA
Warden of Queen Elizabeth House
Director of the Institute of Commonwealth Studies
Fellow of Balliol College, Oxford

SIR RALPH VERNEY, KBE, JP
Chairman of Forestry Commission's Committee for England
Chairman of the Government Advisory Committee on Aggregates

PROFESSOR SIR FREDERICK WARNER, BSC, CENG, FIMECHE, FICHEME
Senior Partner in Cremer and Warner (Consulting Engineers)
Visiting Professor in Chemical Engineering, Imperial College
Visiting Professor in Environmental Engineering and Vice-Chairman of the Council of the Open University
Fellow of University College, London

THE BARONESS WHITE, MA
Deputy Chairman of the Metrication Board
Member of British Waterways Board
Chairman of Advisory Committee on Oil Pollution of the Sea

APPENDIX B

SOME SOURCES OF INFORMATION IN THE UK ABOUT ENVIRONMENTAL POLLUTION

Government departments nearly all have certain responsibilities in the field of pollution. The main one is the Department of the Environment, 2 Marsham Street, London SW1, whose Central Unit on Environmental Pollution has a general coordinating role, usually undertakes UK representation at international meetings and can direct enquiries to suitable specialists.

Technical information on particular subjects is available from the following institutions. This is only a partial list; many universities, for example, have pollution expertise within particular departments.

Air pollution

1 ASSOCIATED OCTEL COMPANY LTD, THE
Engine Laboratory, Watling Street, Bletchley, Milton Keynes, Bucks. MK1 1EZ.
Information Officer: W. D. Pigott, FLA
Air pollution from automobile emissions. A bibliography "Lead in automobile exhaust gases and the environment 1924–70" has been produced. The company has also sponsored research at Manchester University and Imperial College. Publishes "Exhaust gas air pollution abstracts".

2 ATOMIC ENERGY RESEARCH ESTABLISHMENT
Harwell, Didcot, Oxfordshire OX11 0RA
Periodic technical reports; contribution to UKAEA Annual Report. Health physics, monitoring and detection of radioactivity, treatment of radioactive by-products and waste. Hazardous materials service—consultancy on treatment and disposal of hazardous wastes. Atmospheric and water pollution studies.

3 FORESTRY COMMISSION: FOREST RESEARCH STATION
Alice Holt Lodge, Wrecclesham, Farnham, Surrey
FORESTRY COMMISSION: NORTHERN RESEARCH STATION
Roslin, Midlothian, Scotland
Air pollution effects on forest trees. The Commission has close liaison with the Institute of Terrestrial Ecology of the Natural Environmental Research Council (NERC), University and other Government research organisations.

4 GREATER LONDON COUNCIL
County Hall, London SE1
The Scientific Adviser's Department issues an annual report which covers air, noise and water pollution, sewage treatment and waste disposal. The Department of Public Health Engineering issues an annual report covering trade effluent control, river pollution monitoring, etc.

5 INTERNATIONAL ENVIRONMENTAL BUREAU
c/o BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxfordshire OX12 9BJ

6 LABORATORY OF THE GOVERNMENT CHEMIST
Cornwall House, Stamford Street, London SE1 9NQ

One of the research establishments of the Department of Industry. Conducts surveys and studies of oil pollution, radiochemical pollution, industrial effluents and air pollution, toxic metals and pesticide residues. Research and development of analytical methods for these purposes. Issues an annual report.

7 MEDICAL RESEARCH COUNCIL
Information Group, 20 Park Crescent, London W1

The MRC have an air pollution unit within St. Bartholomew's Hospital Medical School and a toxicology unit at Carshalton, Surrey.

8 METEOROLOGICAL OFFICE
London Road, Bracknell, Berks.

Meteorological aspects of air pollution.

9 NATIONAL GAS TURBINE ESTABLISHMENT
Pyestock, Farnborough, Hants. GU14 0LS

Research on noise and air pollution by aircraft engines.

10 NATIONAL SOCIETY FOR CLEAN AIR
136 North Street, Brighton, Sussex

Information and advice given. Extensive library services; mobile modular exhibition stand. Posters/leaflets. Lectures can be arranged. Publications: *Clean Air* (quarterly) and *Clean Air Year Book* which lists current research into air pollution. Member of the Standing Conference of Cooperating Bodies on the investigation of atmospheric pollution.

11 ROTHAMSTED EXPERIMENTAL STATION
Harpenden, Herts.

The Botany Department is concerned with the effect on farm crops of aerial pollution, especially sulphur dioxide and fluorides from brickworks. The Chemistry Department works on the pollution by plant nutrients and organic matter of surface waters and deep aquifers by drainage from agricultural land and by disposal of farm wastes. The Insecticides and Fungicides Department is concerned with the principles of formulation, application, persistence and movement of pesticides and the development of effective and safe compounds, as well as novel methods of pest control. Publication: Rothamsted Experimental Station—Annual Report (includes department reports and publications list).

12 TRANSPORT AND ROAD RESEARCH LABORATORY
Crowthorne, Berkshire RG11 6AU

A laboratory of the Department of the Environment. Concern with the environmental aspects of transport, including use of waste materials in road construction.

13 WARREN SPRING LABORATORY
Gunnels Wood Road, Stevenage, Herts.
A Department of Industry laboratory. The main centre in the UK for air pollution research and monitoring, it publishes *Air Pollution Abstracts* (bi-monthly). Also work on metals recovery, clean-up of marine oil pollution, refuse handling and material recovery, incineration and pyrolysis. Issues an annual report.

Water pollution (also see 2, 4, 6, 11)

14 FIELD STUDIES COUNCIL
9 Devereux Court, Strand, London WC2R 3JR
Oil Pollution Research Unit, Orielton Field Centre, Pembroke, Dyfed
Supported by the Institute of Petroleum, the oil companies and NERC. Studies ecological effects of pollution, particularly in tidal areas. The Unit issues annual reports.

15 FISHERIES LABORATORY
Remembrance Avenue, Burnham-on-Crouch, Essex CH0 8HA
A laboratory of MAFF. Responsible for marine pollution research, with particular reference to fisheries; technical aspects of the Dumping at Sea Act; chemical and biological and bacteriological investigations; chemical and biological monitorings; toxicity assessment of wastes; oil pollution.

16 FISHERIES LABORATORY
Lowestoft, Suffolk
A laboratory of MAFF. Headquarters of Directorate of Fishery Research. Coordination of all aspects of marine pollution research and development in MAFF. Also responsible for the Fisheries Radiobiological Laboratory at Hamilton Dock, Lowestoft, and the Fisheries Laboratory, Burnham-on-Crouch.

17 FISHERIES RADIOBIOLOGICAL LABORATORY
Hamilton Dock, Lowestoft, Suffolk
A laboratory of MAFF. Provides the scientific and technical support to the Ministry on the discharge of its statutory responsibilities for the control of radioactive waste disposal, especially in the context of the aquatic environment. Monitoring of radioactivity for control and research purposes, especially in UK estuarine and coastal waters. Measurement of heavy metals in UK coastal waters and north-west European shelf waters. Experimental work on the metabolism of artificial radionuclides and trace metals in aquatic organisms. Publishes annually *Radioactivity in Surface and Coastal Waters of the British Isles.*

18 FRESHWATER BIOLOGICAL ASSOCIATION
River Laboratory, East Stoke, Wareham, Dorset BH20 6BB
An independent organisation grant-aided by the NERC, pursuing fundamental research in freshwater biology.

19 FRESHWATER FISHERIES LABORATORY
Faskally, Pitlochry, Perthshire PH16 5LB

A laboratory of the Department of Agriculture and Fisheries for Scotland (DAFS). Carries out work on pesticides, PCBs, metals and nutrients in fish and fresh waters. Analyses marine fish for organochlorines. Annual report of DAFS.

20 HYDRAULICS RESEARCH STATION
Wallingford, Oxon. OX10 8BA

Civil engineering hydraulics. Part of DOE. Pollution aspects; the transport and dispersal of buoyant and sediment-laden effluents in currents. Issues an annual report (HMSO).

21 INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH
67/69 Citadel Road, Plymouth PL1 3DH

Ecological investigations of pollutants and environmental stress in marine and estuarine ecosystems. One of NERCs grant-aided institutions.

22 MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM
The Laboratory, Citadel Hill, Plymouth, Devon PL1 2PB

A laboratory grant-aided by the NERC. The Marine Pollution Information Centre acts as a national documentation and information centre on marine pollution. Activities reviewed in the annual report of the Council of the Association published in the *Journal of the Marine Biological Association.*

23 REGIONAL WATER AUTHORITIES (ENGLAND AND WALES)
Anglian Water Authority, Diploma House, Grammar School Walk, Huntingdon
North West Authority, Dawson House, Great Sankey, Warrington, Lancs.
Northumbrian Water Authority, Eldon House, Regent Centre, Gosforth, Newcastle upon Tyne
Severn–Trent Water Authority, Abelson House, 2297 Coventry Road, Sheldon, Birmingham
Southern Water Authority, Gildborne House, Chatsworth Road, Worthing, Sussex
South-West Water Authority, 3–5 Barnfield Road, Exeter, Devon
Thames Water Authority, 140 Gower Street, London WC1
Wessex Water Authority, Techno House, Radcliffe Way, Bristol
Yorkshire Water Authority, 21 Park Square South, Leeds
Welsh National Water Development Authority, Cambrian Way, Brecon

24 RIVER PURIFICATION BOARDS (SCOTLAND)

They are in the process of being reorganised and details are not yet available.

25 ROYAL SOCIETY FOR THE PROTECTION OF BIRDS
The Lodge, Sandy, Bedfordshire

The RSPB organise regular counts of beached birds as a check on marine pollution (since 1971). The volunteer counters can also record emergency situations fully, and help to treat the birds.

26 SEABIRD GROUP
Department of Zoology, Aberdeen University, Aberdeen AB9 2TN
Concern with the effects of marine oil pollution on sea birds.

27 SOUTH WESTERN MARINE POLLUTION GROUP
Department of Zoology, University College of Swansea, Singleton Park, Swansea SA2 8PP
Coastal pollution research.

28 TORRY RESEARCH STATION
Marine Laboratory, PO Box 31, Aberdeen AB9 8DG
A laboratory of MAFF. Carries out research into various aspects of pollution, including oil pollution at sea and air and water pollution by fish processing operations.

29 WATER RESEARCH CENTRE
Stevenage Laboratory: Elder Way, Stevenage, Herts. SG1 1TH
Medmenham Laboratory: Ferry Lane, Medmenham, Marlow, Bucks. SL7 2HD
The Stevenage laboratory was formerly the Water Pollution Research Laboratory of the DOE; the Medmenham laboratory, which was formerly the Water Research Association, has assimilated some staff and programmes of the Water Resources Board. WRC was formed on 1 April 1974. It is funded by its members, which include the ten water authorities in England and Wales, and also receives some Government support. Current research covers most aspects of water supply, water treatment, water pollution, sewage disposal, trade wastes, etc. The Information Service on Toxicity and Biodegradability (INSTAB) provides information and advice on the behaviour of chemicals in sewage treatment processes and surface waters. The Centre also provides the secretariat for the Effluent and Water Treatment Advisory Committee. WRC issues an annual report, *WRC Information*—a weekly abstract bulletin—notes on water pollution, and a newsletter.

Waste materials (also see 2, 4, 5, 13, 28)

30 BUILDING RESEARCH ESTABLISHMENT
Bucknalls Lane, Garston, near Watford, Herts.
A research establishment of the DOE. Carries out work on noise research relating to buildings; refuse handling. Issues an annual report.

31 KEEP BRITAIN TIDY GROUP
Bostel House, West Street, Brighton, Sussex
The national agency for litter prevention. Advertising and public relations, also assistance with campaigns from regional offices to local authorities and groups. Publishes *Tidy Times* (quarterly).

32 LOCAL GOVERNMENT OPERATIONAL RESEARCH UNIT
201 King's Road, Reading, Berkshire RG1 4LH
Responsible to the executive council of the Royal Institute of Public Administration. Some concern with waste disposal problems. Issues an annual report and an information bulletin (irregular).

33 NATIONAL INDUSTRIAL MATERIALS RECOVERY ASSOCIATION
Carolyn House, Dingwall Road, Croydon, Surrey CR9 2YV
Industrial Recovery (monthly).

34 NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING
Wrest Park, Silsoe, Bedford, MK45 4HS
State-aided research institute. Farm wastes.

Pesticides and toxic chemicals (also see 2, 6, 7, 11, 29, 34)

35 INSTITUTE OF TERRESTRIAL ECOLOGY
Monks Wood Experimental Station, Huntingdon, PE17 2LS
Has a toxic chemicals and wildlife section which does toxicological and ecological research on the terrestrial and aquatic environments.

36 PEST INFESTATION CONTROL LABORATORY
London Road, Slough, Berkshire
A laboratory of MAFF concerned with research and development directed to the control of mammals and birds, infusions to growing crops, to stored products and to public health; insects, mites and moulds of stored produce.

37 WEED RESEARCH ORGANISATION
Begbroke Hill, Yarnton, Oxford OX5 1PF
An institute of the Agricultural Research Council conducting applied research into the properties, uses and persistence in the soil of new herbicides with the object of providing safe, practical and economic measures of weed control for farmers and growers. Publishes *Weed Abstracts.*

Noise (also see 4, 5, 9, 12, 30)

38 INSTITUTE OF SOUND AND VIBRATION RESEARCH
University of Southampton, Southampton SO9 5NH
World's largest university engineering acoustics department: acoustics, unsteady fluid dynamics, automotive noise/vibration/emissions, audiology, human vibration, structural vibration, noise and vibration control. Annual report on research and publications; abstract cards available from the Librarian.

39 NATIONAL PHYSICAL LABORATORY
Teddington, Middlesex
A Department of Industry laboratory. Noise research, radiation standards and air pollution measurements, etc.

Radioactivity (also see 2, 6, 17, 39)

40 NATIONAL RADIOLOGICAL PROTECTION BOARD
Harwell, Didcot, Berkshire

Grants administered through DHSS. Issues *Radiological Protection Bulletin* (quarterly). The Board's headquarters are at Harwell with service centres at Glasgow and Leeds. Relevant work concerns health assessment in relation to radioactive materials in the environment and associated research into their metabolism and behaviour.

41 THE RADIOCHEMICAL CENTRE (TRC)
Amersham, Bucks.

Prior to 1971 part of the Atomic Energy Research Establishment.

42 UNIVERSITY OF LEEDS
Department of Medical Physics, General Infirmary, Leeds LS1 3EX

Studies of environmental radiation and radioactivity in man. Studies of trace elements in the environment and in biological tissues.

APPENDIX C

ORGANISATIONS AND INDIVIDUALS WHO SUBMITTED EVIDENCE TO THE COMMISSION IN CONNECTION WITH THE TRAINING AND MANPOWER STUDY

**Includes attendance at meetings with the Commission*

Government departments and research establishments

Department of the Environment
- HM Alkali and Clean Air Inspectorate*
- Directorate General Water Engineering*
- Directorate of Vehicle Engineering and Inspection
- Central Unit on Environmental Pollution
- Water Pollution Research Laboratory

Department of Trade and Industry
- Civil Aviation Division
- Marine Division
- Petroleum Production Inspectorate
- Nuclear Installations Inspectorate
- Warren Spring Laboratory

Ministry of Agriculture, Fisheries and Food
- Fisheries Division
- Safety Pesticides and Infestation Divisions

Scottish Development Department
- Engineering Division*
- HM Industrial Pollution Inspectorate for Scotland*

Department of Agriculture and Fisheries for Scotland
- Fisheries Division
- Safety, Pesticides and Infestation Divisions

Department of Health and Social Security

Scottish Home and Health Department

Department of Education and Science
- University Grants Committee*

Scottish Education Department*

Appendix C

Public corporations

Civil Aviation Authority

Local authorities and local authority associations

County Councils Association*
Association of Municipal Corporations*
Urban District Councils Association*
Rural District Councils Association*
Norfolk County Council—Department of Public Health Engineering*
Local Government Training Board*
Local Government Operational Research Unit

Water authorities

National Water Council
Association of River Authorities
Water Supply Industry Training Board
Trent River Authority
Yorkshire River Authority

Professional institutions

Institute of Water Pollution Control
Royal Society of Health
Institution of Public Health Engineers
Association of Public Health Inspectors*
Institution of Muncipal Engineers*
Institution of Chemical Engineers
Society of Chemical Industry
Institute of Biology
Royal Institute of Chemistry
Institute of Physics
Institution of Civil Engineers
Institution of Water Engineers
Institution of Environmental Sciences
Society of Water Treatment and Examination
British Occupational Hygiene Society

Other organisations and individuals

Mr. J. Finch, Director, Department of Water Pollution Control, Slough Borough Council
Mr. T. H. Iddison, Chief Public Health Inspector, Borough of Dartford
Mr. F. E. Bruce, Reader in Public Health Engineering, Imperial College of Science and Technology
Mr. C. R. Cresswell

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