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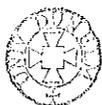
IMPLEMENTATION OF WATER POLLUTION CONTROL MEASURES:
THEORY AND PRACTICE

A THESIS SUBMITTED FOR THE DEGREE OF M.A. OF THE
UNIVERSITY OF DURHAM
by ALISON BISSET

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April 1980



14. MAY 1984

Abstract

This thesis examines the operation of water pollution control measures within England and Wales, especially over the last 20 years. The Northumbrian Water Authority was chosen to illustrate these various measures at a regional level. A contrast is made between theoretical, historical, legal and practical aspects of this topic. An attempt is made to show how various constraints limit the extent to which an ideal effective pollution policy can be implemented.



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Chapter One

Introduction

This study examines the evolution and implementation of water pollution control procedures in England and Wales, especially within the last 20 years. Evolution is implied not only in a historical sense, but more particularly in the modifications and adaptations which may take place between the initial conception of a measure as a theoretical idea or ideal, and its implementation as a practical measure. It attempts to explain how and why any modifications take place and at what stage these alterations have occurred.

To illustrate the possibilities of a process of policy modification, four different types of pollution control measure have been examined. Each shows an aspect of the possible ways in which a policy may be altered as it is put into practice. The four measures chosen are briefly summarised here:

1. Direct Regulation

Many theorists, particularly ecologists, uphold the view that a pollution problem may only be dealt with satisfactorily by control over the exact nature of any effluent discharge. Such a control seeks to impose limitations on the quantity and quality of a waste, and as a final sanction impose a total ban on its disposal. To illustrate such a method of direct regulation the consent procedure as operated by the Northumbrian Water Authority (N.W.A.) is examined (Chapter Four). The consent system is the longest standing form of control, barring the use of common law, currently in use in Britain. It has undergone relatively little change in form, except for an extension of its control to new areas. Recently, however, the procedure has undergone significant reappraisal,

particularly by the water authorities, as a result of implications of certain sections of the 1974 Control of Pollution Act. Such changes can be seen as being in conflict with other conceptions of the ideal system of pollution control, (Chapter Two).

2. Indirect Regulation

Some economists have argued (1) that the problem of pollution, as it is seen to exist by them, can only be effectively dealt with by use of incentive charging methods. In such a system, charges are imposed on polluters in proportion to pollutant load, in such a way as to encourage the reduction of that load (Chapter Two).

For example, water authorities, for many years, have had the power to charge for the costs of dealing with trade effluents. However, it is only recently that such charges have been made on a uniform and rational basis. Until the present, moves to introduce a scheme of incentive charging have been resisted. The reasons for this resistance are examined (Chapter Two).

3. The Operation of Sewage Treatment Works

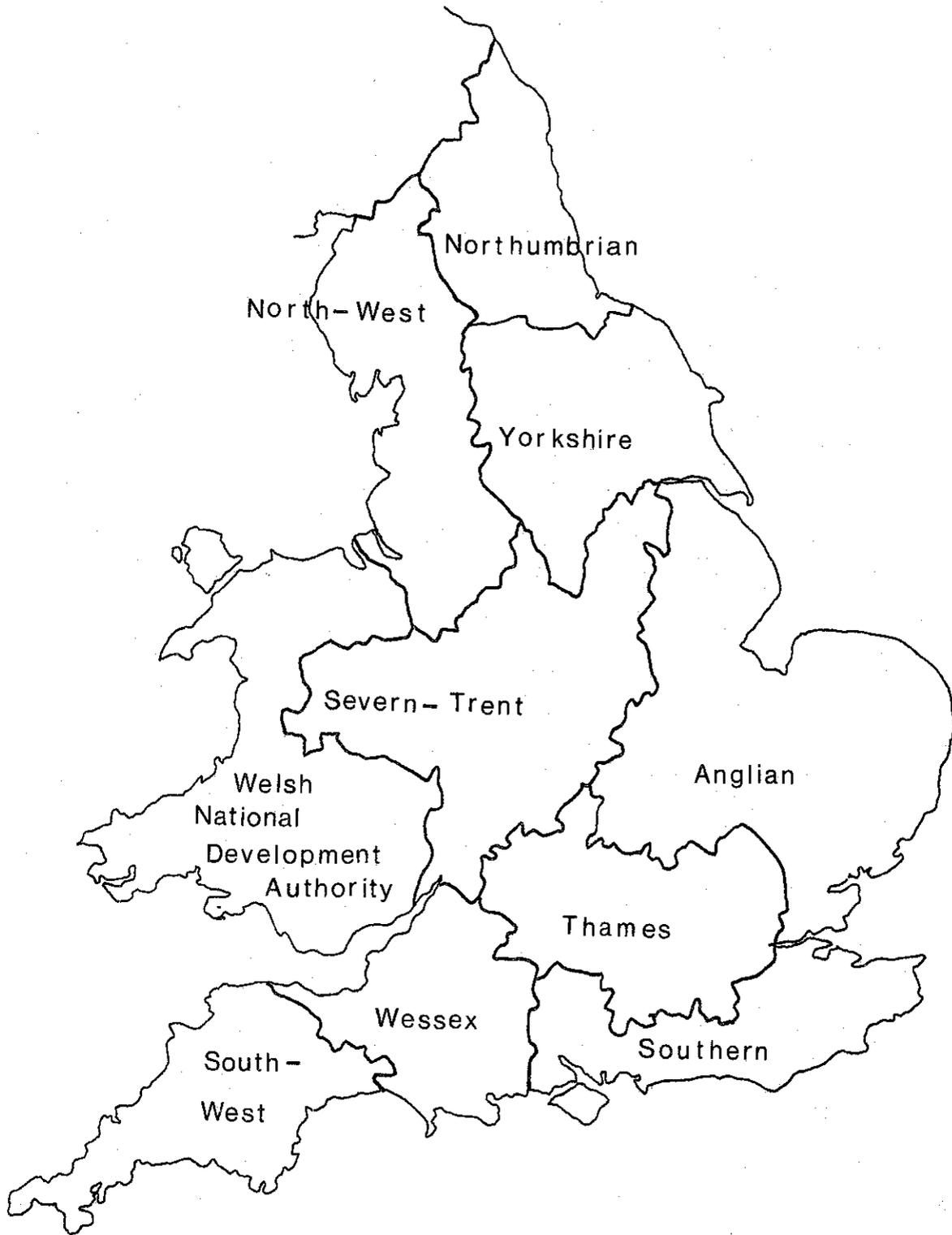
Treatment plants are the principal instruments by which, water authorities may ^{control the} extent of water pollution. Reappraisal of their efficacy took place with the reorganisation of the water industry following the 1973 Water Act. Many constraints, mainly financial, have limited the extent to which a comprehensive improvement in river quality might be achieved, despite the aspirations of government and water industry alike, to the contrary. The limitations which operate within the N.W.A. are examined in (Chapter Four).

4. The Control of Pollution Act 1974.

This Act is the single, most comprehensive, piece of legislation ever to be introduced on the subject of pollution control in

FIG 1

WATER AUTHORITY AREAS



Britain. It covers four main sources of pollution, Section II is devoted to water pollution, the others being land, noise and air pollution. It was enacted after a period of considerable debate both publicly and within government. Chapter Four discusses in detail the implications of this Act, particularly with respect to its impact upon consent and charging systems. Chapter Four uses this piece of legislation to illustrate a model of policy modification.

The N.W.A. was chosen to illustrate a pollution problem at a regional level, and the attempts made, using the various practices available, to counteract that problem. The N.W.A. was one of ten multi-purpose authorities (Figure 1) established under the 1973 Water Act. The area under its control largely coincides with that of the former Northumbrian River Authority (N.R.A.). It extends over an area of some 9,274 sq.km., embracing the Metropolitan County of Tyne and Wear, the Counties of Northumberland, Durham and Cleveland, and small parts of Cumbria and North Yorkshire. It includes three major river basins, those of the rivers Tyne, Wear and Tees.

Reorganisation brought about a radical redistribution of responsibilities. In the case of sewerage and sewage disposal, over seventy separate authorities were amalgamated under the N.W.A. All functions previously exercised by the N.R.A. - water resources, land drainage, fisheries, and the prevention of pollution, became the responsibility of the N.W.A.

A pollution problem is recognised in the more populated and industrialised areas of the N.W.A. region. In general, the quality of non-tidal rivers and streams gives little cause for

concern. (2) Almost without exception, the rivers of the northern and western parts are considered to be of satisfactory quality, in that they are clean, well oxygenated and capable of supporting fisheries. A number of them are used as potable water supply sources. However in the central, southern and coastal parts of the region, the volumes of sewage, trade effluent and minewater, often appreciable in terms of total stream flow, result in conditions which are less satisfactory. The pollution problem in tidal waters and estuaries is particularly severe (3).

The tidal Tyne receives untreated sewage from a population of some 870,000 people (2) and a large number of polluting trade effluents. The latter come from two sources: firstly as direct discharges made from factory to stream, and secondly, as indirect discharges made to rivers via the public sewerage systems. The tidal Wear receives untreated sewage from approximately 300,000 people, along with a limited number of polluting trade effluents. The tidal Tees receives untreated sewage from over 350,000 people, and a further polluting load (greatly in excess of the sewage equivalent) from discharges of trade effluent particularly from the chemical, petrochemical and iron and steel industries. It is estimated (2) that over 80% of the total organic polluting load discharged to the Tees estuary is derived from trade effluents. In addition there are problems of toxicity, due particularly to the presence of phenols, cyanides, heavy metals and ammonia.

Chapter Two outlines conditions as they existed in the late 1970's. Steps towards the rehabilitation of all three estuaries have been taken. Sewerage and sewage disposal schemes are in progress on both Tyne and Tees estuaries. Significant reductions

have been made in recent years, in respect of polluting matter originating as trade effluents. This has been achieved often by voluntary efforts of industrialists.

In addition to a considerable pollution problem, the N.W.A. area suffers from many other social and economic difficulties, not least being the sustained rate of high unemployment and the substantial run down of traditional industries, particularly ship-building and repairing, heavy engineering and coal mining. Many (4) stress the importance of attracting new industry to the area. There is thus the potential for a conflict between the desire for industrial prosperity and the need to control pollution by imposing limitations on industry.

The problems within the N.W.A. reflect many of the problems present at national level. The last 20 years have seen increasing concern over pollutant levels in British rivers, in particular in relation to the quality of tidal and estuarial waters. Britain has a long history of pollution control legislation (Chapter Three), with the result, for example, that approximately 94% (5) of the population of England and Wales is provided with main drainage, and over 80% is served by municipal sewage works. In addition, approximately 70% (6) of all industrial and commercial effluent is disposed of via such works.

Despite this background, England and Wales have a considerable pollution problem. Chapter Three illustrates the extent of the problem. This study seeks to examine some of the reasons for the failure of past legislation (Chapter Three) and presents factors which might hinder the implementation of a fully effective pollution control policy.

Chapter Two outlines the prescriptions given by theoretical ecologists and economists for an effective control policy.

Chapter Four details policies for consent and charging practice, and outlines the ways these are being adapted, principally in response, respectively, to the Control of Pollution Act 1974, and the financial constraints of the 1973 Water Act. The differences between theoretical stances and present practices are noted. Chapter Four concludes with a section on the actual practice of the consent system and contrasts this with statements of practice given earlier.

Chapter Five attempts to draw together in a model, the themes of policy modification introduced in earlier chapters. This model is illustrated with particular reference to the four measures outlined above. This study is not, therefore, looking at a particular measure and trying to determine whether it has changed the volume of pollution, but is examining the evolution of an entire set of measures. More particularly it is looking at the mechanisms and pressures within society which will determine whether a policy is initially formed, strengthened, altered, adopted or entirely dropped. It attempts to point out the factors which will always prevent adoption of a fully effective pollution control policy.

Chapter Two

Theories Concerned With Pollution

Introduction

This chapter is principally concerned with a comparison of the ways in which the sciences of ecology and economics have analysed the problems of environmental degradation and pollution control. A short synopsis of ecology and economics is given as background to, and part explanation of, the various solutions proposed for the abatement of pollution. It is recognised that this is in no way a definitive survey of all possible solutions or theories, but only an attempt to present a consensus view.

This chapter tries to demonstrate how a variety of conclusions have been reached apparently from the same data, but from different theoretical stances. Ecology and economics were chosen to represent such theorising because of their current involvement with policy formulation and their apparent conflicting views. In Chapter Four theoretical solutions are compared with actual practices and an attempt is made to explain differences between the two.

2.1 As an ecological issue.

2.1.1 A synopsis of ecology.

Ecology has been defined (1) as the study of "the inter-dependencies of living things, both between themselves as species, and between them and their environments" or as (2) "the study of the structure and function of nature".

It is seen as having developed from a sub-branch of biology into a major inter-disciplinary science, linking together biological, physical and social sciences. The main features of ecology are briefly outlined below, particularly those aspects which demonstrate a connection with economics. The relationship between ecology and economics is more fully explored in Section 2.3.

A system of living things in relationship with their environment is called an ecosystem. An ecosystem is not a static entity, but is continuously developing and changing as a result of the stresses placed upon it. An ecosystem can be considered to be attempting to evolve towards an optimum state. This is defined and described by two basic concepts. Firstly, there is the idea of biomass - a quantitative measure of the organic matter content in the system (stock). Secondly, there is the notion of productivity - the rate of change of biomass (flow). A system is considered to be productive if biomass is accumulating. An optimum state is said to exist when biomass is practically constant. An alternative name, therefore, is the steady state (3,4,5).

An ecosystem, like any economy, has inputs and outputs. The two categories of inputs are energy and materials. All systems depend on a continuous external supply of energy (ultimately solar

energy) to maintain themselves. This flow is uni-directional, that is without the possibility of re use. Systems are also characterised by flows of matters, which unlike energy flows, are capable of re-use by recycling. Stable ecosystems have developed highly efficient methods of recycling vital minerals so that losses from the system are at a minimum (6). Stocks, are therefore, maintained at almost a constant maximum.

Many ecologists believe that as an ecosystem matures, that is, approaches the steady state, the more species it is likely to contain. In consequence, the system is also likely to be more complex in so far as more inter-relationships must now exist. By increasing the number of these relationships the entire system is strengthened. As a result an essential prerequisite of ecosystem stability is that it supports a maximum species diversity.

The question of stability is central to ecologists' criticisms of economists' approaches to the management of systems (or economies). It is argued that modern technology, and the forces of economic growth, produce specialisation rather than diversification in activities. This must, it is reasoned, lower ecosystem stability. Criticisms apply particularly to the modern agricultural technique of monoculture, but can be extended, theoretically, to all forms of production(7).

2.1.2 Pollution and ecology.

Ecosystem stability implies the ability to withstand exogenous shocks; natural, such as climatic changes, or man-made, for example, pollution. It is argued (8) that man cannot affect his environment detrimentally without serious repercussions. Some suggest (9) that man may even endanger his biological survival.

Pollutants may act in three ways to interfere with ecosystems and environmental adaptability (1). First, they may act to speed up the processes of evolution, to the extent that associated populations cannot adapt at the same rate, resulting in their elimination. Diversity, and therefore, stability is reduced. Thus a habitat may become suitable for only one type of species. An example is the addition of large quantities of nutrients to water bodies which produced 'algal-blooms', which may be to the detriment of other populations (10).

Secondly, pollutants may interfere with the various biogeochemical cycling processes. It has been suggested that nutrient losses are at their greatest in an unstable ecosystem. Pollutants may be capable of increasing such losses from the system and thereby reduce its stability. Populations, dependent on a given nutrient stock or flow, will consequently be reduced.

Lastly, pollutants may be directly or indirectly toxic to supported populations. Directly as in the case of poisons such as cyanides, or indirectly, as in the case of insidious accumulative poisons. This latter group includes cadmium, lead and mercury, which only become lethal or harmful after building up to toxic levels.

Every environment has a limited capacity to absorb, and render

less harmful, pollutants. The quantities absorbed vary depending on the qualitative nature of the pollutant. For example, all rivers are capable of assimilating limited amounts of organic matter, by the decomposing action of bacteria. However, beyond a critical limit, the capacity of such bacteria is exceeded and other forms of bacteria replace them, with subsequent ill-effects. At the other extreme are pollutants such as plastic and glass which are practically inert and therefore cannot be assimilated into the environment.

Pollution, therefore, has two important facets, quantitative and qualitative. It is capable of affecting the physical environment and thereby the species composition within that environment. It also has a qualitative dimension, reflecting the technologies employed in production, at a given level of economic activity. Every addition of a pollutant to an ecosystem, reduces the capability of that system to withstand further stresses; it thus becomes increasingly difficult to rectify internally (1). An ecologist's definition of pollution stresses the concepts of species composition, assimilative capacity, stability and diversity.

2.1.3 Ecological policies.

In general, the types of policies advocated to remedy the problems of environmental pollution, by ecologists, can be divided under two headings. The first, supported by those who can be termed pure ecologists, recommend that stresses placed on the environment should be eliminated or reduced. For pollution, the type of action advocated is one that seeks to impose limits on discharges which are dangerous beyond the assimilative capacity of the environment. Prohibitions are to be made on materials which have toxic qualities.

The second proposed remedy advocates more radical action, seeking to copy the requirements of the steady state. The second policy recommends a political solution, whereby society is fundamentally altered to make the environment more resistant to stresses placed upon it, and in turn making that society more stable. The Ecologist's 'A Blue print for Survival' (1972), probably encapsulates these views most strikingly (8). For example in a discussion on methods of controlling pollution the following was noted:

"Pollution control proper must consist of the recycling of materials, or the introduction of practices which are so akin to natural processes as not to be harmful. The long-term object of these pollution-control procedures is to minimise our dependence on technology as a regulator of the ecological cycles on which we depend, and return as much as possible to the natural mechanisms of the ecosphere, since in all but the short term they are much more efficient and reliable".

Pollution, and its control, is seen as part of a larger

question of attaining the stable steady state; again from
'Blueprint for Survival':

"The principal conditions of a stable society - one that to all intents and purposes can be sustained indefinitely while giving optimum satisfaction to its members - are: (1) minimum disruption of ecological processes; (2) maximum conservation of materials and energy - or economy of stock rather than flow; (3) a population in which recruitment equals loss; and (4) a social system in which individuals can enjoy, rather than feel restricted by, the first three conditions".

To achieve these conditions several recommendations are made which include: halting (and reversing) economic and population growth; replacement of harmful technologies by less harmful ones and substitution of technologies by natural or self-regulating processes; decentralisation of policy and economy to small self-sustaining communities. Some of these requirements are discussed with respect to economists' proposals for a solution of the pollution problem.

2.2 As an economic issue.

2.2.1 A synopsis of economics, as applied to the environment.

Economics has been defined as (11)

"the study of human behaviour and operation of institutions which produce and distribute goods and services for the satisfaction of human wants, utilising scarce resources, including those provided by man's environment".

It is only comparatively recently that the goods and services provided by 'man's environment' have been considered as scarce resources. In the past they were commonly regarded as 'free goods' available in unlimited quantities, and therefore almost free of charge, and as such, excluded from the scope of economics. It is now recognised that all resources are limited in quantity; thus the problem of their most efficient management has arisen.

The environment has been regarded as supplying three types of goods or services (2, 12). Firstly it provides natural resources for the production of economic goods. Secondly, it supplies a means of disposal for the residues of production and the discards of economic activity. Lastly, it provides a supply of natural goods, difficult to quantify on a monetary scale, such as a pleasant view.

It has, therefore, become a function of economics to deal with these scarce resources provided by the environment. More strictly, it has become a problem of integrating environmental effects within the economic mechanisms already operating. It is assumed that natural resources may be efficiently managed by allocating costs rationally.

The problem of allocation of costs can be subsumed under two headings: the problem of internalisation and the problems of optimality, efficiency and equity. It is generally agreed by economists (14, 15, 16), that the problems faced today arise out of market failures. This is the partial inability of market mechanisms to allocate natural resources due to the failure of the price mechanism to account for such resources. Thus when an environmental (or other) effect is not automatically taken into account by the price mechanism it is called an external effect (17).

Opinion varies as to the severity of the pollution problem. Beckerman (18) (1972), is in no doubt that

"the problem of environmental pollution is a simple matter of correcting a minor resource allocation problem by means of pollution charges."

However, other economists are not convinced that it is such a minor problem and that its solution is as simple as Beckerman suggests.

Classical economic theory states (19) that every economic agent seeks to maximise his revenue by some socially useful activity. For example, a manufacturer hopes to show as large a profit as possible by producing goods useful to the community. There is thus harmony between the interests of the producer expressed in terms of private costs (and profits), and that of the community which consumes those goods (social costs). However, if the market fails to price all resources, then the private cost of production may be distorted so as not to represent the social cost of production. Hence the costs to society

may be greater than those to private producers as producers are passing on part of their costs to society at large, thus causing a misallocation of resources. The effect which results from this discrepancy between the private costs of an activity and the corresponding social cost is termed an external diseconomy or negative external effect. Pollution may be seen as one such external diseconomy, in that the costs of damage and removal are paid by society, rather than by those who created the pollutants (17).

The aim of economists, therefore, is to close the gaps between private and social costs, by including in the individual economic calculations of firms the costs of resource misallocation, i.e. internalising the external effects. As, in this case, such diseconomies imply degradation of the environment, internalisation implies (i) better management of natural resources and (ii) maximisation of social welfare by optimum social cost allocation.

In general, whatever ^{the} method advocated, the aim is to internalise the costs of external diseconomies, closing the gap between private and social costs (20).

An environmental objective is determined not solely on economic criteria, but also by ecological, geographical, political and administrative considerations. With an awareness of this, economists see themselves in two roles. Firstly, in helping to define these aims and ensuring that they are compatible with other economic objectives which are operative in the area under consideration. Secondly, they see a role in determining and applying effective instruments for achieving the objectives of an

environmental policy.

Economists are thus concerned with problems of efficiency and equity, how to achieve a given quality standard, at least cost and maximum benefit, and how to distribute that cost. Equity demands that everyone must assume responsibility for any damage they cause, and, if an environmental policy causes unfair redistribution of income, that corrective measures be taken. The requirements of equity may not necessarily be economically efficient, but must be given weighting as a decision criterion (12, 21).

2.2.2 Pollution and economics.

Given that the guiding principle of most economists on this question is to equate social and private costs, several broad types of theoretical solutions can be recognised (19, 22).

There are those who wish to permit negotiation between the polluter and the victim(s), to settle the best cost allocation between them. One method of doing this, would be to assign private property rights to public goods and services. So, as in this case, one could purchase the right to pollute, or withhold that right thus limiting the total pollution permitted into the environment. Other forms of negotiation suggested include subsidies paid by society to prevent firms discharging pollutants, or conversely firms paying society for any damage caused.

More liberal economists argue that the problem of pollution is a much more widespread and serious problem than their conservative fellows would claim. As such, minor patching up is insufficient to deal adequately with the problem. They argue that the costs of production, as example of externalities, pervade the entire economic system. Further, as the benefits of non-pollution belong to all members of society, i.e. are also public goods, it is impossible to divide them up for sale, for the benefit of some, but not others.

Their conclusion, therefore, is that society cannot solve this problem by tinkering with property rights for public goods. As they see no reason why industrialists should develop altruistic intentions, they conclude that this is a clear case for some sort of public intervention, through legislation.

At the opposite extreme to conservative economists are

radical economists. In some ways the radical economist shares similar views to the radical, steady state, ecologist, both believing that capitalism and the profit motive are the root causes of pollution and other externality problems. They believe that any controls, directly by regulation, or indirectly by the use of the price mechanism, cannot work in a capitalist state. They see the motives of the state as in direct conflict with the consequences of pollution abatement because the apparatus of government is geared towards the interests of private property. Any measure which seeks to limit profitability will, therefore, be opposed. The solution proposed is a fundamental re-organisation of society, eliminating the profit motive, the quality of life becoming the prime consideration.

2.2.3 Economic Policies.

The majority of policy solutions tend towards the conservative viewpoint rather^{than} the liberal or radical. Of the three types of measure - sale of pollution rights, subsidy payments and charges - charges are generally considered to be of most practical value.

Appendix A outlines the general theory of charges and compares the advantages of this method over those of another form of control, control by direct regulation (23, 24, 25, 26).

2.3 A comparison of economic and ecological viewpoints

It has been suggested above that within the disciplines of ecology and economics a range of opinion exists on the topic of pollution and the appropriate methods for its control. The following quotes partially demonstrate some of the variety of opinion, and in particular highlight the rift between some ecologists and economists.

One ecologist (27) refers to economists as seeing the "world as a commodity" a view which "fails to evaluate and incorporate physical and biological processes", while one economist (28) describes ecology as "essentially conservative and non-objective and as such as a science or a mode of thinking ill-suited to serve as the basis for developing the central public policies of the modern world".

However, it is possible to find economists and ecologists who do not seem to be so diametrically opposed to each other. One such economist (29) has suggested that

"the greatest service economists can render to posterity is to remain silent".

Even more bluntly Boulding has suggested that

"anyone who believes that exponential growth can continue in a finite world is either a madman or an economist". (30)

If, as Downs (28) suggests, economics or ecology can be used as the central tenets for planning the future, then the divergence in their respective viewpoints begins to attain some importance. If, for example, the ecologist wrongly asserts the requirements of the steady state, advocating policies of zero

economic and population growth, material standards of living may be unnecessarily reduced. Conversely, if economists are unduly optimistic, policies based their recommendations may entail serious risks to the quality of life.

Accordingly, several basic issues are discussed in relation to the conflict between the two camps, with particular reference to pollution abatement. Much of the argument stems from the relationship between economic (and population) growth and environmental quality. The basic question which is asked, is whether growth itself or its particular form is responsible for environmental degradation? If the latter, do the productive and technological possibilities exist to change to a less harmful form of growth? (12, 13)

Radical elements within ecology and economics believe that some form of fundamental change is required. The environmentalist maintains that an inverse relationship exists between economic growth and environmental quality, the root causes being pollution intensive technology and the market mechanism. The radical economist would argue that the profit motive is the fundamental cause, and that these two policies, along with less harmful technologies, are necessary to reach the conditions of the steady state. Some economists, notably Boulding (1966) (31), have accepted the necessity for the steady state as inevitable, drawing parallels with the economy on board a spaceship. Some ecologists echo radical economists in asserting that the changes necessary are impossible in a capitalist economy which must be replaced by some form of socialism, if these are to come about.

Less radical economists have also come to sympathise with the

view that growth, economic and population, is a fundamental cause of environmental degradation. (33) Though not a view with which many would disagree, the majority of economists probably feel that it is a point which can be taken to extremes. Four pertinent points can be made. Firstly: is there such a strong link between economic growth and environmental degradation? Secondly: technology can be beneficial in alleviating the causes of pollution. Thirdly: what would be the implications socially, economically and environmentally, of a no-growth society? Lastly, to follow up the ideas of radical economists, could less pollution be achieved under a different sort of political-economic system?

To take each point in turn; it is claimed that there is no direct, straight-forward, link between growth and environmental quality. Economists define growth in terms of Gross National Product (G.N.P.), which, broadly defined, is a measure of the output of goods and services sold on the market (21). However some goods or services are responsible for environmental degradation (34). Accordingly, the aim is to cut down or eliminate those activities which have the more harmful effects, replacing these with less destructive activities. Further some elements of G.N.P. could actually be increased, for example the production of pollution abatement equipment (35, 36).

Economists have generally assumed that G.N.P. is a rough surrogate for human well being. Ecologists dispute this use of G.N.P., pointing out that welfare also depends on non-marketed goods provided by the physical and social environments. It is claimed that if all the costs of a degraded environment were

evaluated and subtracted from G.N.P. then welfare, as measured by this indicator, may not have advanced appreciably, but may even have declined (37). There is a problem of quantification, since ecologists tend to regard the environment as a priceless asset, while economists prefer a monetary value at something considerably less than infinity. Attempts have been made (38) to adjust G.N.P. for all unmarketed goods and services but with dubious success, so most prefer the simple measure of G.N.P. (39).

Secondly, what is the exact nature and role of technology? While some ecologists claim that technology is at the core of environmental degradation, some economists take the more hopeful attitude that it may be used to solve the problem. This assumes that the appropriate incentives exist to direct polluters towards low polluting technologies, rather than relying on their chance adoption.

Thirdly, what would be the impact, invironmental and social, of a no-growth policy? (8, 30, 40). It is felt that it is impossible to consider no-growth policies without reference to income redistribution (21). Many feel that 'no-growth' implies a stagnation of the current socio-economic system, with little possibility of redistribution of income towards the poor. A similar stance is taken by poor nations in their reactions to suggestions by affluent Westerners that no-growth policies should be implemented in their countries.

It is also argued that a no-growth society is not necessarily a non-polluting society - the appropriate forms of technology must also be implemented. Further, some economists (40) maintain that growth may be necessary if we are to afford programmes of environmental improvement (41, 42) and that a no-growth society would be

incapable of generating sufficient funds for such schemes. More over under such conditions the pressures from other quarters for a share of the national budget are likely to be at their most severe. Ecologists are reminded that their view of the world is, perhaps, too restricted and that other forms of degradation, other than that of the physical environment exist (12). Thus the claims of slum clearance, health and education programmes and crime prevention must be weighed against those of environmental improvement schemes. Such choices are a matter for the political machinery and the electorate.

By way of a summary, a digest of the types of solutions proposed can be made. These fall into three broad categories.

1. Direct measures, including the use of regulations.
 2. Indirect measures, implementation of the price mechanism.
 3. Societal restructuring.
1. Direct measures.

This heading includes all regulations imposed by public bodies upon polluters. This includes absolute bans and imposition of maximum standards on emissions. These measures are supported by most ecologists and some economists. The ecologist aims for the minimum possible recovery of the environment. His viewpoint stems from the importance attached to pollution as a hazard to health, life, and ecosystem stability. A high value is placed on aesthetic and amenity value of the environment; the perceived benefits from a high grade environment to an environmentalist are higher than those perceived by the public in general and economists in particular. Those economists who support bans and standards believe that the price mechanism is inadequate as a

method of control.

The advantages of bans and standards are that they set a clearly defined set of objectives, independent of the vagaries of the market. This is generally preferred by governments as it produces a clear-cut concept, within the existing administrative framework. Regulations give precedence to environmental, rather than economic, objectives, and are the surest way of preventing irreversible effects and unacceptable pollution. Their disadvantages are that they are cumbersome and expensive both to administer and in the information required for efficient operation. They do not aspire to any principles of economic efficiency, nor do they provide any incentive to improve on the required standard. Direct regulations are consistent with the requirements of the 'polluter-pays' principle (24) in that the polluter pays for the cost of achieving the set standard. Further, once the standard has been set and complied with, no further payment is required.

2. Indirect measures.

These measures include payments, subsidies and charges. The economists' decisions are based on the trade-off between costs and benefits. Thus an economist will weigh up the demands of the physical environment against those of the social environment. An economist, therefore, is more closely bound to society's value judgements - in this case judgements on desirable environmental quality and hence, the permissible level of pollution. Problems are seen within the context of the current political and social situation. An economist attempts to equate social and private costs to achieve an optimum level of pollution, and therefore an

optimum amount of environmental degradation, at the minimum overall cost to society as a whole.

To achieve this equilibrium of social and private costs, the implementation of charges is preferred to payments, subsidies or tax incentives, on the grounds of the economic criteria of efficiency and equity. The "Polluter-pays" principle as defined by the OECD (24), prefers charges; partly on the grounds of economic efficiency, and partly because it is morally incorrect to implement any measure which forces any victim(s) of a polluter, to pay that polluter in any way to inhibit his actions.

3. Societal restructuring.

This heading includes those elements within ecology and economics which wish to replace a society based on the profit motive with one that is not. In the case of radical ecologists this is a no-growth society, aimed at emulating the conditions of the well-run ecosystem. The radical economist wishes to replace capitalism with some form of democratic socialism, eliminating the profit motive, but not necessarily growth.

Chapter Three

Perspectives on Pollution Control

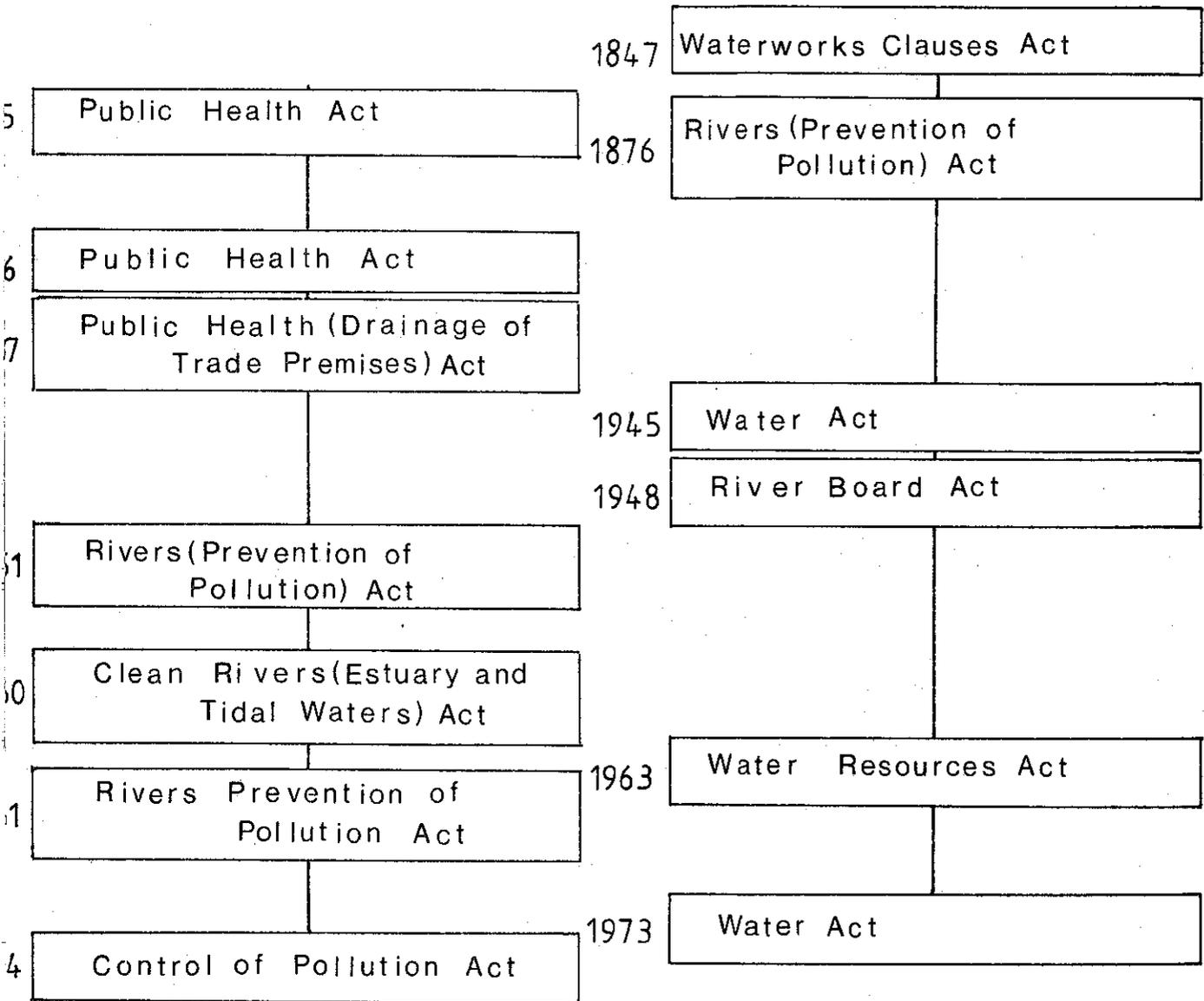
This chapter reviews the historical development of water pollution control legislation and the evolution of those authorities responsible for its implementation. It notes the influences which affected the scope of such legislation. The interaction between pollution control, river quality and other priorities of river management are discussed in terms of the potential conflicts in objectives which may arise. Lastly, this chapter reviews the conditions prevailing in the rivers of England and Wales and indicates some of the factors which have determined these circumstances.

LEGISLATION

FIG 2

POLLUTION CONTROL

WATER ADMINISTRATION



3.1 Historical developments

3.1.1 Developments in Britain before 1945

This section examines the changes in the water industry and legislation relating to pollution control prior to the inter-war period. It shows how the prevalent ideas and criteria of earlier times have been carried on into more recent times, despite changing circumstances (1).

Early statutes, such as the Bill of Sewers of 1531, indicate that some form of pollution of our waterways has always existed. However it was not until the Industrial Revolution that it became a problem of more than localised proportions. Two factors combined to bring about an abrupt deterioration of river quality, especially within the urban areas. These were the rapid growth of (urban) population and the expansion of industry. These circumstances brought about conditions whereby not only was the volume of waste increased but also its disposal was largely restricted to the urban areas.

Throughout the history of pollution control, the health of the community was, and is still, the most fundamental criterion governing water resource management. (The prevention of disease and its transmission is one of the basic requirements laid upon a water authority). This criterion dates back to the work of Dr. John Snow who first established a link between cholera and sewage (1). His work had a dramatic effect on water supply and sewage disposal practices, the consequences of which can still be felt today (2). A period of 'supply-grabbing' (3) was initiated in which local authorities sought to control uncontaminated up-stream and ground water sources (4). The

construction of water supply and sewerage systems began at this time.

The repercussions of this mode of thinking were numerous. Responsibility for river quality was given to the multiplicity of newly created sewage disposal authorities. As they had no incentive to have regard for overall river quality they did little more than collect waste from within their areas and dispose of it at their boundaries. Each authority attempted to develop its own upland sources, despite the wasteful use of the resource, tacitly regarding lowland rivers as open sewers. The development of such upland sites was given over to water engineers, who received what amounted to a carte-blanche, to provide the urban areas with a clean, safe supply of water (5).

The scramble for upland sources showed the need to divide sensibly available supplies between competing demands. Often dry weather flow (D.W.F.) (Glossary) was so reduced as to affect downstream abstraction rights. So, many came to believe that river water should be managed in terms of quantity and quality; water supply being recognised as inseparable from water quality. These ideas were expounded by three Royal Commissions (1), set up in the decade 1865-75, to examine water supply, sewage disposal and river pollution.

Their recommendations included

1. Administrative control related to catchment areas, instead of the artificial boundaries of local authorities.
2. Exploitation of water resources for sensible distribution to all users.
3. Priority not given over to any one sectional interest.

However these far-sighted recommendations were largely ignored and continued to be so for nearly a century. Instead during the next 25 years the scope and powers of the local authorities, including their role as those responsible for water supply and sewage disposal, were expanded.

The Rivers (Prevention of Pollution) Act 1876 (Appendix C) was typical of the type of legislation of this period, incorporating two serious disadvantages. Firstly, it sought to enforce local autonomy, making local authorities responsible for its enforcement. Thus administration was divided between dozens of urban and rural sanitary authorities between the source and mouth of a river. As their responsibility extended only as far as their boundaries, each authority remained uninterested in water quality downstream, making co-ordinated control impossible. This attitude was reinforced by a need to minimise local expenditure, a constraint which implied the disposal of sewage as cheaply as possible. Secondly, the provisions of the Act made enforcement by local authorities on private polluters difficult, if not impossible to implement effectively. Not only were the local authorities the enforcers of this Act, they were also the principal offenders in their capacity as sewage disposal agents. This compromised their capacity to dictate to others. Further, a polluter could not be penalised if he could show that he had used the "best practical and available means to render the polluting matter harmless" (1). Even if this had not been accomplished, no action could be taken that materially damaged an enterprise. In practice therefore, the Act exempted industrial interests

from the possibility of legal action, consequently giving no incentive to curb pollutant discharges. A further weakness of this particular Act was that it sought, unrealistically, to limit pollution by prohibitive measures which were ignored by most. Despite these faults, this Act survived for 75 years before modifications were made. During the last quarter of the nineteenth century, the general standard of health of the community improved. However the overall quality of rivers continued to decline, caused by the additional load from increasing population and rising economic activity. This situation was not aided by the proliferation of local authority undertakings (6), and came about despite the rapid growth of sewerage networks and sewage disposal works. Considerations of thrift and the protection of industrial interests prevailed over that of improved river quality.

From the turn of the century until the Second World War, efforts were made to centralise control of water resources. For example, in 1910, a Private Members Bill was introduced in Parliament. This sought to limit the powers of water supply undertakings. These had been criticised for their inconsiderate abstraction practices which took little account of other water users. This was partly due to the narrow brief given to water engineers to extend supplies to all households, often to the exclusion of other water uses. This Bill would have changed practices, if it had not been forestalled by the outbreak of the First World War.

With peace, the Ministry of Health was established, taking over from the Local Government Board. It assumed responsibility

for water supply and sewage disposal. Thus health considerations remained the dominating concerns in the provision of these services, their practical implementation being committed to the hands of water engineers. However, as an exception to this, the Board of Trade had established a Water Power Resources Committee, whose terms of reference came to include conservation of the national water resource. The Board of Trade's committee drew attention to the way different water uses were separated between many government departments and recommended what amounted to nationalisation of the nation's water resource. Central direction was to be provided by a Water Commission which would exercise control over all water allocations. It was acknowledged that health must remain the pre-eminent concern, the Water Commission being subordinate to the Ministry of Health. However it was felt that such a Commission would usurp the power of the government departments involved and interfere with the autonomy of local authorities.

However, the idea of centralisation was not totally abandoned. In 1934 a conference was convened to consider again a national water policy. The report that followed stimulated Parliament to set up a Joint Select Committee. This recommended that a Central Advisory Water Board (C.A.W.B.) should be formed to represent all Ministries concerned with the water resource, as well as independent bodies. These included riparian owners, water supply undertakings, and fishery boards. The Committee purposely discounted giving the Ministry of Health any special status, on the grounds that such an act would give undue preference to the water supply service to the detriment of other interests, particularly those of industry, agriculture and

fisheries. The result was the formation of a Central Advisory Water Committee (C.A.W.C.) in 1936. This had responsibility for advising government departments on water legislation and all questions relating to the conservation and allocation of water resources. Its first act was to consider how the law relating to public water supplies could be consolidated. However the outbreak of the Second World War preempted any action on these matters.

A resumé of relevant legislation is given in Appendix C, Figure 2. It includes notable legislation of the inter-war years, particularly the 1936 and 1937 Public Health Acts. These were responsible for establishing control over the discharge of industrial effluent by the consent of the appropriate local authority.

3.1.2 Developments between 1945 and 1972

This period was one of changing attitudes. The pre-occupation with water supply, dictated by the concern for the health of the community, lessened as the equal importance of all parts of ^{the} water cycle was recognised. It is also a period when concrete steps were taken towards rationalisation of organisational units based on catchment areas. This had consequences for the effectiveness of any action taken, for example on pollution prevention.

In 1943, the C.A.W.C. produced three reports (7) which were consolidated into a government White Paper. 'A National Water Policy' (8). This was given legislative effect by the 1945 Water Act (Appendix C). This Act attempted to give force to some of the ideas on water management which had been discussed over the past century. For example the Act gave powers for the compulsory regrouping of water supply undertakings into self-contained units. It attempted to introduce a two-tiered administrative structure: an advisory C.A.W.C. acting at a national level; joint advisory committees acting on a regional basis. However the continuing reliance on the local authority structure, and the lack of powers granted to these bodies. ^{limited their effectiveness} A change in attitudes was indicated by the legal recognition granted to the idea of managing rivers in terms of quantity and quality. Water engineers, used to being regarded as the leaders against pollution, were now criticised for allowing unnecessary abstraction and over-looking other possible river uses, often to the detriment of river quality. According to one critic:

"There is a danger, that in concentrating on the standard

of effluent discharged into our rivers, we will lose sight of the need to preserve the natural flows already there and in many cases sadly reduced by existing abstractions. The two problems are of equal importance". (9)

However despite these advances, the 1945 Act largely perpetuated the past system, with its over-reliance on local authorities and over-emphasis on the importance of water supply. It remained until 1963 to define the pattern of water supply management.

Following a wartime report of the C.A.W.C. on river management, a government White Paper made suggestions as to the organisation of some functions of water management, including pollution prevention, under single comprehensive authorities. These were to be known as river boards. The number of authorities was to be drastically reduced, their boundaries defined by catchment areas. Its recommendations were partly fulfilled by the River Boards Act, 1948. This established 32 river boards, transferring to them all functions relating to land drainage, fisheries and river pollution prevention. As recommended, boundaries were defined by natural landscape features.

This had important implications for the likely effectiveness of any pollution prevention measures. Each authority had to have regard for quality along the entire river, as rivers were no longer subdivided between authorities. Those that paid for pollution abatement could now be sure of enjoying the benefits of such measures, rather than passing them on to the authority downstream. Similarly, it could no longer be argued

that poor river standards were due to the ineptitude or laziness of an upstream authority.

Beyond the steps taken to improve the administrative organisation of water resources, the Rivers (Prevention of Pollution) Act 1951 (Appendix C), sought to take direct measures towards pollution abatement, replacing the Rivers Pollution Prevention Act 1876. It transferred powers for pollution control from the local authorities to the river boards. It attempted to replace the prohibitive system of the 1876 Act by two devices, one of which (byelaw minimum standards) was considered to be unsuccessful and was repealed 10 years later (10). The other device, control by consent, had been introduced by the 1937 Public Health Act. The 1951 Act declared all new discharges illegal unless they had obtained the consent of the river boards, (as opposed to the various local authorities); individual consents specifying the standard of quality and quantity of an effluent. Thus control, unlike the 1876 Act had become anticipatory. It was considered so successful as to be extended by the 1961 Rivers (Prevention of Pollution) Act. This Act brought under its control waste discharges existing prior to, and therefore uncontrolled by, the 1951 Act. Significantly, for the first time, an unsatisfactory effluent had to be treated at least to the conditions of consent, despite any additional cost. Penalties included a period of imprisonment or, as an extreme sanction, closure of the works. However the financial penalties for an infringement of the consent conditions, were in most cases minimal, a maximum of £100 for a first offence, £20 - £30 being more usual (11). The previous

year, 1960, these regulations had been extended to estuaries and coastal waters by the Clean River (Estuaries and Tidal Waters) Act.

In 1963, following the Proudman Report of its Sub-Committee on the Growing Demand for Water (12) and a government White Paper on Water Conservation (13), the Water Resources Act was passed. The Act formed 27 river authorities plus the Thames and Lee conservancies. These were responsible to the Ministry of Housing and Local Government rather than the Minister of Health. This perhaps indicates the way in which most health requirements had been met; 90% of the population now had a piped water supply, for example (11). Emphasis could now be shifted towards other priorities. To implement the new national water supply policy the minister was to work through these new authorities, and a new central agency, the Water Resources Board.

The river authorities took over all the old duties of the river boards, including pollution control. For future development they were required to estimate current and future water requirements and formulate proposals to meet expected demand. Three areas of general responsibility were defined. Firstly, improvement of river quality by suitable works, to augment the quantity of flow. Secondly, prevention of excessive abstraction which would reduce the flow and adversely affect quality. Lastly, management of rivers for the best interests of all users. Thus, there was a move away from the preoccupation with water supply, illustrated by the change over to the construction of regulating rather than storage reservoirs. Representation on river

authorities attempted to reflect the interests of all users, notable omissions being the factions for amenity, recreation and aesthetic values.

The consent procedure was further extended to include the discharge of effluents to underground strata; the conditions of consent being much as those for discharges to water courses. The 1963 Act also made provision for a register in which a record of all permitted discharge consents was to be maintained, available for public inspection. The likely effectiveness of the consent procedure was improved by giving officers of the authority the right to take samples of effluent, to check whether the conditions were being satisfied. However this right was subject to several limitations including advance notification of when sampling would take place. Given that the river authorities chose to allocate limited resources to a sampling programme, the opportunities were available for those wishing to contravene the conditions of consent to do so.

To summarise, several influences can be identified in this period (1945-1972). Historically, the concern for health initiated a preoccupation with the provision of water supply. Often this was to the detriment of other forms of river use. It was left to water engineers to provide these facilities as they saw fit, frequently resulting in over-investment and short-term planning. Administration for many years was in the hands of small self-interested local authorities, between whom overall co-ordination of pollution control and water quality was practically impossible. No improvement in circumstances could reasonably be expected until: firstly, administration was handed

over to much larger units, based on catchment areas; secondly, measures instead of being unrealistically prohibitive, were related to the individual polluter; and lastly, supply was given equal rather than over-riding priority with other river functions. By the 1960's several new ideas were being introduced which can be seen expressed in current legislation.

3.1.3 Current legislation

Despite the fact that the 1963 Water Resources Act had been hailed as

"a giant step forward in England's response to contemporary water problems" (14)

the Act lasted barely 10 years, and was superseded by the 1973 Water Act. Amongst its other responsibilities, the 1963 Act had required an assessment of the of the availability of supply and likely future demand. It was soon apparent that in many authorities a deficit would soon occur. In conditions of shortage the interaction between quantity and quality becomes important. It became accepted that efficient management of water resources did not imply provision of a universal water supply to drinking water standards, but ensuring a range of qualities suitable for a variety of uses. The river authorities were faced with the problem of how to satisfy these requirements given such constraints as a limited budget, conflicting demands, aesthetic considerations, and a need for an equitable distribution of costs.

These ideas led to a reappraisal of water resources. Until then, if a demand (real or otherwise) could be envisaged then steps were taken to satisfy it. This has been described as a 'supply-fix' (15). Now, closer examination was made of the exact nature of any demand, and even new measures, such as demand management, for example by metering (16), or tariff manipulation were considered (17, 18).

Indicative of the changing attitudes of this period are the ways in which economists became involved with the water

industry. Firstly, as a finite limit to supply could now be envisaged, economists, traditionally concerned with the allocation of scarce resources, brought their skills to bear. Secondly, moves were made to treat water management as an industry with inputs, expenditures and a product, as any other industry. Economists, therefore became involved on this second count.

These types of difficulties and changed attitudes led to a 1971 C.A.W.C. report 'The Future Management of Water in England and Wales' (19). After general discussion with all parts of the industry, the 1973 Water Act was passed.

Coming into force on the 1st April 1974, this Act radically simplified the fragmented organisation of water resources. These had been administered by just over 1600 authorities, which existed until then, despite the efforts towards amalgamation, made over the previous 25 years. Overnight these were collapsed into 10 multi-functional regional water authorities, responsible for every aspect of the hydrological cycle. (Figure 1). Their boundaries were defined by catchment areas. Although each authority is autonomous, they are co-ordinated nationally by the National Water Council (N.W.C.).

New responsibilities fall into three categories. Firstly, the 1973 Act attempted to make good the lack of representation for amenity, recreation and aesthetic interests, which were noticeably omitted from the 1963 Act. It is possible to ascribe this to a change in societal values with a higher priority attached to these than previously (Chapter Two). Secondly, a provision is made for the regular survey of water resources, with

regard for availability, demand and quality in relation to existing and prospective uses. These surveys are intended to lead to a more efficient management of water and a higher overall quality standard. Much more emphasis therefore is placed on accurate information and careful prediction.

Lastly, and perhaps most importantly, Part 3 (Schedule 3) of the Act, lays new financial obligations upon the water authorities. It established that each authority should be self-supporting, with revenue to be raised by a system of charges on those who benefit from a provided service. Government, while permitting borrowing for investment schemes, imposed a collective overall limit of £3750 millions (20, 21). As the river authorities handed over debts of approximately £2200 millions, along with a stock of poorly repaired or antiquated equipment, it can be seen that these new financial obligations must have a fundamental effect on water management. For example, managerial success would be measured not by the involvement with prestigious projects, as was the tendency previously, but by profitability.

Lastly, in this section on current legislation, mention must be made of the 1974 Control of Pollution Act. This is the most major and comprehensive piece of legislation on pollution control and environment protection to date. This Act is the first ever to consider all forms of pollution (22). It re-enacts much of the 1951 and 1961 River Acts, and so repeals these, and parts of other related Acts. Details of its provisions are outlined in Appendix C and Chapter Four, but mention is made of the provisions for greater publicity for details of effluent discharges.

3.2 Current conditions

This section attempts to illustrate, by means of tables, diagrams and short comments, some of the facts of river quality and sewage treatment plant operation in England and Wales, and the N.W.A. area. Of necessity data is limited to the 1960's and the early 1970's.

It examines some of the factors which have affected trends in river conditions and efficiency of plant operation. By way of a small study, trends in selected variables are noted for a sample of 100 sewage treatment works (23). It tries to illustrate the main relationships between these variables, using a correlation structure. Trends in treatment capability are noted.

Lastly expenditure on pollution prevention and sewage disposal is noted. Abbreviations are explained in the Glossary.

3.2.1 River quality

Most of the data for this section are based on the results of the five River Pollution Surveys of England and Wales, for 1958, 1970, 1971, 1972 and 1975 (24, 25, 26, 27, 28). Strictly, none of these surveys is directly comparable for instance different lengths of rivers were surveyed in each case and different authorities were responsible for their reconnaissance (29). The 1970 to 1975 surveys most closely resemble each other, that for 1975 being considered the most complete.

Table 1 shows the classification of non-tidal and tidal rivers according to a chemical classification. This is outlined in Appendix D (30). This table shows that for all rivers there has been a gradual, if marginal, improvement in the percentage of river stretches in classes 1 or 2, with a corresponding decline in classes 3 and 4. It clearly demonstrates the poor quality of tidal water, approximately 25% being designated as poor or grossly polluted, compared with approximately 7% for non-tidal waters (1975).

Table 2 attempts a partial comparison of these data, with those ^{equivalent} for the N.W.A. Non-tidal rivers appear to be of a much higher quality than the national average; however, for tidal waters the opposite appears to be true. Overall there seems to be a trend towards improved river quality.

The 1975 survey represents a significant advance over those previously carried out, in that it classified rivers not only in terms of quality, but also in quantity. This attempted to overcome the disadvantages of using lengths of stream as a surrogate for volume. Table 3 presents this classification.

It can readily be seen that the majority of non-tidal rivers

are within the minimum flow range (less than 0.62 cumecs.). The same information, for the N.W.A. in 1975, is presented in Table 4. Data are not available for tidal rivers. These tables permit one inference to be drawn; the river surveys have been heavily weighted towards small streams, the majority of which are classified as unpolluted. Tidal rivers, more important in terms of the volumes they represent and in their proximity to centres of population and industry, are disproportionately represented. The significance of the poor quality of tidal waters is thus understated by the particular method adopted in the river pollution surveys.

This brief summary of the findings of these surveys serves to show, at least partially, prevalent conditions of the early 1970's. The next sections attempt to survey some of the factors which affected river quality and plant operation by looking at determinants of effluent quantities and qualities.

FIG 3

METERED AND UNMETERED WATER CONSUMPTION

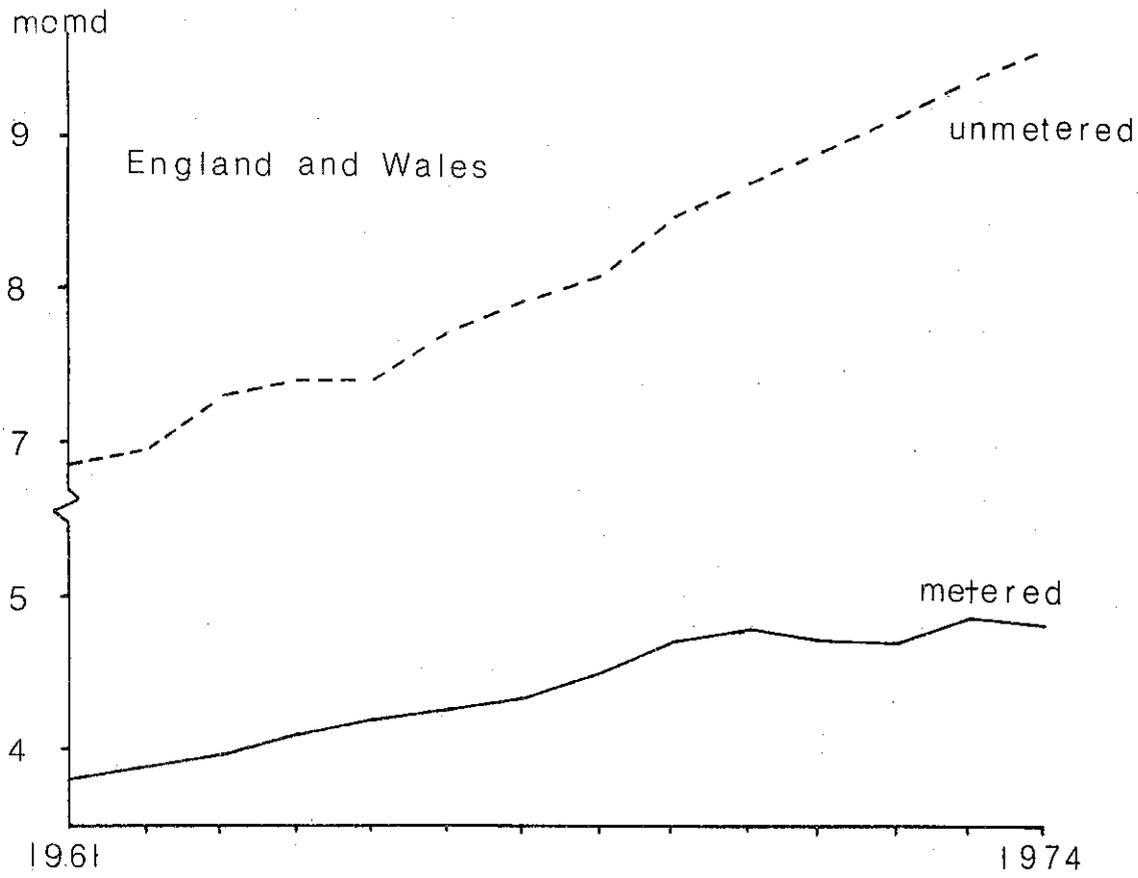


FIG 4

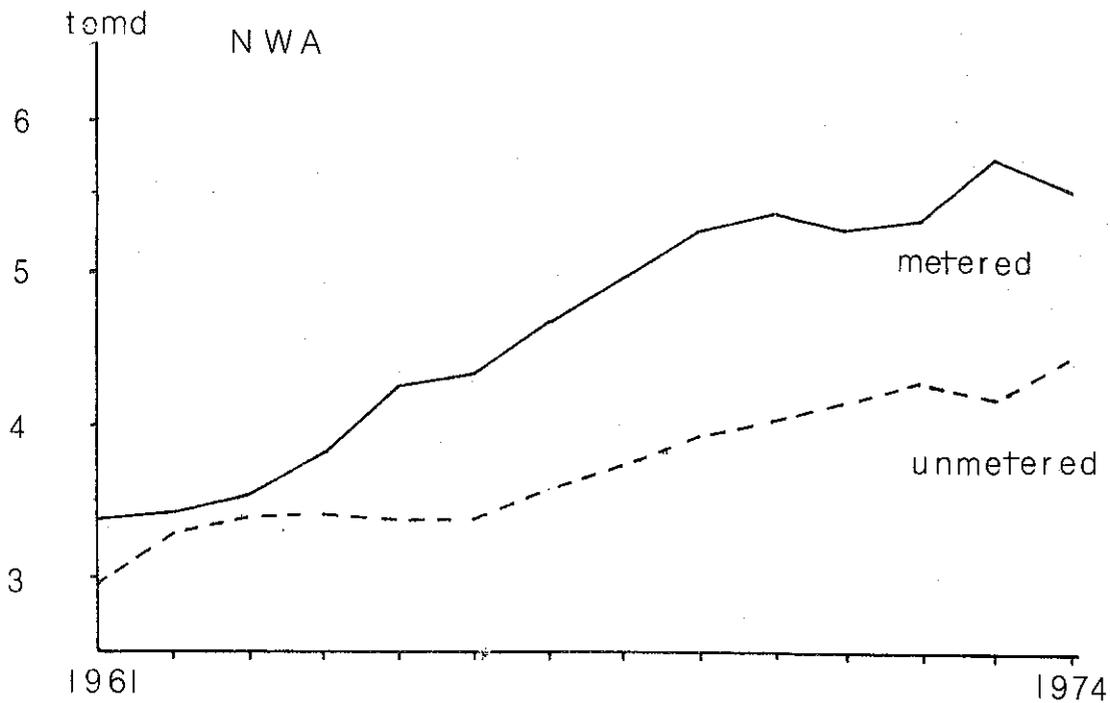
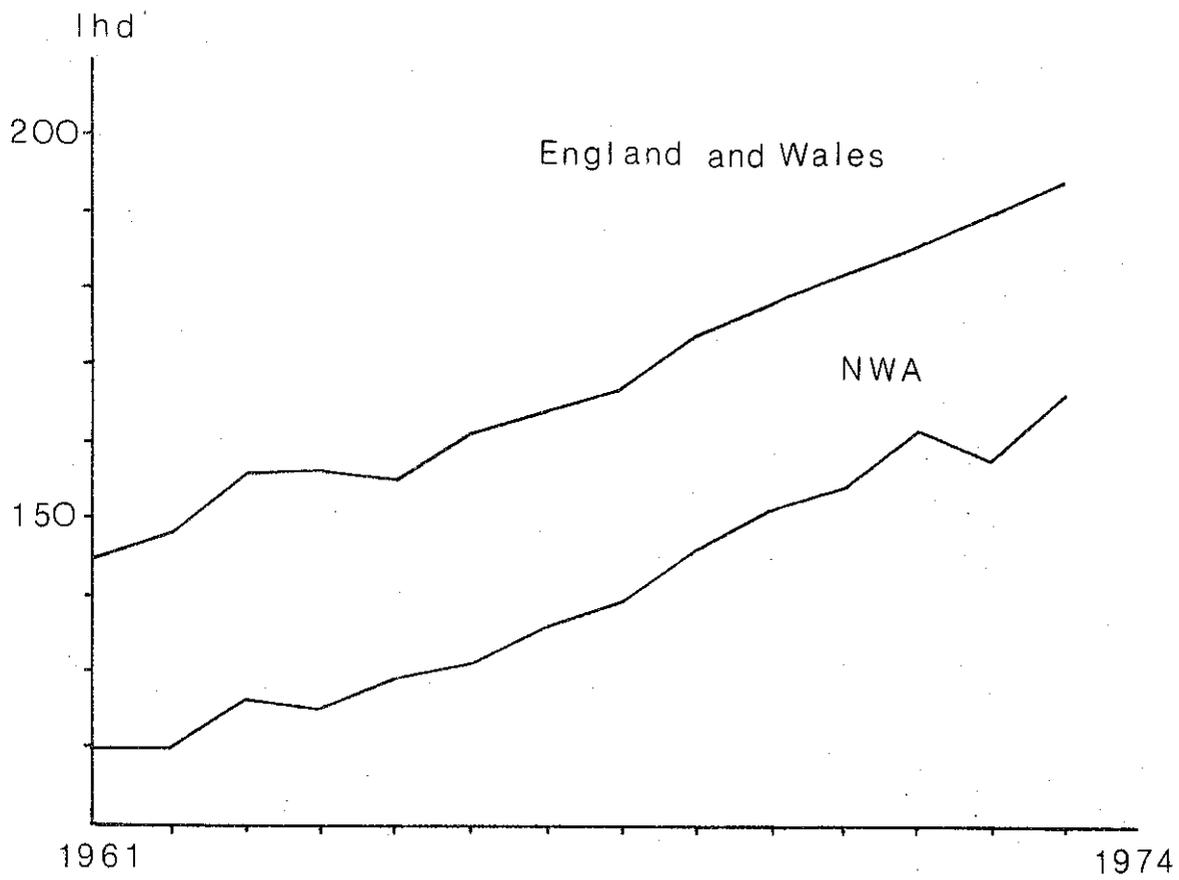


FIG 5

Per capita unmetered water consumption 1961-74
litres per head per day



3.2.2 General determinants of effluent conditions

Table 5 shows population estimates and projections, drawn from N.W.A. sources (31). England and Wales experienced a 6% increase in the period 1961-75; however within the same period, the population of the N.W.A. remained almost static, and was predicted to fall by 1981 (32, 33, 34).

The size of population has direct consequences for the pollution load received at treatment works. These domestic sources, along with industrial effluents, determine the rate at which new treatment capacity must be provided. To ensure the standard of works effluent does not fall, treatment capacity must increase, at least at the same rate as these exogenous factors.

In addition to an absolute increase in numbers (at least nationally), per capita water consumption, and therefore per capita effluent, is also rising. Table 6 shows that per capita unmetered water consumption rose by 37% and 39% in England and Wales and the N.W.A. respectively. Thus water consumption is rising faster than increases in population would suggest. It would be expected that treatment capacity must match these trends. These data are also plotted in figures 3, 4 and 5 (35).

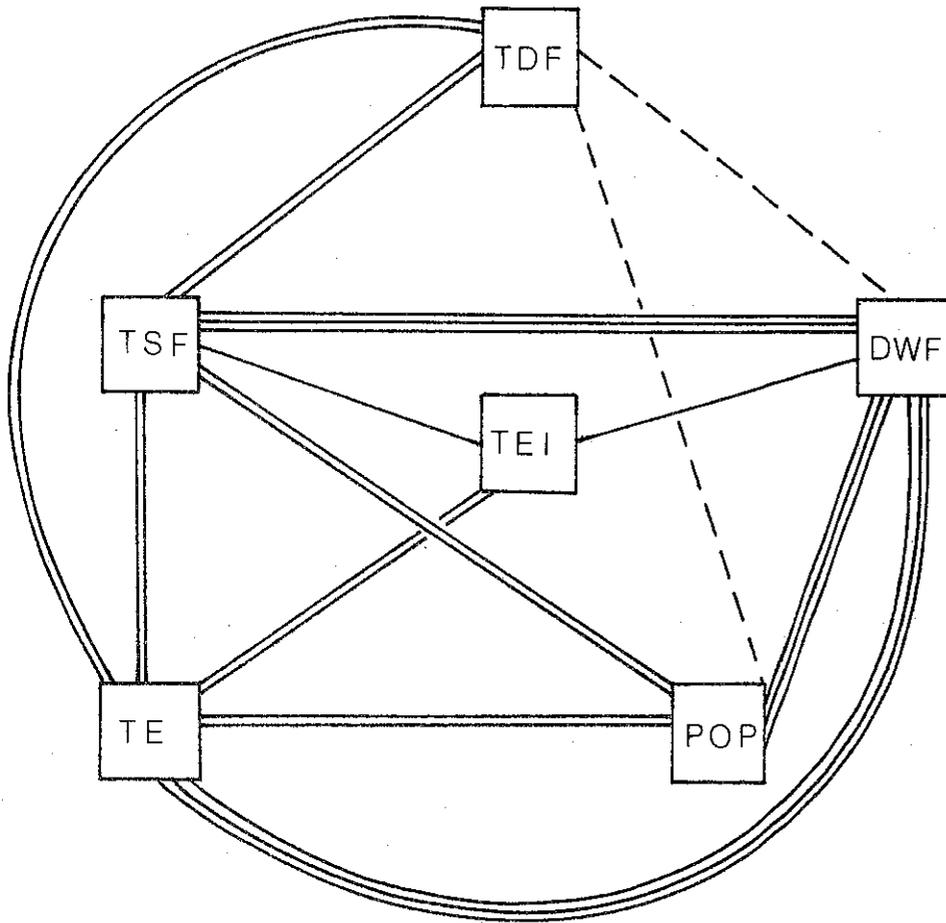
In all cases, the N.W.A. has experienced greater percentage increases in the period considered than the national figures. In general, unmetered consumption ^{is} increasing faster than metered consumption. For all sets of data the rates of increase are several times those of population increases.

Table 7 details non-potable water consumption, over the 1961-1974 period (36). The N.W.A. accounts for an average of nearly

30% of national non-potable water consumption, this proportion increasing since 1970. The N.W.A. consumption therefore determines a large proportion of overall national trends. Most non-potable supplies are used by I.C.I. Ltd. and the British Steel Corporation on the Tees estuary (37). It can be seen that the rate of increase in consumption of these supplies has been extremely rapid, more than doubling in this period, in the N.W.A. area. Trends in these supplies are solely determined by the individual firms concerned, and are thus extremely difficult to predict, and therefore make provision for.

FIG 6

Correlation structure : Stress factors



TSF Total Sewage Flow

TE Total Effluent

TEI Total Effluent Income

TDF TSF - DWF

DWF Dry Weather Flow

POP Population served

Correlation Coefficients

==== .8-.89

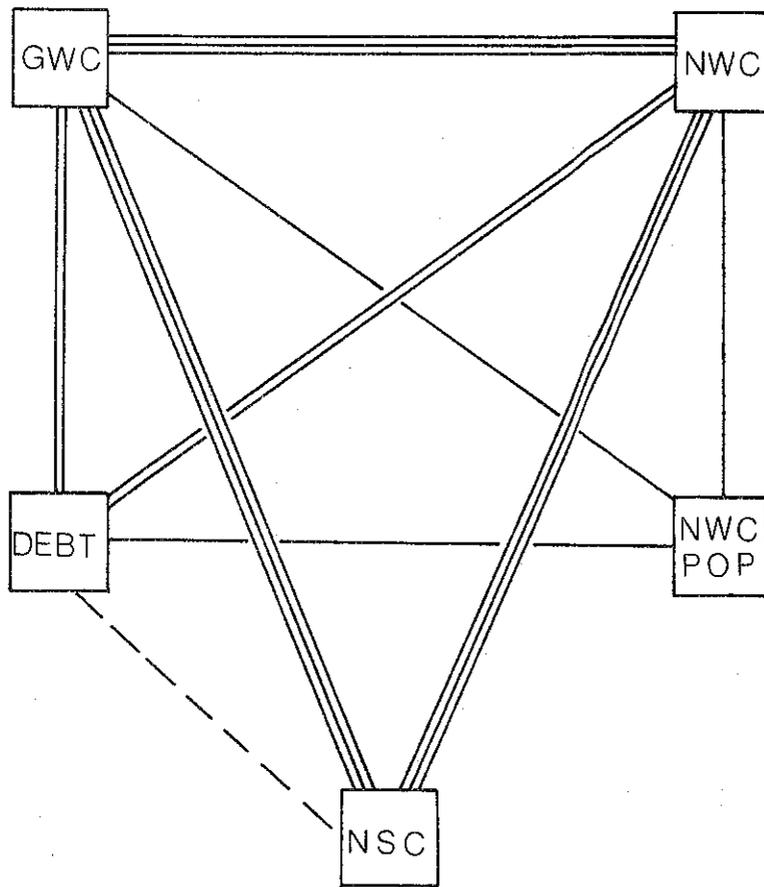
==== .7-.79

_____ .6-.69

---- .5-.59

FIG 7

Correlation structure : Cost factors



		Correlation Coefficients
NWCPOP	Net Work Cost	
GWC	Gross Works Costs	≡≡≡ .8-.89
NWC	Net Works Costs	≡≡ .7-.79
NSC	Net Service Costs	— .6-.69
DEBT	Debt Charge	- - - .5-.59

3.2.3 Plant operation: a study of 100 works.

Leaving aside general data, this section examines factors which affect sewage plant operation.

Tables 8, 9 and 10 show the results of a survey of 100 sewage treatment works. (38). Figures 6 and 7, correlation structures, show interrelationships between selected variables. A number of points can be made from these data.

(a) Age of plant and population served.

None of the variables bear any strong relationship (i.e. averaging a correlation coefficient greater than 0.5 over the 9 year sample period) with the age of the works (DATE). There is, thus, little evidence to suggest a link between efficiency of plant operation and its age (39).

Table 8 shows that the population served (POP) by these works more than doubled in the period considered. This does not correspond to the conclusions of Table 5, and suggests anomalous results for 1964-67 to 1972-73 was experienced, more closely resembling the national average. Data for DWF, trade effluent (TE) total sewage flow (TSF) and TDF (TSF minus DWF) show a similar pattern and must be interpreted with care as a consequence.

(b) Correlation structure.

Figure 6 shows a correlation structure for variables variously connected with the volume of flow through these works. It shows strong relationships between the population served, the resultant DWF and the total sewage flow (TSF). The population/DWF link is as expected, as by definition, DWF is flow directly attributable to domestic effluent, and thus excludes other factors, such as rainfall and industrial effluent (Glossary). The variable

TDF (TSF minus DWF) shows flow over and above DWF, and corresponds to a stress placed upon treatment works (assuming treatment capacity remains approximately constant). In general this stress has been increasing, but has shown erratic fluctuation since the early 1970's.

As expected trade effluent income (TEI) is most closely associated with volume of trade effluent flow (TE). No close links seem to exist with either influent B.O.D. or suspended solids qualities. Trade effluent flow is strongly linked to DWF, TSF, TDF and population served.

Figure 7 shows a correlation structure for variables connected with the cost of running a treatment plant. No strong relationships seem to exist between the various flow variables and these cost variables (Table 9).

The core relationships are those between gross (GWC) and net (NWC) works costs and net service cost (NSC). Net works cost per 1000 people (NWCPOP) served is less strongly linked to the above three mentioned, suggesting population trends are not as closely aligned to changes in these. It must be noted that debt charges (DEBT) account for approximately 50% of all expenditure, this proportion remaining almost constant throughout the period considered.

(c) Influent and Effluent Quality and Standards Applicable

Table 10 shows average annual quality of effluent received at the 100 sample works (influent quality) and the quality of that effluent after treatment (effluent quality). It also gives average annual figures for the standards which are supposed to apply to effluent quality. For both B.O.D. and suspended solids

FIG 8

Percentage of works by date of commencement

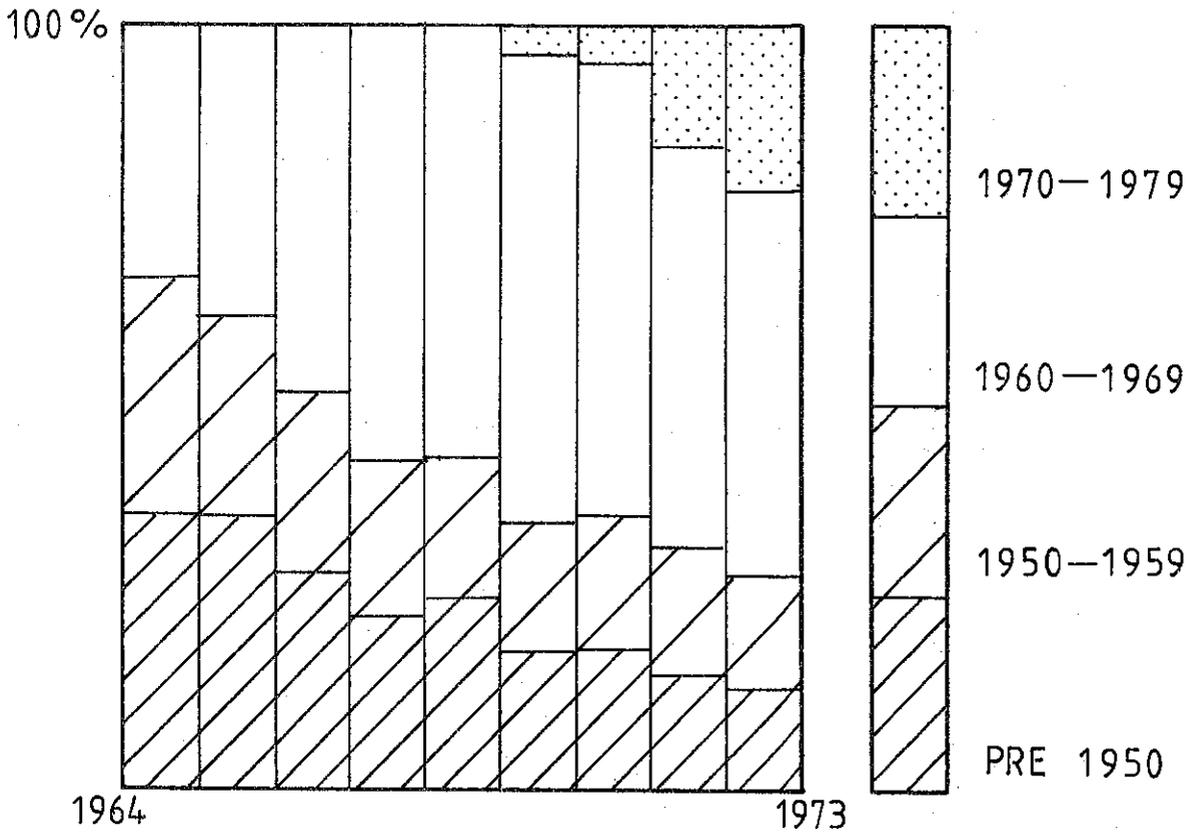
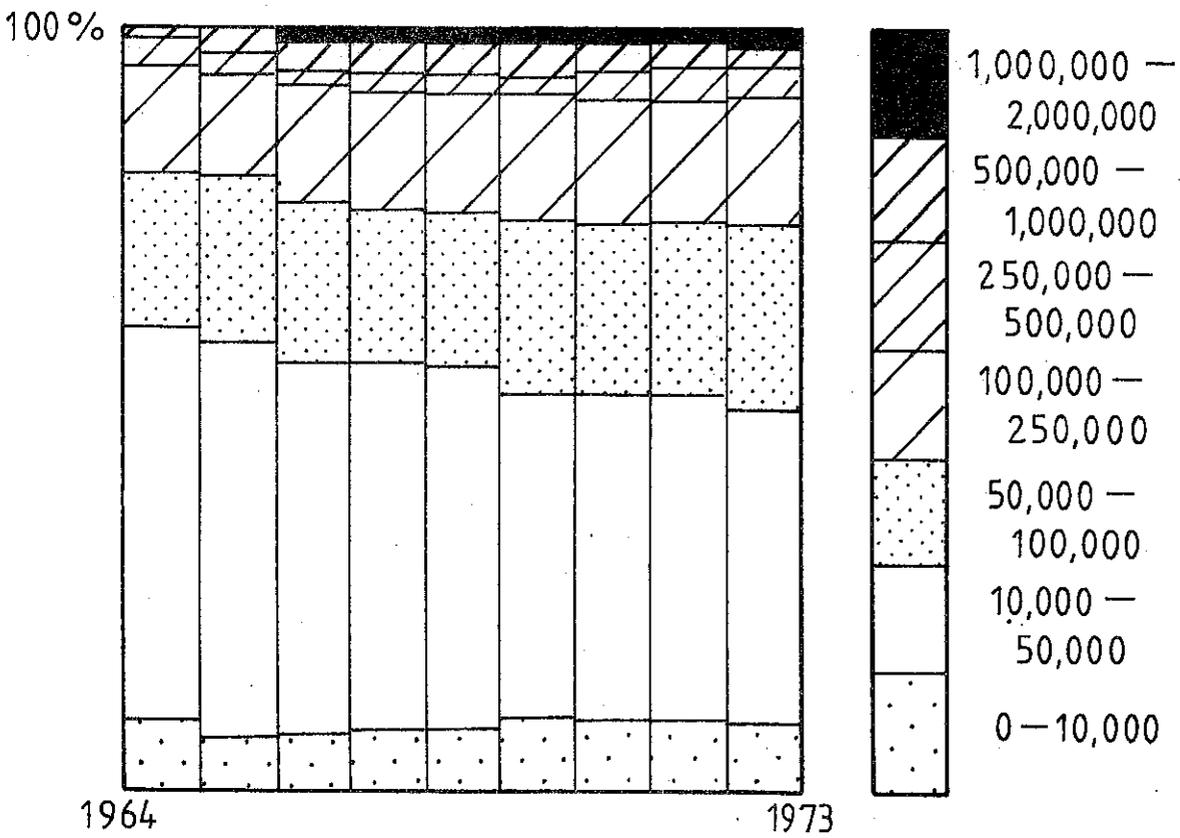


FIG 9

Percentage of works by size of population served



content (S.S.), influent quality exceeded 300 mg/l (or p.p.m.), and in one case 400 mg/l. After treatment these strengths had been reduced to approximately one-tenth of their former levels. However, in all cases this was insufficient to comply with river board standards. In most cases the average standard which should define maximum limits, approximates to the 30:20 standard (Glossary). In general, the quality of effluent has been improving.

Despite the problems of interpretation, these data give a more detailed picture of how treatment works operate. There appear to be no strong links between variables which may be termed stress factors, - population, volumes, strengths, and the costs of running the plants. A major determinant of these costs seems to be the size of debt charges. Presumably as the quality of effluent is improved, new treatment capacity must be provided either on site or elsewhere.

(d) Age and Size

Table 11 and Figure 8 show a breakdown of the 100 sample works by date of commencement of operation. They show a gradual replacement of older works by new ones. However by 1973-74 a significant proportion (28%) were at least 15 years old. Table 12 shows a breakdown according to the size of population served. This is illustrated in Figure 9. It shows a very gradual increase in the proportion of large works (greater than 500,000 people served) and a slow decline in smaller works (especially in the range 10,000-50,000 served). In general, the situation appears far more static than that portrayed in Figure 8.

3.2.4 Expenditure on pollution prevention.

Finally mention of recent spending trends on sewage disposal and pollution prevention is made. Tables 13 and 14 give details of some items of revenue and capital expenditure for two financial years, 1974-75 and 1977-78. In the earlier year total revenue expenditure was some £620 millions, of which the NWA accounted for 3.7%. This dropped slightly to 3.6% of the £1,110 millions spent in 1977-78. Both nationally and regionally, expenditure on sewage collection, treatment and disposal accounted for approximately half of all revenue expenditure. Expenditure on specific pollution schemes dropped substantially between the two years, but at no time did such expenditure exceed 1% of total revenue expenditure.

Nationally, capital expenditure was less than revenue expenditure. However, this was not so for the NWA, possibly due to heavy spending on two current, capital intensive, projects, the Kielder Water scheme and the Tyneside Sewerage scheme. With respect to specific pollution abatement schemes, such capital expenditure accounted for 1% of the total.

This picture is reinforced when total expenditure (capital and revenue) per capita is examined (Table 14).

3.3 Summary

Data from the river pollution surveys show that the majority of rivers, especially non-tidal rivers, in England and Wales, can be considered to be of satisfactory quality. However these figures partially obscure the serious condition of tidal rivers. They under-emphasise the importance of such waters, in terms of their volumes, their importance as waste disposal agents, and lastly their proximity to centres of population.

Section 3.2.2 showed how absolute, per capita, and non-potable water consumption and, by inference, waste volume, were increasing. It suggested that effluent quality could only be maintained, or improved, by an expansion of treatment capacity at a rate similar to these exogenous factors. The ability to do so would depend at least partially on the accuracy with which these factors could be predicted.

The sample study outlined in Section 3.2.3, revealed two apparently separate groups of variables, those related to volume of flow and those related to running costs. Strength of effluent, age of works and size of population served do not seem to be directly related to either group. The most striking results of this survey was the way in which river board standards bore little relationship to actual effluent quality, despite a 90% reduction in influent waste quality by treatment.

Chapter Four

Pollution Control : a Case Study

Chapter Four examines two pollution control methods: consents and charges and the way in which they operate in practice. The Northumbrian Water Authority is chosen to illustrate their use at a regional level and to point out differences from national policies. Emphasis is placed on the ways in which the 1974 Control of Pollution Act has affected, and will affect these practices.

Consents are the longest established method of control, their practice remaining fundamentally unchanged by the 1974 Act. However, pressures for more freedom of information are forcing the water authorities to review their method of determining consents. This section gives examples of how many effluents fail to reach the standards imposed upon them.

Charges, preferred by economists, have been introduced, not as a method of controlling pollutants but as a means of recovering costs. This was a result of financial pressures to enforce economic self-reliance on the water authorities, in part brought on by the 1973 Water Act.

4.1 Northumbrian Water Authority : Consent Policy

Until the 1974 Control of Pollution Act is fully implemented a system of control by consent of the water authorities is operative. This system is governed by the Rivers (Prevention of Pollution) Acts of 1951 and 1961. Appendix E outlines the consent policy as it will operate under the 1974 Act. This Act does not substantially alter the method of control, but differs in several significant details.

In brief, these differences are:

1. An unrestricted right of public prosecution in respect of failure to meet consent conditions is permitted.
2. Water authorities are required to publicise applications for consent and details of consents granted in a register; this register must be made available for public inspection.
3. The 1974 Act will bring under its control effluents that are at present being made lawfully without a consent.

Included in this class are effluents made to estuaries and tidal waters which preceded the 1960 Clean Rivers (Estuaries and Tidal Waters) Act.

These differences have implications for the way the water authorities will operate a consent system. Some of these effects are discussed below.

The next sections review the current and proposed methods used to determine the consent conditions attached to surface and public waters. The implications of the Control of Pollution Act 1974 are discussed, with particular reference to previously exempted discharges and effluents, disposed of to surface waters.

4.1.1 Direct discharges to surface waters.

(i) Determination of Consent Policy

The N.W.C.'s attitudes and proposals for determination of consent conditions are outlined in a 'Report of Working Party on Consent Conditions for Effluent Discharges to Freshwater Streams' (1) (The Fish Report). In this, the N.W.C. state that the major aim for the control of pollution is to maintain or improve surface water quality. This is to be achieved by the regulation of the characteristics of discharges solely with reference to the effect of a discharge on the receiving waters.

Beyond this prerequisite, it is stated that "the objective of control is to ensure the proper and maximum practicable use of water for all legitimate purposes." (Page 4), "adding that the use of waters for effluent control within the constraints of the control system, is legitimate." It is suggested that a good control system must be equitable, simple to operate, understandable, adaptable and efficient to operate.

Following from these statements it is argued that the basis of a system must be the specification (or classification) of the quality of surface waters in relation to use. Such a classification is to be based on safeguarding the uses of waters for public supply, fisheries and environmental protection, in the belief that then substantially all other uses will also be protected. In general, use for disposal of effluents is in competition with the other categories of use. It is accepted that the chemical quality of receiving waters must vary but it is stated that every reasonable practical effort should be made to ensure that the quality of effluent discharges is firmly controlled.

Subject to these criteria the Fish Report states that -

"it must be accepted as axiomatic that one cannot specify river quality requirements to be achieved 100% of the time. The only practical alternative is to seek to specify the maximum levels of contamination of water which can be accepted in respect of water at a given statistical probability of achievement."

(Page 7)

The N.W.C. believes that their experiences shows that, in general, such maximum levels should not be exceeded more than 5% of the time. Allowances are to be made for occasional freak events such as drought or a prolonged cold spell.

Appendix F sets out the chemical and physical river classification in terms of use. The notion of maximum level of contamination is replaced by 'class limiting criteria' which is represented by upper 95 percentile limits (2). This classification is used by the Department of the Environment in its River Pollution surveys. Appendix G contains the amended version of Appendix F, as used by the N.W.A.

The N.W.C. note that, whatever the financial circumstances in which the water authorities operate, it will take time to clean rivers of presently unsatisfactory quality to a desired state. Since the authorities are currently severely constrained by national economic pressures, quality objectives and pollution control should be divided into two categories, maintenance and improvement. Accordingly, it is suggested that all rivers are assigned to a quality class. Where a reach of a river is considered satisfactory for all existing and foreseeable future uses, the assigned class is to be regarded as a permanent objective

to be maintained. However, where this satisfactory situation does not exist, the assigned class is only to be regarded as an interim objective. A higher quality class into which this reach should be improved should be regarded as an upgrading objective.

(ii) Current Basis for Determining Consent Conditions

Having established a classification of river quality and the quality objectives to be maintained or achieved, the next issue to consider is the limitations which should be applied to effluent discharges so that these goals may be achieved.

Several problems are noted:-

1. Even with the maximum practical control of the design, operation and loading of effluent purification plant, variations in effluent volume and quality will occur.
2. The volumetric dilution given by river flow to a discharge of effluent at any point and the quality of diluting river flow, usually vary markedly.
3. The fate of polluting matter added to rivers varies according to the nature of its components, and according to the quality state and physical characteristics.

The implications of these variations have been dealt with in the following ways:

1. The lowest river flow expected at the point of discharge is to be estimated, or deduced from flow records and related to the worst quality of river water, in terms of significant quality factors expected immediately upstream from the point of discharge. This is used to define the minimum dilution available for the discharge.

2. A quality objective for the downstream reach is selected; the load of polluting matter permissible in the discharge is calculated from the dilution available and the downstream quality objective.
3. The permissible load is then translated into a maximum concentration of pollutant in specific discharge volumes. These maxima are subject to an upper limit such that 30 mg/e suspended solids and 20 mg/e B.O.D. are seldom exceeded. For trade effluents to a river, a similar, if somewhat less stringent cut-off is applied (3).

This approach was initiated by the 1912 Royal Commission on Sewage Disposal (Chapter 3) (4). It was given, at least partial, official status by a 1960 Ministry of Housing and Local Government Technical paper (5). This paper laid down the philosophy that for sewage effluents, treatment to the 30:20 standard was to be regarded as the norm.

The Fish report states that:

"in practice minor variations in effluent quality beyond the consent conditions imposed have to be accepted as inevitable. Assuming that such breaches are unlikely to lead to unacceptable river conditions, they are not subject to legal enforcement."

Section 4.3 examines the extent to which effluents of all types and origins, comply with the conditions of discharge imposed upon them.

(iii) Proposed Method of Determining Consent Conditions

The Fish report states that

"the ideal technical approach should be that the load of polluting matter discharged be controlled at all times to exactly the level that a river could accept without harming river uses. This is wholly impracticable at the present time

because we do not have the necessary continuous and fine control of sewage treatment processes and of effluent and river flow, and quality monitoring" (page 11).

The suggested river quality classification and statement of quality objectives are based on the premise that 95 percentile quality figures should be used. The Fish report believes that if this is accepted then a similar percentile basis should be used for determining consent conditions for effluent discharges (6). It is suggested therefore, that:

"for the time being it seems reasonable enough to adopt the expedient of calculating initially the polluting load (for each relevant quality determinand) permissible in an effluent as that which would not cause the quality of river water at the first point of complete mixing to exceed the class limiting criteria, assuming that the river flow was at the rate which is exceeded for 95% of the time." (Page 11)

The derived maximum permissible load could be expressed directly as a consent condition (7), but enforcement of such conditions would pose problems due to the lack of adequate flow data. The suggested alternative would be to convert this maximum load into a concentration at the average rate of discharge. This could be expressed as a maximum permitted concentration at the maximum authorised discharge rate. It is recognised that a polluting load greater than that desired might be released occasionally, but it is felt that in practice this would balance out over a normal working day.

(iv) Review of Consents : Recent Developments

Recently, the water industry has been looking at the implications of the full implementation of the Control of

Pollution Act 1974. Subsequently a need has been felt for a review of consent conditions. The pertinent factors are as follows:-

1. The Control of Pollution Act 1974 grants an unrestricted right of public prosecution in circumstances when a failure to meet applied conditions occurs. The current position under the 1951 and 1961 River Acts, only permits prosecutions when initiated by a water authority or by others who have first secured the consent of the Attorney-General.
2. The 1974 Act requires that water authorities enter into a register details of consents, information derived from analyses of effluents and river waters, and any steps taken as a consequence of this information. Such a register must be made available for public inspection. Further, the Act requires that applications for consent be advertised.
3. In the words of the Fish report (Page 1, 1)
"The reality that on average only about 50% of samples of existing discharges conform with currently applicable quality conditions of consent."

This is confirmed by the findings of Section 4.3.

Thus the water authorities find themselves in the unenviable position of being forced to open their books. They do this knowing full well that a high proportion of all the discharges they are supposed to oversee, (their own included along with those of industry) will be seen to be unsatisfactory, even by their own quality standards. Further, they are now liable to be prosecuted for any contravention of their own consent conditions. The water industry, therefore, had a choice between matching practice to consent conditions, or conditions to

reality. They opted for the latter, justifying this approach on several grounds. In this respect the response of the N.W.A. to this situation, was typical of other water authorities. Firstly, a note (Appendix H) sent by the N.W.A. to traders who released effluents directly to surface waters stated that:

"The fact that an effluent does not comply with its existing consent conditions does not necessarily mean that it is having an unacceptable effect upon the quality of receiving river."

It is felt that the new river classification system (Appendix F and G) based on 95 percentile class limiting criteria, and the related determination of consent conditions, formed a satisfactory basis for planning river water quality.

Secondly, it was felt that existing conditions were sometimes unduly severe, often having been fixed arbitrarily. Thirdly, it is stressed that treated effluents, like rivers, are subject to unavoidable fluctuations in quality. Hence it was more reasonable to state lower consent conditions which would be exceeded roughly only one in twenty times, rather than a more stringent figure which must be exceeded more often. Fourthly, the 95 percentile performance figure gave some basis for designing the hitherto indeterminate, quality objectives of new treatment works, and was thus a clarification from the water industries point of view.

The N.W.A. policy for setting new consents has been to examine the effluent quality records of all discharges to water-courses for the previous two years, and set new class limiting criteria at the upper 95 percentile mark (Appendix 1). Data sources include the authority's own sampling records and, if a

trader so desires, an industry's own internal records. This procedure is also being applied to previously un-consented legal discharges, i.e. discharges to estuaries and tidal waters which commenced prior to the 1960 Clean Rivers Act. In the case of the Tees estuary this applies to a large part of all discharges including some major industrial concerns.

Used as a basis for revised consent conditions, it is stressed that this is only a device for maintaining the status quo. The water authorities state (1)

"they firmly intend to raise effluent standards and improve unsatisfactory rivers as fast as the financial position will permit" (Page 17).

In the meanwhile, by the time that the full implementation of the Control of Pollution Act 1974 takes place, the majority of consents will have been revised to reflect actual conditions. The Fish Report states that (1)

"The 95 percentile basis of this approach involving nominally the consequences that effluents will not conform with consent conditions for around 5% of sampling occasions may be considered to be too stringent in terms of works design costs, or too lax in exposing water authorities to an unacceptably high risk of private prosecution. Overall we believe that this 95 percentile approach is about right, giving consistency of approach, a fair balance between the risk of prosecution and expenditure on treatment plant, and certainly a far better stance for water authorities to take up than their inherited exposure to an even or worse chance of being privately prosecuted for non-conformity of almost every discharge with consent conditions." (Page 15-16).

(iv) Criticisms and Responses

The water authorities are aware that the specification of the conditions in ^{the} way outlined above will result in much criticism of them (7).

"The review will be seen by some as 'cooking the books' by relaxing standards to avoid prosecution, while the setting of conditions for new discharges will be seen as a device for reducing expenditure on purification plant." (Page 16)

Several criticisms of the new procedures are possible

1. This is a legitimisation process; standards are being lowered to match reality instead of improving effluent quality achievements to match set standards. This avoids the possibility of prosecution and the need for heavy expenditure on treatment plant. Several defences can be made:-
 - (a) initial standards were unduly severe, the new standards will not result in a decline in river quality
 - (b) inadequate finances exist for the upgrading of sewage treatment plant
 - (c) the cost to industry of an enforced change in production processes would be unduly prohibitive; as the 1974 Act will be fully implemented in the near future, insufficient time is available to make the necessary alterations to upgrade effluent quality.
2. Statistically this procedure is spurious.
 - (a) sample distribution; two samples with the same mean, but of differing frequency distribution, will have the upper 95 percentile set at different figures.
 - (b) sample content; by allowing traders to submit their own sample records, it would be worthwhile including unusually

high values as this would bias the resultant consent conditions to a higher value than would be otherwise.

(c) sample size; the use of a two year sample records may be inadequate to give a true picture of discharge quality performance, especially for infrequently sampled effluents. There is no guarantee that two years of records are an adequate sample for previously un consented pre-1960 discharges.

3. This procedure for setting consents results in conditions which give no incentive to traders to improve effluent quality. In many cases, consent conditions may be set lower than previously. Traders are aware that these new conditions may only be exceeded one in twenty times. This could lead to two circumstances. Firstly, standards of effluents may decline but still remain within the new limits; this is a particular danger if the upper limit was set unduly high by rogue sample results. Secondly, traders may now feel they can exceed conditions for 5% of the time, the water authorities being unlikely to take action against them. These two possibilities may result in a decline in river quality, instead of maintaining the status quo, as is intended.

4.1.2 Discharges to Public Sewers.

The consent system under Part II of the Control of Pollution Act 1974 does not apply to certain areas, notably, sewers and canals. Water authorities control the discharge of trade effluent into each sewer by a system of consents issued under the Public Health (Drainage of Trade Premises) Act 1937 and the Public Health Act 1961. The system of control is much as the 1974 Act but differs in that the public health legislation does not provide for the publication of applications for consents or the details of consents and samples. The eventual discharge of sewage by water authorities into water courses is (or will be) governed by the 1974 Act, the provisions of which apply equally to the water authorities as to anyone else.

Since the early 1900's it has been felt that the most appropriate method of disposal of trade effluent was to a public sewer. This was stated in 1930 by the second report of the Advisory Committee on River Pollution (8) and subsequently incorporated into the 1937 Act. It was again endorsed as recently as 1960 by the Armer Committee (9). This long history of a single policy has led to a considerable difference in strategy between Britain and its European neighbours, as Table 15 demonstrates.

It can be seen that approximately 70% of trade effluents (with a consent) discharge to a public treatment works and as such will not be subject to the publicity provisions of the 1974 Act.

Appendix J details the guidelines by which consents for discharges to public sewers are determined. The main objectives are:-

1. Efficient running of treatment works, prevention of damage to sewers and other works, prevention of harm to employees.
2. Collection of data.
3. To ensure that a trader pays a fair charge for the reception, conveyance, treatment and disposal of his effluent.
4. Prevention of pollution.

The review of consent conditions does not apply to these discharges. The presently operative consents will remain in force, despite the fact, as section 4.3, demonstrates, that they bear little relationship to the reality of effluent quality discharges. These consents, and compliance with them, are not subject to the publicity provisions of the 1974 Act, with the subsequent likelihood of private prosecution. As a result, it is unlikely that water authorities will feel the need to review these consents in the manner applied to consents to discharges made to surface waters.

4.2 Northumbrian Water Authority : trade effluent charging policy

The 1961 Public Health Act permitted a charge to be made for the collection, treatment and disposal of trade effluent, via sewage treatment works. (11). While local authorities administered trade charges they were inconsistently levied, usually of nominal value. The charge was proportional to the volume of discharge provided that a reliable meter reading was available. In addition, a basic charge was made towards administrative costs. As it has been the policy to encourage disposal via the public system, rather than directly to water-courses more traders have become liable for such charges. No charge is made for direct discharge to a river.

From 1st April 1974 a new system for charging was introduced, aimed at rationalising trade effluent charges at local, regional, and national levels. This was part of a reappraisal of charging for all water services, embodied in the financial provisions of the 1973 Water Act. These issues had been discussed by the three Jukes Committee reports (12) and by the National Water Council in their document 'Paying for Water' (1976) (13). The final guidelines for trade effluent charges and disposal practices were agreed by joint discussion between the regional water authorities and the C.B.I. (Appendix J) (14). This document points out that its object was to establish a 'fair method of levying charges for a service performed by a water authority, and was not intended as a method of regulating pollution.'

(i) Current Policy

Part Two of a N.W.A. report, 'Trade effluent discharges to

public sewers' (15) details the findings and recommendations of a corporate management working party on charging policy. It notes that these recommendations were an interim policy, commencing October 1975, for an indefinite period, no definite decision having been made about a long-term policy.

The Working Party noted the lack of a consistent approach to charging for trade effluent collection, treatment and disposal by those formerly responsible, the local authorities. In some areas a form of the Mogden formula (16) was applied, the charge being proportional to volume of effluent. In other areas, the charge reflected the desire, on the part of the local authorities, to attract or encourage industry. It was almost uniformly true that the level of unit charges did not reflect the true costs of providing the service. Coupled with the stringent economic climate in which the new water authorities found themselves, it was recommended, as a matter of urgency, that some form of standardisation of the method of calculating these charges be found.

The Working Party outlined two problems. Firstly, a new set of charges could not be levied on those who had discharge agreements or consents which contained provisions for the payment of charges. It was felt that these eventually could be superceded. Secondly, until Section 52 of the Control of Pollution Act 1974, is implemented charges are governed by Section 59 of the Public Health Act 1961 and Section 30 of the Water Act 1973. According to this legislation, the charge for any discharge should be related to the cost of receiving and treating the effluent. Literally interpreted, the charge for a

given effluent should be related to costs of individual sewage treatment works. Thus section 30(4) of the 1973 Act states that

"in fixing charges for services facilities or rights a water authority shall have regard to the cost of performing these services, providing those facilities or making available those rights."

To a large extent it appears that local authorities ignored this stricture. If a consistent charge was applied, it was a single unit charge, rather than many individual charges related to costs at particular works. This situation never seems to have been challenged by the C.B.I., probably because of the low level at which these charges were set.

Section 52 of the Control of Pollution Act 1974, will repeal this limitation, the inference being that an authority will be able to move away from charges based on actual costs. While the water authorities look forward to the implementation of this section, most industries regret its inception (17).

(ii) Formula Method of Charging

The Working Party noted both that trade effluents varied not only in quantity but also in quality and in addition noted the consequent need to take account of these two variables. It recommended the adoption of a charging formula of the type outlined in the 'Recommended Guidelines for Control and Charging of Trade Effluent Discharged to a Sewer' (C.B.I./R.W.A. 20.2.76, Appendix J) (17). Appendix K outlines the formula adopted by the N.W.A. It was felt that such a formula would provide the financial system needed to cover the cost of treatment provided.

The N.W.A. formula varies in a few significant details from

the C.B.I./R.W.A. guidelines.

1. R, V, B, S, os and ss are related to regional costs, rather than costs at individual works.
2. B, S, os and ss are related to average sewage strengths, this being calculated from a sample of the authority's treatment works.

Where:

- R Reception and conveyance charge per cubic metre.
- V Volumetric and primary treatment cost per cubic metre.
- B Biological oxidation cost per cubic metre of settled sewage.
- S Treatment and disposal costs of primary sludges per cubic metre of sewage.
- os The COD (m mg/l) of settled sewage.
- ss The total suspended solids (in mg/l) of crude sewage.

In both cases, costs are not related to individual costs, but abstracted one step from reality by averaging . Point 18 of the Guidelines suggests that in order to assess the total flow and pollutant load of mixed sewage (i.e. domestic plus trade effluent) received at the authority's treatment works, a two year moving average, based on data for the two prior years, be used. The N.W.A. however, opted to use data for the current year to calculate these values, on the grounds that the current inflation rate would lead to a lag in revenue raised and actual costs if a two year period was used.

As far as possible it was felt that the trade effluent discharge should be measured separately; however for mixed discharges, it was recognised that this would not always be possible. It was therefore, recommended that the charge for trade effluent

should be reduced to take account of the domestic element (18). In calculating ot and st for a mixed discharge, the domestic sewage was assumed to be of average strength; the charge, therefore, should be proportional to the strength of the trade effluent component of the total discharge.

(iii) Cost Basis

The Working Party gave consideration to whether charges should be based on costs at each works, or on divisional or regional averages. It was felt that charges based on individual works would be unnecessarily complicated and would unfairly penalise those traders who discharged to works with high unit costs, - for example newly constructed works with high capital financing costs. In addition, it was felt that insufficient data was available to calculate financing charges and, therefore, unit costs for individual works. It was recommended that charges based on regional/authority averages be adopted; divisional averages, it was believed, would lead to excessive intra-authority variation in prices. (See section N : criticisms). Appendix L sets out the method of allocating costs.

Costs are derived, therefore, from a selected number of sewage stations in each division, for which data on financing costs are available. The regional unit charges and average strengths applied, reflect the financial and operating characteristics of these stations, and are not, therefore, necessarily representative of the true costs within the authority.

(iv) Criticisms

This section is divided into those criticisms of a purely technical nature, of the N.W.A. charging scheme and the C.B.I./R.W.A.

Guidelines, and those of a more general nature.

1. Technical Problems

(i) The use of Chemical Oxygen Demand (C.O.D.)

The recommendation that the charge for biological oxidation of trade effluent should be based on C.O.D. rather than Biological Oxygen Demand (B.O.D.) is viewed with misgivings by many industrial dischargers, particularly those in chemical and allied industries (17). Much discussion has taken place regarding the relative merits of C.O.D. and B.O.D. On balance it seems that the main justification for the use of C.O.D. is its greater convenience. For example the C.O.D. test is simpler, quicker and reproducible. In most cases the use of C.O.D. should not result in an increase in the total proportion of biological treatment costs paid by industry. However in some industries, notably those cited above, the use of C.O.D. will result in a substantially higher charge (19). In such cases, the Guidelines permits the use of a biological oxidation factor, so avoiding this situation.

(ii) The use of suspended solids rather than settleable solids.

In many industrial effluents quite a high proportion of suspended solids are not removed after quiescent settlement for one hour, and will therefore also be measured as C.O.D. This material will consequently be charged twice, once as suspended solids and once as C.O.D. (19). Three water authorities have adopted the use of settleable solids as a fairer basis for charging, despite some data problems (20).

1. (iii) It must be briefly noted that the reception and conveyance charge (R), is unrelated to the distance between the point of discharge to a public sewer and the treatment works. Areas with a dispersed pattern of population and industry would be expected to give a higher unit charge, due to the greater lengths of piping involved.

2. General Problems

- (i) Equalisation of charges across a water authority's area.

This procedure has aroused considerable opposition from industry. Their view is that, in general, a trader should pay a fair charge for reception, conveyance, treatment and disposal of effluent based on the costs at the sewage works at which it is treated. This is, therefore, in line with current legislation, but in conflict with the 1974 Control of Pollution Act and the views of the water authorities.

The following illustrates industry's attitude (17) -

"Discharges in areas where sewerage and sewage works have been long established and where loan charges are consequently low, feel that they have already contributed, through trade effluent charges towards the capital costs of these services without help from the dischargers in other regions, where expenditure has historically been low. They do not see why they should now be asked to contribute towards the capital costs of providing facilities in those areas previously lacking them." (Page 4)

Other opponents of equalisation are more concerned with geographical differences. Discharges to a sewage works near a mouth of a river where standards are relaxed, receive only

partial biological treatment. It is felt that equalised regional charges would unfairly force such dischargers to pay unduly high charges, based on unit charges, weighted towards the higher costs of inland stations.

The water authorities argue that regional equalisation is a practical necessity due to the lack of cost data. Industry point out that at least two water authorities (21) are able to base charges on areas considerably smaller than the region and suggest that what is needed is the development of management information systems.

Table 16 illustrates an illogicality in the water authorities moves towards regional equalisation. Their argument is, that, on the grounds of equity, one unit charge should apply across their entire region. Making several assumptions, the total annual charge, calculated using the Mogden formula variant, for an imaginary effluent of constant volume and strengths is shown (Table 17). It is readily apparent that inter-regional water authority variations are quite considerable. On the grounds of equity it would seem reasonable to calculate national unit charges rather than regionally based charges.

(ii) Domestic sewage from industrial premises discharged to a public sewer.

The general service charge (or miscellaneous service charge), levied on industry on the basis of rateable value, is intended to cover the cost to water authorities of dealing with domestic sewage and surface run-off. Industry has suspected that this charge is in many cases greater than the actual costs incurred. There seems to be general agreement

among water authorities that there is no statistical evidence to link the cost of sewerage and sewage disposal to rateable value. Prior to reorganisation, many industrial concerns did not seem to object too strongly to the general service charge, since in some cases it was accepted that the trade effluent charge (if one operated) did not in fact cover the full cost of the service. However, since the operation of the new charging scheme, there has been the claim that industry is now being doubly charged, first by rateable value and, second, by the trade effluent charge. It is urged, therefore, that the whole basis of the general service charge be re-examined and replaced by systems that more closely relate charges with cost incurred.

(iii) Long term policy.

Economic theory recommends the use of marginal cost principles (section 2.2.3) as the most effective, equitable and efficient method of administering a charging policy. In this connection the Jukes Committee (12) recommended introducing marginal costs for trade effluent charges; however the water authorities considered this to be not feasible. For example, paragraph of the CBI/RWA Guidelines states that

"The concept of marginal cost pricing is not sufficiently developed to recommend at this stage."

While economists see this as an opportunity to build incentives into the control of effluent through charges, the water authorities, strongly supported by industry, regard trade effluent charging as no more than a method of recovering costs. Industry accepts that they must pay a charge for services rendered by the water authorities, but resist

any attempt at external control. Thus -

"It should not attempt to alter the pattern of use of that service by providing incentives, or penalties such as might be used in a pricing policy." (17)

Further to this, industry wishes to see a charging system that allocates the costs of a particular service fairly between its users and in a manner that is clearly seen to do so. They stress that any individual user should be able to identify the charge with the particular service rendered to him. If this was not the case, then they believe that charges would take on the appearance of taxes. Given the reservations outlined above, they believe that the CBI/RWA Guidelines provide a reasonably satisfactory basis for a charging system.

4.3 Compliance with standards.

This section examines the compliance of discharge qualities with the consent conditions or standards which are attached as a prerequisite to their disposal to water courses. The Glossary contains definitions of the terms 'Royal Commission Standard' (RCS) and 'satisfactory'. It notes that the '30:20' standard is often used as the criterion to define a satisfactory effluent. Data are largely drawn from river pollution surveys (22, 23, 24, 25, 26) and sewage purification and disposal statistics (27).

Tables 18 and 19 set out the performances of sewage treatment works, nationally and within the NWA respectively. Lines 1-6 give data relating to the number of discharges, the population served, DWF, and the proportion of each considered as satisfactory. Nationally, approximately two-thirds of all discharges were considered to be at least adequate, compared with approximately 70% in the NWA. However, in terms of the populations these discharges represented or served, this proportion was much lower, with the NWA again performing better than the national average. Similarly, the volumes of satisfactory effluent as a percentage of total D.W.F. are much lower. A general inference is that larger works serving larger populations tend to produce less satisfactory effluent.

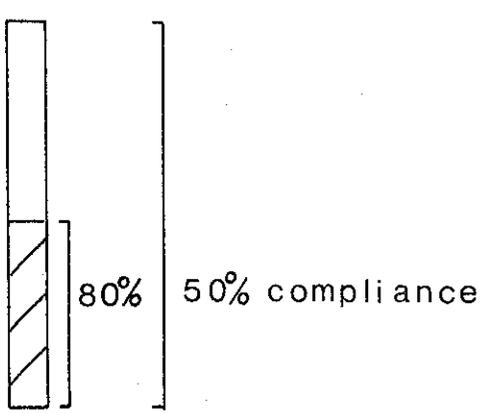
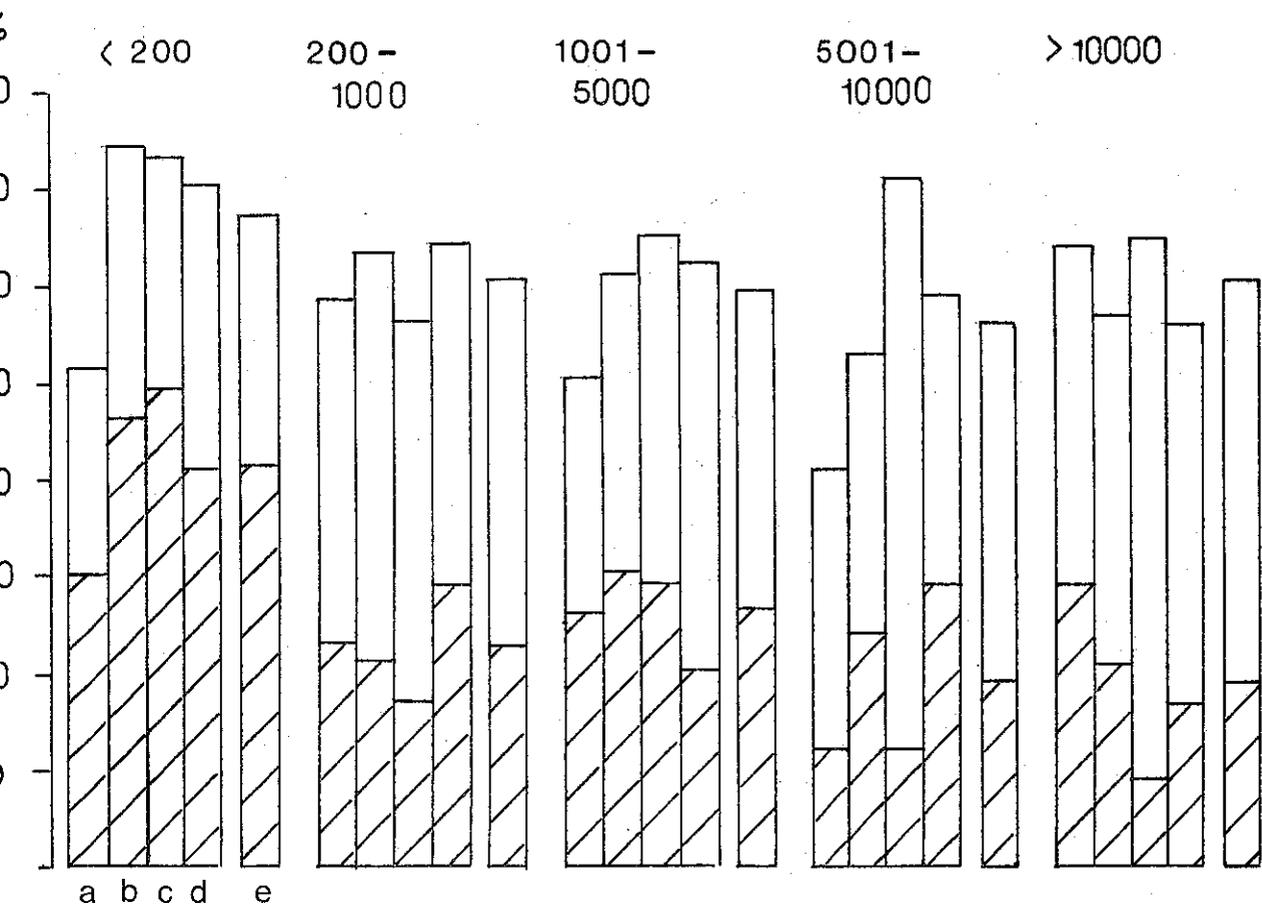
In general, if the receiving waters are of low quality (classes 3 or 4) or are tidal, the quality of effluent is less likely to be satisfactory. Discharges to tidal waters deal with far greater volumes of effluent than those made to non-tidal waters, 2083.9×10^3 g.p.d. per discharge compared with 389×10^3 g.p.d. per discharge. Similarly, non-tidal discharges

FIG 10

SEWAGE WORKS EFFLUENT QUALITY

Works sampled, annual 80% and 50% compliance

Population served



- a 1974-75
- b 1975-76
- c 1976-77
- d 1977-78
- e mean

serve smaller populations (19,000 per discharge) than tidal discharges (35,700 per discharge). These data serve to stress the facts of poor performance and poor quality of discharges to tidal waters.

Table 20 gives the proportions of satisfactory and unsatisfactory effluents, showing how these have changed between 1972 and 1975. In 1975, the majority of all discharges, in terms of numbers, were found to be satisfactory. The greater part of such outfalls were also adequate three years previously, but also included a smaller proportion which had been upgraded since 1972. Unsatisfactory effluents (1975), 35% of the total, were derived nearly equally from downgraded effluents (c. 40%) and unsatisfactory 1972 discharges. The NWA figures differ in that a greater proportion were satisfactory in 1975, with fewer changes in grade taking place between 1972 and 1975.

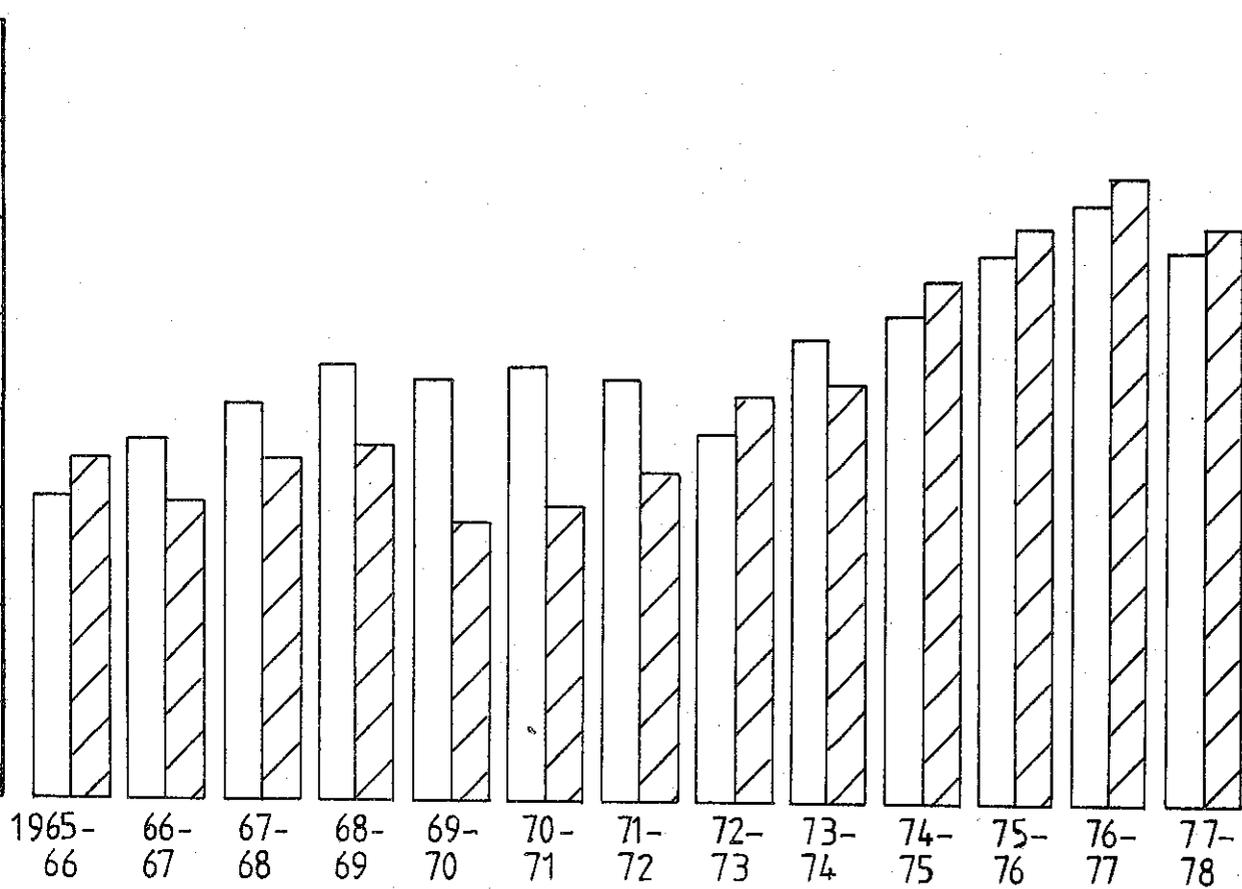
In terms of the volumes these discharges represent, the possible conclusions are slightly different. The proportion of satisfactory effluents, by volume, was smaller than the proportion by number i.e. the number of discharges understates the volumes of unsatisfactory effluent. Between 1972 and 1975 greater fluctuations in status seems to have occurred than consideration solely of the numbers of discharges would suggest.

Figure 10 illustrates the results of sampled works effluents in respect of their compliance with consent conditions. Data are specific to the N.W.A. area, 1974/75 to 1977/78. Works are grouped according to size of population served (28). The diagram shows the proportion of samples in any one year for which, firstly, 50% of the samples and, secondly, 80% of the samples

FIG II

SAMPLES AND ANALYSES OF EFFLUENTS

PERCENTAGE SATISFACTORY



SEWAGE EFFLUENT

TRADE EFFLUENT

achieve the consent conditions. Thus, for example, in the period 1974-75, for works serving less than 200 people, half of a set of samples could be expected to comply with the consent conditions for 52% of the year. 80% of the samples were satisfactory for 30% of the same year. The diagram clearly illustrates how no sample was within the standards imposed for a whole year (29).

On the whole, smaller works tend to perform better than large works, although there are considerable fluctuations. Given that larger works play a more important part in determining river quality, it would seem essential that these should operate more satisfactorily. As no general trend is readily apparent it cannot be stated conclusively whether compliance is improving.

Figure 11 shows the proportion final effluent samples, for sewage and trade effluents, considered as satisfactory. In general, both types have improved their compliance with standards. Latterly trade effluents have proved more satisfactory than sewage effluents, after having lagged behind in the late 1960's and early 1970's. (Data applies to the N.W.A.).

Table 21 shows the numbers and volumes of sewage effluents (with percentage satisfactory) categorised according to the consent standard which applies to them. Tables 18 and 19 show these data further divided according to class of receiving waters (lines 7-24)(30). The main points in Table 21 can be summarised as follows:-

1. For all rivers, and non-tidal reaches, most discharges (approximately 90%) are made with the 30:20 standard as part

1. of the consent conditions.
2. For tidal waters, although the 30:20 standard still applies to most discharges, at least one third (1972 and 1975) have more stringent conditions attached to them.
3. For all rivers, and non-tidal reaches, the proportion with less stringent conditions appears to be increasing, whereas tidal waters seem to be moving towards more stringent conditions.
4. For those effluents complying with the 30:20 standard, ie. the majority, approximately two-thirds by number and half by volume, were considered satisfactory. More notable, however, was the poor compliance (by volume) of discharges to tidal rivers, reaching as low as 15% in 1972. These data are inadequate to reveal trends in performance.
5. Similarly, data on more or less stringent standards are inadequate to draw general trends. In all cases the percentage considered satisfactory was substantially below 100%.

Before looking at data for industrial as well as sewage effluents, an examination of a 100 sample sewage treatment works, with respect to compliance to consent standards, will be made (31).

In Table 22, cases where no data are available on the applicable standard, the 30:20 standard (R.C.S.) was assumed; throughout Table 11 the R.C.S. was assumed.

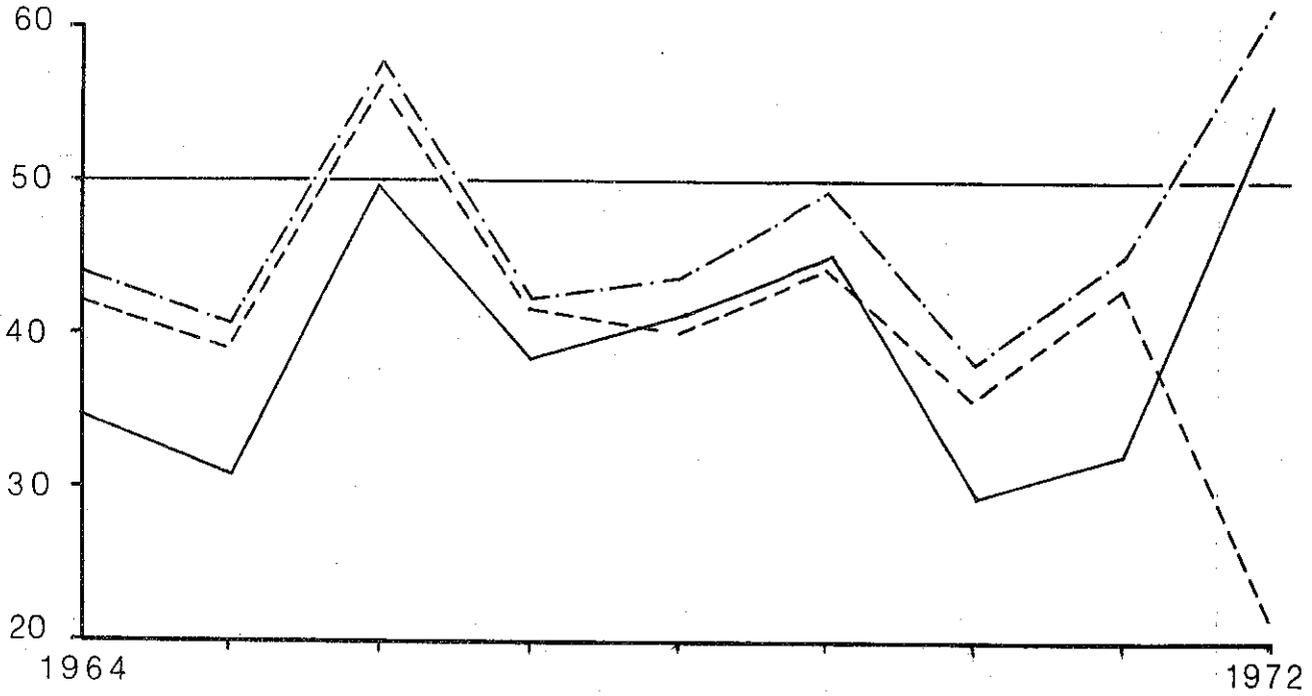
Table 22 shows how D.W.F. has doubled, albeit erratically, in a nine year period. In parallel, the volume of effluent (tcmd) which exceeds the applicable standard has increased. If the volumes of D.W.F. which exceed at least the suspended solids standard (usually 30 mg/l) are examined, it can be seen that

FIG 12

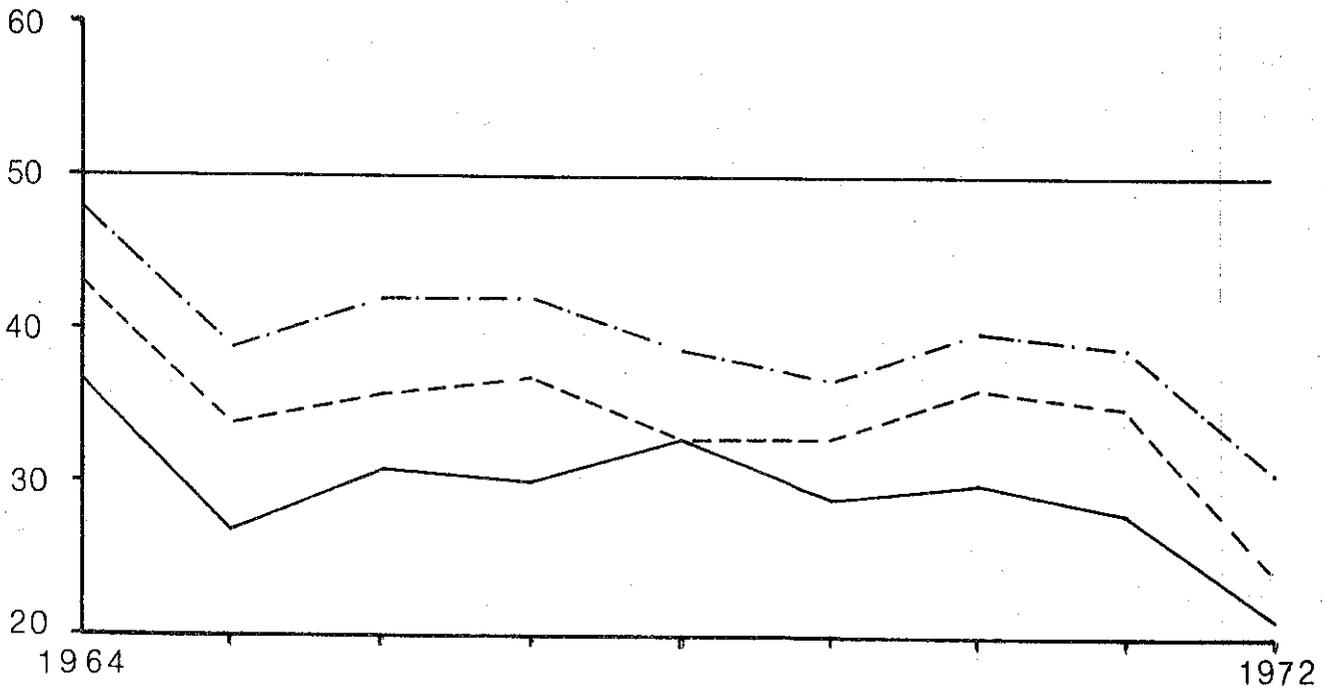
Percentage unsatisfactory by volume and by number

Sample of 100 sewage treatment works

Percentage unsatisfactory by volume



Percentage unsatisfactory by number



Effluent > Standard

— BOD

- - - SS

these have also increased, but with no general trend discernible. On the whole the number of such unsatisfactory effluents have declined (Figure 12), and if 1972-73 figures are ignored, this would also seem to be true for volumes of unsatisfactory effluent. Figure 12 shows that, in general, percentage unsatisfactory by volume is higher than percentage unsatisfactory by number.

With respect to the B.O.D. standard (usually 20 mg/l), results are equally unclear. The percentages of unsatisfactory effluent, by number and by volume, seem to be in decline. Performance, judged by the B.O.D. standard was likely to be poorer than if judged by the suspended solids standard.

The last three columns of Table 22 give data on discharges which exceed either the B.O.D. or suspended solids limits. In general the volume of unsatisfactory effluents has been increasing but in terms of the percentages by number of discharges or percentages by volume, the trend is unclear.

Table 23 shows a slightly different set of figures, discharge effluent qualities are compared to the 30:20 standard. Compared with Table 22, for suspended solids, fewer discharges exceed the 30 mg/l limit. This indicates that, in reality, standards are less stringent than this figure. For B.O.D., the situation is reversed. The evidence suggests that more severe standards than 20 mg/l are being applied. Both tables confirm that fewer effluents conform to 20 mg/l B.O.D. than 30 mg/l suspended solids.

Tables 24 - 26 cover the performance of industrial effluents. Appendix M defines five categories of effluents which are considered

in this section. Table 24 gives data for five types of effluent for four river pollution surveys (22 - 26). It can be seen that over half of all discharges originate from domestic sources. In all cases industrial effluent is less satisfactory than domestic effluent. In the period 1970 to 1975 an improvement in compliance with standards of 8% occurred.

As with sewage effluents, industrial effluents tend to be less satisfactory if the receiving waters are tidal. No discharges of crude sewage or mine-water are satisfactory; however, their numbers are declining as they are either channelled to sewage works or mine workings cease operation. Cooling waters tend to be largely adequate, completely so in the N.W.A. area. As Table 26 demonstrates, 90% of all discharges to tidal waters, and just over 80% to non-tidal waters, were cooling waters.

In conclusion the following points can be made -

1. Compliance with consent conditions never reaches 100%, except in the discharges of cooling water. Most types of effluent show slow signs of improving compliance.
2. Compliance is likely to be lower when a discharge is made either to rivers classed as poor or grossly polluted, or tidal waters.
3. In general, the volumes of satisfactory effluent as percentages of total effluent flows is less than the percentages of satisfactory effluents considered only by number of discharges.
4. The term 'satisfactory', as defined by the river pollution survey, does not state the time period for which this status must be maintained in order to qualify for this

4. description. No effluent, with the possible exception of cooling water, remains within the consent conditions all the time.
5. The majority of consent conditions are set at the 30:20 levels. It appears these are being relaxed for non-tidal waters and tightened for tidal waters.

Chapter Five
Policy Formation

5.1 Environment as a political phenomenon.

Chapter Two outlined some of the theories and proposed solutions of two groups of theoreticians, ecologists and economists. Chapter Three summarised U.K. legislation on the water industry and the pollution problem in general. To bridge the gap between theory and the emergence of legislation requires an examination of how these issues became matters of both public and political concern. An explanation of the evolution of pollution legislation must include an account of those precipitating factors which, alone, could not explain the passing of legislation but resulted in a popular movement in which the political climate was ripe for such action.

Legislation is either the result of action taken because of a consensus of opinion, or, of action taken which attempts to strike a balance between conflicting interest groups. Pollution control legislation was the outcome of a conflict situation, it is therefore a balance between the interests of different groups. A summary is given of the interests of these various groups and the point at which legislation has struck a balance between them.

5.1.1 Emergence of 'environmental awareness' in Britain.

While there has been sporadic legislation on environmental problems since 1945, it was not until the late 1960's that environment, pollution and ecology became issues upon which Parliament took action (1). This cannot be explained solely with reference to a deteriorating environment as pollution and its recognition

as a problem, (at least by some individuals) has existed for centuries (2).

The historical roots of 'environmental awareness' stems from the conservation and amenity lobby row over 150 years old (1, 3, 4, 5, 6). The professed aims of this lobby was, and is, the conservation and preservation of the countryside as a part of the national heritage. However this was not so much an assertion of mass popular rights as an affirmation of the interests of a small section of society (3). The development of the lobby paralleled that of the Romantic Movement of the early nineteenth century, and that of the science of natural history. The conservation lobby, as a consequence drew on these bodies, and incorporated their philosophies.

Up until the late 1930's the proponents of amenity and natural history were poorly organised and despite their relatively large membership had little impact, either politically or on public opinion. In the post war years they utilised the developing media of radio and television. Their message was initially largely escapist but broadened out in the late 1950's to voice the aims and problems of the conservation issue (1).

Prior to the 1960's it was possible to identify long-standing groups which represented broad categories of environmental concern. These included nature conservation, leisure and recreation, preservation of the urban and rural landscapes and prevention of pollution and dereliction. However the mid-1960's saw the development of highly organised, politically motivated groups (7). Unlike their forebears, these groups took a broader, holistic approach to all environmental topics.

Thus the Conservation Society (formed 1966) claimed that it:

"differed from existing societies concerned with conservation in emphasising the need to treat the common cause of the environmental problems and not merely their symptoms." (8)

Thus there seems to have been a major change of emphasis in the way in which the environment was regarded in the mid and late 1960's.

Many factors can be seen to have brought about this change. Part of the responsibility for the initiation of this change can be put down to the impact of certain individuals, the most notable, being the effect of Rachel Carson's 'Silent Spring' in 1962 (9). The main theme of this book was the impact of pesticides on the environment. However, it went further, articulating the links between ecosystem stresses, such as pesticides, and the effect these had on the environment. This book aroused considerable public interest on the effects of pesticides and the themes of ecology in general (10).

Since the publication of 'Silent Spring' the environmental movement, in America at least, has been characterised by the more extreme elements or ecological evangelists as Gunningham (1974) termed them (11). Such attitudes are exemplified by Prof. P. Ehrlich's 'Population Bomb' (1968) (12). Since that time the market has been flooded by a stream of literature in a similar vein, the most notable being the Ecologists 'Blueprint for Survival' (1972) (8) and D. L. Meadows et al (1972). 'The Limits to Growth' (13).

Such popularists of the environmental movement have been aided by the various forms of mass media. It seems that the

various themes of environment were largely by-passed until the mid-1960's when these issues were chosen as suitable material by the media.

A content analysis of the 'Times' (14) over the period 1953-73 was used to test the hypothesis that there had always been an interest in the component problems of the environment. It was shown that from approximately 1965 onwards the proportion of news items given over to environmental topics rapidly increased. (As the sampling was at four intervals this date can only be an approximation) For example the percentage of environmental news items increased by nearly 200% from 1965 to 1969 and by nearly 300% from 1969 to 1973. In the period 1961 to 1965 a drop in this percentage had been experienced. The conclusion which was reached was that a form of subsumption had taken place; items had become newsworthy in two respects, firstly from their own intrinsic value and secondly in their abstract value to the wider issue of environment. Thus component problems of the environment became more likely to be reported because they had assumed a greater interest as a part of a much wider topic of environmental quality and degradation.

The treatment of environmental topics by the media has tended towards the sensational, concentrating on crisis events - for example the Torrey Canyon and Seveso incidents - or the polluting effects of large industries or corporations such as RTZ at Avonmouth (15). The new environmental groups drew impetus from the publicity potential of the mass media; their methods, which include direct action and political lobbying, were calculated to provoke publicity and utilise the potential of the media to

the full.

However the action of individuals and (media-backed) groups does not completely explain the way in which pollution became the social problem that it did in the 1960's. Thus in 1661, John Evelyn attacked

"the sordid and accursed avarice of some few particular persons which make the inhabitants breath nothing but impure and thick mist, accompanied by a fuliginous and filthy vapour - corrupting the lungs and disordering the entire habit of the body." (11)

Why, if Evelyn could not convince people of the dangers of pollution, should Rachel Carson be able to do so in the 1960's? Several factors can be put forward to account for this.

Firstly, it is claimed that the amount and intensity of pollution increased as a result of the post-1945 boom in production. Pollution was no longer a localised problem. Indeed the debate about whether it had reached global proportions (16) stems from this time. Secondly, the eruption of crisis events had a catalytic effect (as publicised by the media) not only in creating an awareness of the potential dangers, but also a demand for action. Demand for action after a crisis was almost instantaneous and often short lived. This had consequences for the type of legislation which resulted in that it catered towards allaying the public's fears, rather than tackling more mundane but persistent pollution problems. It could be claimed (11) that only at times of strong public outcry could the advocates of pollution control neutralise the objections of those whose interests would be adversely affected by stricter controls. These

include the bulk of British industry supported by the inertia of government.

Thirdly, the 'ecology boom' came about at a time of improved living standards and moreover, at a time of rising expectations, thus enabling people the comparative luxury of concern about pollution (17). Fourthly, it has been claimed that concern for the environment was partly generated by experts as a means of furthering their own interests and careers. Thus ecology, once a branch of biology, achieved the status of a science in its own right.

Lastly, awareness has been heightened in recent years, by the added capability to measure pollutants. The statistical link between air pollution and respiratory diseases is ^{now} well-established. Further, this had lead to the demand for more efficient monitoring so that yet more research can be made.

5.1.2 Pollution politics in Britain.

To explain the growth of environmental concern, and the demand for legislation does not, however, necessarily explain the emergence of legislation. Indeed, even if legislation is passed as a (partial) result of such a campaign, the content and aims cannot be guaranteed to be totally in accord with those of the initiators of action. It seems that over the issue of pollution control measures a conflict exists between the interested parties. The outcome of a campaign for legislation will depend on the balance of power between these parties within the political system. As a conflict of interests seems to exist, it can be inferred that the 'environmental awareness' campaign has not succeeded in changing the values of society as a whole. As no workable consensus of opinion has been reached, legislation must be explained in terms of the various motives and interests of pressure groups involved and the power they wield. Legislation should therefore be regarded as a balance struck between all of these groups.

Chapter Two presented some of the extremes of thought which have been developed, ranging from those who regard pollution as a minor problem to those who see pollution as a contributing factor to global eco-catastrophe. At present the consensus view holds that a balance be found between the benefits of economic activities and its undesirable side-effects. Further, that given sufficient funds, this balance can be achieved without changing the prevalent aims and policies of our society. This viewpoint is typified in the First Report of the Royal Commission on Environmental Pollution (18). This

states that

"pollution should be reduced to the point, where the costs of doing so are covered by the benefits from the reduction of pollution." (para. 20)

Thus the relative power of those who oppose and those who demand stricter controls must be examined to explain, firstly, the nature of the prevalent legislation and, secondly why this has come to occupy a moderate position. Four groups have been identified as requiring stronger action (11). The first includes the various environmental pressure groups described in section 5.1.1. Their power lies mostly in their ability to influence the media and so heighten public reaction. The second group, which includes individual entrepreneurs such as Rachel Carson or Ralph Nader, also draw on their ability to provoke public concern through the media.

A third group contains unaffiliated specialists who see pollution as harmful and regard themselves as qualified either to deal with it or express an opinion on it. Their power, lies in lending a 'pseudo-scientific legitimacy' (3) to the environmental lobby, the assumption being that any decisions will be rendered purely technical, apolitical in nature. As they have an important advisory capacity to government and other bodies, their influence can be important.

Lastly, and for the sake of completeness, must be mentioned a mixed group, which has been termed the 'Modern'Romantics (11). They appeared during the post-war period of affluence, rejecting the material rewards of an industrialised society. They have developed social theories which refute the central values of contemporary society. Such theories embraced pollution as an anti-

materialistic issue, implicating capitalist industrial society. Their impact on politics and political decisions was small, mainly because of their conscious desire to remain outside the prevalent social system.

In Britain, pollution and the environment has yet to become a genuine political issue in the way that it has in Europe or the U.S.A. The newly formed Green Party, which was created to contest the last general election, had little success, but achieved publicity for their cause. Environmentalists have no direct contact with the parliamentary machinery, and must therefore, depend on other means for influencing political decisions.

In government the advocates and opponents of stricter pollution control measures cannot be easily classified according to party allegiance. Indeed it seems to be one of the few topics which cuts through party political lines. Britain's political inertia to pollution has been attributed to several causes. Firstly, the problems are not felt to be as severe as for example the U.S.A. Secondly, the existing control legislation is comparatively well developed. Lastly, and most importantly in this context, the system of party affiliation and discipline makes it less easy to raise general questions of priorities and thus represent environmental interests in a party political fashion. This is in contrast to the American system, where the individual member has much greater freedom of action.

Beyond direct contact with the parliamentary machine, the environmental lobby also lacks informal contact with government departments. It thus is not enveloped in the formulative stages of government policy. Consequently, it must seek to influence



policies and decisions at a later and more formal stage, either through representation to individual M.P.'s or through contacts with statutory agencies within government departments. These include the Countryside Commission and the Nature Conservancy. However within the Civil Service hierarchy, these agencies are politically marginal, having comparatively small budgets and therefore carry little weight (4). Their work does not lie within the area of any party political controversy, such as employment or industry. It is also considered to be largely specialist or technical in nature and to impinge little on the work of other departments. For all these reasons, these agencies carry little political influence, and therefore the interests they protect are given low priority.

The opponents of stricter control measures have a much greater degree of political access and indeed the interests of government often coincides with their interests. Traditionally, industry has been the main opponent of control measures, on the grounds that they are costly, adding to production costs and detracting from profits and competitiveness. Government, in general has resisted limiting the actions of industry, the Conservative party on the grounds that there must be no limitation to profitability and growth, and the Labour party on the grounds that such measures might endanger jobs. However in recent times the position of government and industry has been less clear.

Within the last 15 years (approximately) industry seems to have begun to take the pollution issue more seriously, the larger firms apparently more so than smaller ones. It seems that an explanation in terms of the profit motive may be

inadequate. Several motives have been suggested. Firstly, legislation as it stands may still be inadequate or inadequately enforced. Secondly, those firms with a larger profit margin may be willing to accept a cut in profitability by curtailment on pollution at the present, rather than risk absolute bans in the future. Thirdly, large firms tend to be image conscious and may practise image management in the form of pollution abatement. Lastly it has been suggested (11) that large firms actively support stricter controls as a means of forcing out smaller competitors, leading to oligopolistic control of a market and higher long-run profits. There are thus many non-altruistic reasons for firms, especially large firms, to practise or advocate some form of pollution abatement.

The position of government has also become ambivalent recently. Although the vote catching potential of environmental issues is not as great as it is in America, government cannot be seen to be harming public welfare by overtly supporting polluters. It has therefore become necessary simultaneously to support the viability of industry and to take measures to protect the public's interest.

The outcome is, as Gunningham (1974) (11) puts it, that "their solution is likely to be a mild interference with the present system rather than a far more radical reversal of our allegedly, destructive technology and acquisitive growth technology" (Page 41).

Such a solution is unlikely to please any environmental groups and can be viewed as supporting the interests of industry, and yet satisfying the public's demand for some form of action.

5.2 Policy modification : a model.

Between the recognition of the existence of a phenomenon as a problem to society and action taken as a response to that situation, a series of decisions must be taken regarding the exact nature of the problem and the appropriate measures required as a consequence. Several stages may be involved from problem identification to practical action being taken. At each juncture, the way in which the predicament, and the subsequent proposed policy of action are viewed may vary. A variety of opinions may be held, the resultant measures being a compromise between these views. Thus initial conceptions may not necessarily be those which are used as a basis for remedial work.

A general model of policy modification is outlined (11). In section 5.2.3 this will be related to the ways in which the Control of Pollution Act 1974 has been modified as a policy. Several stages can be identified.

1. Problem Definition

Any social problem exists in two senses. It has an objective condition which is verifiable, for example, by quantification. Further, it has a subjective definition which sees the objective condition as an actual or likely threat to certain societal values. Thus the physical existence of a phenomenon is insufficient for it to be recognised as a problem. A further subjective assessment of the condition on the basis of likely injury is required for this to come about. The types of proposed measure require analysis not only in the context of the actual physical situation but also of the various interpretations

which have classified it as a problem. Further these interpretations must be examined with respect to the biases of the various groups who have an interest in the matter. Thus a divergence may appear between the physical condition and the way in which it is defined.

Having subjectively defined a physical condition, that assessment must gain a wider acceptance. Others must be convinced that the situation is dangerous enough to require public action. In the case of a natural disaster, for example, the need for action is obvious and imperative. However some problems may not be recognised so instantaneously and wholeheartedly as this. It is often up to small sections of society to persuade the rest that a problem exists and that steps must be taken to resolve it.

Section 5.1.2 outlines the contacts that conservation and ecology groups have evolved, as means of putting across their fears for environmental well-being and means of influencing government through various agencies.

To gain attention the problem in question must become newsworthy. The object of some groups is to give a particular problem such an appearance. To achieve this the problem must be redefined (or simplified) and related to current prevalent societal values. Redefinition may involve a certain amount of eclecticism in that reinterpretation for public comprehension may involve drawing on other viewpoints of the same problem. The commonly accepted definition does not, therefore, necessarily accurately reflect the actual problem or initial perceptions of its condition.

The results of a successful publicity campaign may

take one of two paths. Firstly, the campaign may result in a wholesale change in opinion, from which the demand for action is widespread and (largely) unopposed. For example, public outcry for the withdrawal of thalidomide resulted from exposure of the dangers of the drug in the press. Secondly, the campaign may succeed in persuading a significant proportion of society, but considerable opposition still remains. Assuming such a successful campaign, it may be decided that action must be taken, and that its appropriate form should be as legislation rather than as an extension of tightening up of current practices.

At this point, active opposition may appear. If a wholesale change in societal values has not occurred, then this will almost certainly be the case. The content of legislation must be a compromise between the various interested groups; the point at which compromise is reached will depend on the relative powers of all groups, internally and externally to the legislature. Opposition may criticise the proposed measures on several grounds. Firstly, that the problem does not exist at all, or secondly, that the definitions of that problem are inaccurate or exaggerated, or lastly, that the problem deserves a lower priority compared with other objectives.

2. Legislation

The debate will now proceed inside and outside the legislature. Internally the problem may be referred back for reassessment. For example, in Britain, re-examination may take place as an informal civil service investigation, as a formal Royal Commission, or as a Select Committee of

Parliament. These may verify the existence of a problem, the accuracy of its perception, the need for action, and the most appropriate measures to be taken. Criteria for this assessment will be current governmental and societal objectives. Assuming a case is found for practical measures, the topic will be debated when it is presented as a piece of legislation. Here conflicting views will be expressed by the composition of opinion.

As Section 5.1.2 states, the need to improve environmental quality has tended to be a non-party political issue. However, related issues, such as profitability and employment levels, are closely identified with party political policies. Some legislation may not reflect the general composition of opinion in Parliament but may be overridden in deference to strong public opinion (19). In so reacting to external pressures, the form of proposed action may be more in line with a publicised version of a problem than either a technical definition or a theoretical stance.

The type of resultant action depends on numerous factors. These include, the need to be seen to be doing something; pressures from those who will be responsible for policy implementation; pressures from those who will be affected by new controls.

3. Implementation

Any subsequent legislation is passed on to those who have been made responsible for its implementation, in this case the water authorities. They have direct contact with the actual problem, local circumstances and those likely to be affected by the implementation of any provisions.

The likely effectiveness of any legislation will depend on a number of issues. If such authorities initiated the original campaign, or favoured the passing of the legislation, then they are likely to implement its provisions fully and effectively. If it was imposed upon them, then this is not likely to be the case.

Given a will to fulfil their legal obligations, local circumstances may act to reduce the success of any action. For example, many measures may require the co-operation of other authorities and concerns. Given less than full understanding or even direct opposition, implementation may be fraught with difficulties. If past policy has been to achieve change by co-operation on an informal basis, then the introduction of measures on a more formal level may affect the amount, and successfulness, of collaboration. In addition, these authorities may have an awareness of local circumstances, for example, employment problems, which may influence the rigour and timing of new measures. Lastly, given the will on the part of the implementing authority financial constraints may assign other problems a higher priority.

Modification of any policy may take place at several junctures, initially in its formulation and subsequently in its implementation. If a policy is perceived to be inadequate then this may result in moves to alter the current policy to produce more effective results. Re-assessment of policy may occur at any of the stages at which it is considered, thus the implementing authority may be dissatisfied with its operation and make appropriate changes.

Similarly an external pressure group may press for action closer to the original spirit of legislation or a total change in that legislation. Equally the new policy may be recognised as too harsh and changes may be made in compensation.

5.2.2 Pollution prevention measures.

To illustrate the possibilities of policy modification three measures related to pollution prevention are examined. These are, the consent procedure, the new trade effluent charging schemes and the operation of sewage treatment works. Each illustrates a particular form of modification and is indicative of the gap between the theoretical ideal (Chapter Two) and practical outcome (Chapter Four). As background to these measures, the opinions and influences which affected the passage of the 1974 Control of Pollution Act are examined.

1. Theoretical Definitions

This section examines how definitions of the pollution problem as devised by ecologists and economists (Chapter Two) have been translated into legislation.

(i) Ecological definitions. In brief, ecological prescriptions come under two headings. Firstly there are those who wish to see limitations or bans placed on the discharge of pollutants, relating permissible levels of output to the assimilative capacity of the receiving environment. Secondly, there are those who wish to see a radical re-organisation of society based on the ideas of zero growth. Each view has had a degree of success in promoting its ideas to the legislature and the general public. It is now recognised that absolute bans, for example, are the only appropriate forms of control for toxic effluents. The second school has success in publicising the dangers of uncontrolled growth (13) but whether this affected government could be debated.

In terms of the 1974 Act these ideas have been partially incorporated, but also substantially modified. The Government chose to readopt a policy of control by limitation and minimum standards as operated under the 1951 and 1961 Rivers Acts. The case for national uniform minimum standards was rejected, therefore control remains very much at the discretion of the water authorities. The arguments of the no-growth school (or political ecologists) were totally refuted thus by the (then) Secretary of State for the Environment, Mr. Anthony Crosland, at the second reading of the Control of Pollution Bill (20).

"We certainly shall not solve the problem by adopting what in my view is the fatalistic attitude of the Club of Rome or the Doomwatch school of thought and calling a halt to economic growth. One can find circumstances where growth and the environment are in conflict but one can find many more circumstances where continued growth is a necessary condition of improving the environment."

The Minister went on to cite a meeting he had had with the Chairman of the N.W.C. and the Chairmen of the regional water authorities. They had stated that astronomic sums would be required to improve river quality to an ideal state. The Minister was of the opinion that these sums would be impossible to raise in a no-growth economy.

However not all of the House was so totally dismissive of no-growth arguments. Mr. Arthur Blenkinsop was of the opinion that society should be more critical

of growth, in that some forms of growth, for example built-in obsolescence of some products should be rejected as unacceptable.

Prevailing attitudes coincided more closely with Mr. Crosland's; in consequence the Act did not extend control beyond the powers of the Rivers Acts. The real advances for the environmental lobby, however, were twofold. Firstly control was extended to tidal and estuarine reaches previously uncontrolled by the Rivers Acts and the 1960 Clean Rivers Act. Secondly the Act contained provisions to make the availability of information on effluents, especially trade effluents, more readily available. These measures are discussed in sections 5.2.3 and 5.2.4 (below).

Arthur Blenkinsop summed up the advances for effective environmental protection, thus -

"let us be under no misapprehension about the modest advance that we are likely to be able to make under its provisions. Some of the problems created by modern technology challenge us to make certain reassessments of our standard of values in society (20).

(ii) Economic definitions. Chapter Two states the reasons why charges are commonly accepted as the appropriate solution to the pollution problem. The function of charges is to act as a direct incentive to the polluter to regulate pollutant output to some optimal level, mutually satisfactory to the polluter and society as a whole.

Prior to the debate of the Protection of the Environment Bill and its immediate successor the Control of Pollution Bill, these arguments had been discussed at a variety of

stages. Due to the largely theoretical nature of such discussions these questions were largely unfamiliar to the public in general, discussion taking place largely within academic circles.

Several important precursors to the Control of Pollution Bill contained discussions of the merits and demerits of an incentive charging scheme. For example, in a Minority Report of the Third Report of the Royal Commission on Environmental Pollution, Lord Zuckerman and Professor Beckerman outlined the use of pollution charges as economic instruments for controlling pollution (21). Although they outlined a number of reservations, mostly on the practicality of some facets of incentive charging theory, their arguments are much as economic theory outlines (22). However, the other members of the Commission were unable to accept the case for charges, preferring to leave control by regulation. Lord Zuckerman and Professor Beckerman noted the lack of evidence of the practical application of incentive charging theory. However their case was taken up by the 1974 Third Report of the Jukes Committee on charging policies (23). Although this report post-dated the 1974 Act, it has influenced the attitudes of the water authorities towards long-term policies for charging and pollution control.

In debate, the Government took a similar line to the Majority Report of the Royal Commission (21), that the price mechanism was inadequate. It was also influenced by similar findings of the 1970 White Paper on the Protection of the Environment (24). During the second reading of the

Control of Pollution Bill, (20) Mr. Grosland stated that -

"We shall not solve the problem by relying solely on market mechanisms. While increase in demand can call forth increasing supply of such things as cars and hi-fi equipment, it cannot call forth cleaner air or cleaner rivers. There is no such automatic effect." (pp 104-105).

However even if the principles of incentive charging theory were so refuted, the related concepts of efficiency and equity were not. The problem of pollution was seen as a question of balancing the benefits of control with the costs arising from action taken. The Royal Commission and Parliament intuitively saw the question in terms of cost-benefit analysis. Thus the First Report of the Royal Commission (18) stated that:

"pollution should be reduced to the point where the cost of doing so are covered by the benefits from the reduction of pollution."

Similarly the Secretary of State talked of a balance between the rights of the community to a cleaner environment. He implied that the balance had swung too far towards the interests of the polluter and that the demands of the community must therefore be given higher priority.

The principle of equity was embodied in the Government's broad acceptance of the polluters - pay principle (25, 26). In terms of the Bill this meant that those responsible for any form of pollution should pay the cost of reaching the standards which the controlling authorities may require. This principle had been

promoted from several sources, including the E.E.C. (27). The Government did not regard the general principle as inviolate, as they foresaw circumstances in which public expenditure would be unavoidable if quality targets were to be reached.

In general, the theoretical arguments of economists, at least on the benefits of incentive charging, were largely ignored. However a measure of success had been achieved in that charging for trade effluents was now to be placed on a more rational footing, as recommended by the Jeger Report (28), amongst others. In addition the principles of incentive charging had been recognised to be of sufficient merit to warrant further discussion. How much this owed to the financial circumstances of the time is unclear.

5.2.3 Legislative definitions : The Control of Pollution Act 1974.

In the previous section the reactions of the legislature towards specific theoretical arguments was discussed. This section examines some of the broader considerations which influenced the provisions of the Control of Pollution Act. These include groups, other than ecologists and economists, which affected, or would be affected by, the proposed measures.

The Control of Pollution Bill had no specific party political connections. It was introduced by a Conservative government as the Protection of the Environment Bill and was passed in July 1974 as the Control of Pollution Act, by a Labour government. Its parliamentary origins began four years previously with the establishment of the Royal Commission on Environmental Pollution, the formation of the Department of the Environment's Central Unit on Environmental Pollution and the publication of the White Paper on the Protection of the Environment (1970) (24). The Jeger report (28) on the disposal of sewage effluent, was also influential. The content of the Protection of the Environment Bill was largely based on the White Paper, and in turn the Control of Pollution Bill was substantially founded on this Bill.

The Secretary of State outlined the government's requirements for effective pollution control, during the second reading of the Control of Pollution Bill. These were:

1. The need for comprehensive scientific and technical knowledge as the basis for effective action (29). In general the overall lack of data concerning the environment was noted and provisions were made, therefore, to rectify

this deficit. However the most important deficit was felt to be the general lack of information available to the public concerning pollutants, particularly trade effluents. The wish to make such data more readily available was expressed in the Second Report of the Royal Commission (30), their recommendations being accepted by the previous Conservative government, and incorporated with their Bill. The succeeding Labour government was of the opinion that their predecessors

"were perhaps a little too tender to industry about the protection of trade secrets." (20, pp 96).

They intended therefore to strengthen these measures. To quote Mr. Crosland on information availability

"This is vital not only for the Government and local authorities; the public has the right to know and to be made fully aware of the state of the environment and the sources of pollution. Obviously we must live with some degree of pollution. A perfectly clean world would be a dead world. But the public must participate fully and actively in decisions about how much pollution should or should not be tolerated. These are not matters to be settled behind closed doors." (20, pp. 95-96).

And further,

"Our over-riding objective surely must be a freer and fuller flow of information to the public, and the requirements of the Bill will go a long way to achieve this." (20, pp 96)

2. A second requirement of any pollution control programme which was cited, was the need to establish a correct

framework for economic analysis. This framework had to attempt to reconcile any conflict of interests of the individual, as a polluter, and the interests of society as a whole. The reasons why government preferred control by regulation to control by incentive charging were given above (Section 5.2.2).

3. The last requirement was the need for an adequate administrative framework. This had largely been achieved by the reorganisation of the water industry in 1973, and the reforming of local government authorities. Thus the desire to manage all aspects of the water cycle by single cohesive authorities had been largely achieved.

Although the government had noted the vast sums that the water authorities had judged essential for proper restoration of river quality, the Act contained no specific financial arrangements to assist them in their task. The Jeger Report (28) had stated as a recommendation, the pressing need for a substantial increase in public expenditure to provide treatment works for the production of satisfactory effluent. It stated that:-

"The higher standards of discharges needed to fulfil these priorities will require greater expenditure on water pollution control. Despite all the other competing claims on national resources, we are convinced that this expenditure is justified." (pp 22)

The Water Act 1973 included specific measures to attempt to ensure that the water authorities paid their way; for example the Secretary of State may direct water authorities to conduct their business so as to secure a

specific rate of return on the value of their net assets (31). Thus the Government imposed stringent controls on public expenditure and yet apparently supported the urgent need for expenditure on pollution control.

Industry, in general, was strongly opposed to the use of incentive charges and any attempt, thereby, to attempt to change the pattern of use. The provisions of the 1974 Act therefore reflected such wishes. However the Act also included provisions for the disclosure of trade secrets. It has been shown how the general tone of the debates considered industry to have been over-protected. The Government, however did accept that genuine cases might exist for secrecy, and built in clauses to allow exemption from publicity (Section 5.2.2). It was stressed in Chapter Four that as yet, the general policy on this is unknown. The Act makes no provision for the disclosure of information relating to discharges to public sewers. As the majority of discharges came in this category, the attempt at making more information available is not as complete as it could be.

Trade Unions

The interests of Trade Unions were noted by several speakers. It was foreseen that a clash of interests could arise between those of the unions and those concerned with improving effluent standards. Circumstances were envisaged that might lead to choosing between dealing with pollution rigorously and maintaining employment levels. How to bring about a conciliation in such a situation was not discussed, it was hoped that close co-operation with the Unions would

accomplish a workable understanding.

E.E.C.

Lastly several references were made to discussions with other members of the European Community (26). The British Isles had accepted several directives from the E.E.C. concerning environmental pollution, notably the control of land-based sources of marine pollution. However, up to that point, the Government had resisted the idea of setting national minimum effluent standards on the grounds that they were inappropriate to the British case, an effective method of control by discretionary regulation being well established.

In conclusion, several aspects of policy modification can be seen in the progress from theoretical discussion, publicity, demand for action and the expression of that demand as legislation, in this case, the Control of Pollution Act. All interested parties had cause for a degree of discontent with its provisions. Environmentalists had achieved a greater accessibility to information but not a wholesale conversion of the economy to one run on ecological principles. Similarly economists had not seen the introduction of marginal cost pricing but had gained credence for the notions of equity and efficiency.

Industry was now liable to closer public scrutiny but not to incentive pricing or statutory emission standards; control remained at the discretion of the water authorities. Water authorities had gained fuller powers over tidal and estuarial waters, and the authority to operate controls as they saw fit. However financial circumstances were envisaged as a constraint to achieving water quality objectives.

5.2.4 Implementation by the water authorities.

In section 5.2.1 it was stated that the effectiveness of a policy depends on the way in which it is implemented. The likelihood of full implementation depends on many factors, some possibly beyond the control of the responsible authority.

In general, the water authorities welcomed the Control of Pollution Act, in that it extended their control over the water cycle and over polluting discharges in particular. They had backed the call for the extension of control over estuaries and tidal waters, and approved of the tightening of the consent procedure. However their reception of the new publicity provisions was less than whole-hearted. This could be explained by the fact that they, as well as industry, would be forced to declare the exact nature of effluents from water authority controlled works and their compliance with consent standards (Chapter Four).

In their Fourth Annual Report and Accounts (1977-78) (32) the N.W.A. reported that control over most major trade effluent discharges was nearly complete. By late 1979 they were in the process of extending control to all relevant discharges anticipating the implementation of the appropriate sections of the 1974 Control of Pollution Act. Section 4.3 illustrated 100% compliance with consent conditions is rare. Section 4.1.2 demonstrated how, as a result^{of}, the new publicity provisions, the conditions applying to direct discharges are being revised to avoid the possibility of prosecution. As far as the intentions of Parliament were concerned, there was a desire that matters concerning the environment should not be settled behind closed doors. The 1974 Act, however, seems to be having the opposite effect.

In addition to the factor of 'willingness', local and financial circumstances were mentioned as influencing the likely effectiveness of new measures. As the water authorities have been awarded a wide degree of discretion to their handling of the pollution problem, such conditions may have a significant modifying effect on their intentions and subsequent actions. It can also be noted that the reorganisation of the water industry could also have affected attitudes and intentions.

At reorganisation the river authorities handed over a number of pressing problems, the most notable being the poor quality of many rivers, particularly tidal stretches; a stock of equipment of variable quality and lastly, heavy financial commitments in the form of debts on capital expenditure. The new authorities were faced with a duty to maintain or improve river quality but also strive toward financial stability. The river and water authorities were also, increasingly, aware of a general concern by the public for problems of environmental degradation.

To a large extent, the water authorities were committed to continuing the practices of their forebears, the river and local authorities. For example, they felt that consent and charging policy could not be altered radically as it would be practically impossible for industry, or even their own works, to make the necessary adjustments at short notice. They were thus committed to maintaining the status quo, bringing about long-term improvement using the consent system (33).

The N.W.A., in its first Annual Report (32), cited some of the commitments and problems inherited from their predecessors. One of the most serious was the condition of works, which

varied widely, many of the smaller works operating well below acceptable standards. These operational inadequacies, whether caused by run-down or overloading, were exacerbated by other minor problems. These included a lack of trained personnel, lack of vehicle and plant, badly maintained equipment, inadequate sludge disposal facilities and a general absence of works records. Further they were committed to a programme of heavy capital expenditure, the principal being the Tyneside sewerage scheme, as well as a back-log of debts. The First Report states that :-

"There are pressing needs throughout the region to relieve overloading of sewers and pollution of watercourses by the excessive operation of storm overflow; to implement plans for cleaning up the outstanding industrial estuaries; to alleviate the adverse effects of sea outfalls; and to establish a rational programme for the economical replacement of worn out sewers. However from the outset the economic climate had compelled severe restriction on the Authority's capital works programme, to include the minimum number of new schemes."

As a consequence, priorities were allocated in the following order of priority

1. schemes already committed
2. new housing development
3. new industrial development
4. improvements essential to safeguarding health
5. other projects.

Thus many schemes, especially the replacement of antiquated stock had to be deferred until finances permitted. However the authority did commence a programme of small capital expenditures

and tightening procedures, which would have an immediate beneficial effect. For example, smaller works were grouped together and operated by mobile gangs. Similarly, efforts were made to recoup costs, notably, in this context, the introduction of a rational scheme of trade effluent charging, as a response to the 1973 Water Act. The water authorities' new obligations, as defined by this Act, were summarised in a N.W.C. publication, 'Paying for Water' (31)(34).

The scope of those liable to trade effluent charges has been extended since reorganisation. As a consequence revenue from this source has increased rapidly. Thus in the financial year 1974-75 such charges amounted to £139,000, however by 1977-78 this had risen to £877,000.

In conclusion, three stages of policy evolution have been identified. These are problem identification, (any) subsequent legislation, and lastly, implementation of new policy. Each of the measures mentioned above, consent and charging policies, and operation of sewage treatment works, have passed through this process with varying results.

Trade effluent charging is a comparatively new, and in some circles, controversial method of control, its origins deeply rooted in economic theory. Incentive charging has largely been evolved at a theoretical level, being little understood or condoned, as yet, elsewhere. Financial pressures and a notion of equity which require the polluter to pay for the costs he imposed, have changed this idea of incentive charging into a method of rationally covering costs.

At the other extreme, the strategy for operation of treatment works has evolved under the constraints which affect the

implementing authority. In this case these pressures include historical inheritance, previous practices and tightened financial controls and obligations. Thus, though the legislature may wish to see an improvement in operational efficiency of plant, and sympathise with the arguments for increased expenditure, they are unable to reconcile this with other governmental and societal objectives. These demand a decrease in the amount of borrowing by nationalised industries.

Consent policy formation approaches the general model of evolution and modification most closely. Its theoretical roots are in ecological and environmental philosophies. Although the Government may not appreciate the arguments concerning assimilative capacity and steady state ecosystems, they have supported the idea of control by regulation as the appropriate method for the British case. While the 1974 Control of Pollution Act strengthened the consent procedure, its publicity provisions have acted to alter the information available, against the original intention and spirit of the law.

These three issues serve to show how theoretical intentions are rarely implemented in the manner in which they were originally conceived. Even given the will to fulfil such aspirations, practical circumstances and other societal obligations may make this impossible. As a result the problems of the environment are often having to take a lower priority than perhaps they deserve.

Chapter Six

Conclusion

This study has attempted to examine several aspects of the same issue, namely the appropriate forms of pollution prevention and control. These aspects are as follows; firstly, theoretical suggestions for the most effective measures, such as incentive charging or control by regulation. Secondly, legislative solutions, the result of debate and compromise and thirdly, implementation of practices and legislation by the water authorities. Lastly, the facts of actual river conditions were presented.

This study has tried to show that these facets are not discrete entities, and that the possibility of links between each aspect exist. This work was not, therefore, about whether or not a particular measure or instrument would produce an improvement in river quality conditions, but about the nature of those links. It attempted to examine the proposition that effective action and instruments can only ever be produced by accident rather than design.

Four measures or instruments were chosen to illustrate aspects of these links. As a result normative conclusions about their relative effectiveness are peripheral rather than central questions. No attempt, therefore, is made to recommend one practice over another. Consent policy and sewage works operation are two practices which are well established, and have therefore, been moulded, to a certain extent, by prevalent constraints. These constraints may be presently acting, or have existed in the past. Charging for trade effluents and the 1974 Control of

Pollution Act are new practices, and are therefore imposed upon current conditions and practices. The extent to which they are altered by current constraints was examined.

Consents and charging for trade effluent were chosen to represent measures which have some connections with theoretically recommended solutions. The Control of Pollution Act 1974 and the operation of plant do not have this theoretical underpinning, but represent measures evolved by government and water authorities respectively.

Ecologists and economists were chosen as examples of groups of theoreticians who have taken an interest in the pollution problem. They have in common a lack of direct contact with the practical problems of implementation, in that they are little involved with the water authorities. Both have found a limited outlet for their theories in some of the practices of the water authorities and in the legislation which partially dictates those policies. However, the extent to which theoreticians directly influence legislative bodies or the water authorities is in question.

Economists have been identified, in this study, with incentive effluent charging methods. It has been shown that, outside theoretical circles, these methods are neither fully understood nor condoned. Trade effluent charging practices, as they exist, are in no way intended to reproduce these theories. They arise from a need for financial viability.

What, therefore has been the impact of economic theory, and economists, on pollution prevention practices? There is little evidence to suggest they are capable of arousing public debate through the media in the same way in which the environmental

lobby have been able. Although economists are perhaps more respected than ecologists in government circles they have had little success in promoting their ideas as legislation or approved practices. However there are signs that incentive charging practices may be taken more seriously in future, when evidence of consistent practical applications can be presented. At present, ecologists, politicians, industry and the water authorities regard these methods as inappropriate; thus considerable opposition remains to be convinced.

Briefly, it is worth mentioning the impact of economists within the water authorities. As the water industry is being increasingly run as an industry, economic principles will play an increasing role in determining the lines on which it is run. Thus economic theory as regards incentive charging may gain greater credence through familiarity.

In many ways it is difficult to assess the impact of ecological theory on pollution control and prevention practices, especially as two dominant groups have been identified. Apolitical ecologists, advocating control by regulation and bans, have seen the extension of such controls, particularly to estuaries and tidal waters. As the consent system was established prior to environmental pressure groups these measures cannot be regarded as antecedents to ecological thought. The extension of the consent system was an inevitable measure which the water authorities required. Like most economists, such ecologists have had little impact on the media and public opinion.

In one sense, political ecologists have had relatively little success in that no measure had been put into practice directly as a consequence of their ideas. However these ideas

have given rise to much discussion, both theoretically and publicly and have achieved a measure of public awareness for the possibilities of environmental disruption. Thus, their impact has been an indirect one, a result of their ability to arouse public concern and thereby pressure for action to be taken. It is therefore debatable whether the Control of Pollution Act 1974, could have been passed if the public has been antagonistic to it.

The environmental movement, as a hybrid of ecological theory, has been successful in modifying legislation on some pollution prevention practices. Government recognised the external pressures for a wider availability and greater freedom of information, particularly regarding industrial effluents. This was given force as part of the Control of Pollution Act 1974. The Government's intention was to give the fuller access to details of the environment and to press for improved environmental quality. However as far as water pollution and the water authorities were concerned, these provisions have had the opposite effect.

The water authorities, as much culprits of causing water pollution as industry, found it necessary to downgrade their consent regulations so as to protect themselves from the risk of prosecution. There is thus a divergence between the implementation of legislation, the spirit of that legislation and ecological theories, political and apolitical.

Many mitigating factors can be identified to justify this action by the water authorities. Firstly, despite the fact that the government stipulated the urgent need for restorative action, the Control of Pollution Act 1974 did not provide addi-

tional financial assistance for this purpose. Indeed the 1973 Water Act imposed upon the water authorities the duty to become self-financing, with the restriction of a collective upper limit on borrowing. These factors alone, it might be supposed, would have curtailed any pollution abatement programme, however other constraints conspired to limit action even further. As Chapters Three and Five noted, the water authorities were further handicapped by the inheritance of poor equipment, heavy debts and commitments for expenditure on capital intensive projects. It is not surprising that faced with probable heavy expenditure needed to bring treatment plant up to standard, they chose to revise consent conditions.

This particular example brings up the question of priorities for government. A government may be pressed into passing legislation to protect the environment, but may be unwilling (or unable) to commit funds to achieve those ends because other aims take a higher priority. The present government, for example, is absorbed with the need to limit public spending. Thus government has gone on record as urgently requiring environmental protection and rehabilitation, but in effect, have only made this job more difficult for the water authorities to achieve. However it would be difficult to prove deliberate evasion of responsibility by either government or the water authorities.

For the measures examined, it can be seen that theory has not been directly influential in producing legislation or new practices. It would not be fair to say that ecological theory has been more influential than economic theory, rather that current practices operated by the water authorities have altered

as a consequence of other pressures, mainly financial. The water authorities have been awarded a great degree of discretion by the legislation; practice is therefore moulded by constraints on the water authorities rather than by legislation or theorists. Thus if a particular measure is to be implemented exactly, as for example, government requires, full control of these constraints must be taken. It would thus be possible to overcome most of the obstacles to effective environmental protection by providing sufficient funds.

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20. In reality, it is far from easy to reach this optimal solution. Indeed, one may ask whether even if it could be achieved, would it necessarily fulfil the requirements of an economic policy? To achieve the optimal solution assumes that a state of perfect competition with a complete knowledge of the 'damage' function, exists. Economically rational management of natural resources would be achieved when the marginal social costs and marginal social benefits equate. Such a situation requires knowledge of both functions.

As it is unrealistic to assume either perfect competition or perfect knowledge, it seems likely that an optimum situation will never act as more than a theoretical ideal.

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35. One suggestion (36) is to split GNP into two components. Type I GNP would consist of goods and services produced from renewable and recyclable wastes. Type 2 would be a measure of the total value of production based on the exhaustions of irreplaceable resources and production of indestructible wastes. The aim would be to maximise Type 1 and minimise Type 2 production. Ecologists dislike the concept of throughput, preferring to attain a steady state economy, which provides a long term sustainable stock with minimum exogenous requirements.
36. Dolan, E. G., (1969) 'TANSTAAFL. The Economic Strategy for economic crisis'. (Holt, Rinehart and Winston Inc.).
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3. Smith, K. (1972), 'Water in Britain. A study of Applied Hydrology and Resource Geography (Macmillan).
4. The power to do so was granted by the 1848 Public Health Act (Appendix E).
5. Herrington, P. R. and Tate, J. C. (1970) 'Evidence on factors determining the domestic demand for water'. Progress Paper (Survey) : S1 March 1970. Water demand study, final report, Department of Economics, University of Leicester.
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7. Central Advisory Water Committee (1943), Third Report, River Boards, Cmnd 6465.
8. HMSO (1944), 'A National Water Policy', Cmnd 6515.
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27. D.O.E. and Welsh Office (1974) Report of a River Pollution Survey of England and Wales. Vol. 3. Discharges of sewage and industrial effluent to estuaries and coastal water. HMSO.
28. D.O.E. and Welsh Office (1978) River Pollution Survey of England and Wales. Updated 1975. River Quality and discharges of sewage and industrial effluents, HMSO.
29. The information for the 1958 survey was derived from informal work conducted by the Ministry of Housing and Local Government, subsequent surveys being carried out by the Department of the Environment.

30. It must be noted that a degree of subjectivity exists in class definition, especially between classes 3 and 4. Attempts have been made to define more objectively, these groups in each survey. It is possible that variations in class assignment exist purely because of these alterations, especially as those responsible for water services changed in 1974.

31. Personal communication with the N.W.A.

32. These data are at variance with alternative sources, notably (33) and (34).

33. Central Water Planning Unit, (1976), 'Analysis of trends in public water supply. February. (Reading).

34. D.O.E., (1978), Digest of Pollution Statistics, (HMSO).

35. For England and Wales there is no direct correspondence between metered consumption and trade consumption, similarly, between unmetered and domestic consumption. Any correspondence depends entirely on the metering policy within each water authority. However, the N.W.A. and its predecessors, made it policy to supply all trade and commercial premises. As a result, within the N.W.A. area, metered consumption largely corresponds to industrial consumption. It must be noted that unmetered consumption is simply the difference between total consumptions and metered consumption. It therefore contains an unknown proportion attributable to leakages. As these losses are not constant, unmetered consumption cannot be directly, and readily interpreted as proportional to domestic use.

36. Non-potable supplies are of a lower quality than potable supplies, tending to be used only by a few industrial concerns, in a few areas.

37. Porter, E., (1973), 'Pollution in four industrialised estuaries - Four case studies undertaken for the Royal Commission on Environmental Pollution' HMSO.

38. These were a random sample of nearly 300 works. The sample consists of the same 100 works in each consecutive year.

39. In this context, efficiency is defined as high quality of discharge with low running costs.

Chapter Four

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3. Northumbrian Water Authority. Annual Report and Accounts.
4. Royal Commission on Sewage Disposal (1912) Eighth Report, Vol. 1 Rpt. Cmnd. 6464, HMSO.
5. Ministry of Housing and Local Government (1960) 'Technical problems of river authorities and sewage disposal authorities in laying down and complying with limits of quality for effluents more restrictive than those of the Royal Commission', HMSO.
6. The Report notes that variations in river quality do not necessarily correspond with variation in river flow, effluent quality or discharge volume; lack of data preventing a proper understanding of these relationships.
7. For example as a maximum of x kg. BOD.
8. Second Report of the Joint Advisory Committee on river pollution. 'The reception of trade effluents into the sewers of the local sanitary authorities'.
9. The trade effluents sub-committee of the central advisory water committee. Final Report. HMSO 1960.
10. 'Agence de l'Eau Picardie', (1976), 'The State of Pollution Control in Four Countries'.
11. This charge was made in addition to a charge for the disposal of domestic effluent for trade premises, calculated on the basis of rateable value (the general service charge).
12. Department of the Environment, (1974), 'The Water Services: Economic and Financial Policies. Third Report of the Secretary of State for the Environment. (Jukes Committee). HMSO, London.
13. National Water Council, (1976), 'Paying for Water'.
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16. Griffiths, J. and Kirkbright, A.A.J. Inst. Sew. Purif., 1959, (4), 505.

17. Dart, M.C., (1976), 'Charging Principles for Effluent and Sewage Disposal in Industry'. The Institute of Water Pollution Control. Annual Conference, Blackpool. 14th-17th September.
18. An allowance of 25 or 30 litres per employee per working day, depending on whether canteen facilities were provided, was assessed as reasonable.
19. Dart, M.C., (1976), 'Trade effluent Control and Charges'. The Institute of Water Pollution Control. Annual Conference Blackpool 14th - 17th September.
20. One of which was the North-West water authority.
21. The North-West water authority and the South-west water authority.
22. D.O.E. and Welsh Office (1972) Report of a River Pollution Survey of England and Wales 1970. Vol. 2 HMSO.
23. D.O.E. and Welsh Office (1972) River Pollution Survey of England and Wales. Updated 1972. River Quality HMSO.
24. D.O.E. and Welsh Office (1973) River Pollution Survey of England and Wales. Updated 1972. Discharges of Sewage and Industrial Effluents. HMSO.
25. D.O.E. and Welsh Office (1974) Report of a River Pollution Survey of England and Wales. Vol. 3. Discharges of Sewage and Industrial Effluent to estuaries and coastal water. HMSO.
26. D.O.E. and Welsh Office (1978) River Pollution Survey of England and Wales. Updated 1975. River Quality and discharges of sewage and industrial effluents. HMSO.
27. Institute of Municipal Treasurers and Accountants. 'Sewage Purification and Disposal Statistics'. Published annually. The Institute, London.
28. The number of works sampled in each group varies annually, the majority being in the population range of less than 200 people served.
29. This fact must be borne in mind when interpreting data on the adequacy, or otherwise, of effluent quality. The river pollution surveys, for example, give no indication as to the time period over which an effluent must maintain an adequate performance, for it to be classified as satisfactory.
30. Data for 1970 do not include canals, these however are negligible.
31. These stations were randomly selected from approximately 300 ^{and} included the Institute of Municipal Treasurer's and Accountants 'Sewage Purification and Disposal Statistics' (27). There is no guarantee that these 100 stations are either representative of the larger sample or of national conditions. The same sample was used in section 3.2.3.

Chapter Five

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2. For example, one of the earliest statutes on this problem appeared in 1388. It prohibited "the throwing of dung, filth, garbage etc. into ditches, rivers or other waters and places within, about or nigh to any cities, boroughs or towns under penalty.
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5. Lowe, P. (1975), 'The environmental lobby (2). Formation and structure'. Built Environment Vol. 1 No. 2 September pp 158-161.
6. Lowe, P. (1975), 'The environmental lobby (3) Participation in planning'. Built Environment. Vol. 1 No. 3 December pp 235-238.
7. Parallel to this, the older established groups experienced a rapid increase in membership. For example, the National Trust whose membership stood at less than 10,000 at the end of the war, experienced an average growth rate of about 10% during the 1960's, with a surge towards the end of the decade. As a result membership stood at 200,000 in 1972. Even more remarkably this had doubled to 400,000 by 1974.
8. The Ecologist magazine, (1972), 'A Blueprint for Survival' The Ecologist. February.
9. Carson, R. (1962), 'Silent Spring'. Penguin.
10. It has been recognised that this book prompted U.S. Federal action against water and air pollution, as well as against persistent pesticides, several years ahead of when it might otherwise have been taken - if at all. By the end of 1962 over 40 Bills had been introduced to various U.S. legislatures to regularise pesticide use.
11. Gunningham, N. (1974) 'Pollution Social Interest and the Law' in C. H. Campbell, W. G. Carson and P. N. P. Wiles (eds) 'Law in Society Series' Martin Robertson.
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14. Brookes, S. K., et al (1976) 'The growth of the environment as a political issue in Britain'. British Journal of Political Science pp 245-255.

15. Bugler, J., (1972) 'Polluting Britain. A Report'. Penguin.
16. Bulletin of Atomic Scientists. (1970) 'Summary of M.I.T., Study of Critical Environmental Problems (S.C.E.P.)'.
17. It is quite possible, if this view is valid, that in times of economic stringency, pollution abatement will once more take a backseat in policy decisions and as a criterion for choice.
18. Royal Commission on Environmental Pollution. First Report. Chairman Sir Eric Asby Cmnd. 4585. February 1971. HMSO.
19. Gunningham (11) cites the instigation of the 1956 Clean Air Act as a measure consequent on a crisis event, in this case the 1952 London smog. The initial concept of this Act favoured the interests of industry but was altered in the face of strong public opinion.
20. Hansard Volume 875. 17th-28th July 1974.
21. Royal Commission on Environmental Pollution. Chairman Sir Eric Asby. Third Report, 'Pollution of estuaries and coastal waters. Cmnd 5054. September 1972 HMSO.
22. They supported pollution charges for two main reasons. Firstly, firms would be able to find the most economical way of reducing pollution without external interference, and secondly, total abatement would be distributed between firms in the most economical way.
23. Department of the Environment. (1974). The Water Services: Economic and Financial Policies. Third Report to the Secretary of State for the Environment. HMSO.
24. H.M.S.O. White paper (1970), 'Protection of the Environment' Cmnd 4373.
25. O.E.C.D. (1975) The polluters-pay principle.
26. O.E.C.D. (1976) 'Water pollution charges'. Paris.
27. Costs could be incurred either at source (i.e. within the industrial premises) or at a public treatment works. In the former case, costs are internal to the firm, and in the latter, costs are in the form of charges levied by the appropriate authorities.
28. Department of the Environment and Welsh Office (1970) 'Taken for Granted. Report of the Working Party on Sewage disposal'. (The Jeger Report) HMSO.
29. It was felt that the reports of the Royal Commission had particularly contributed towards a better understanding of the problems of the environment. The Jeger report had been particularly important in the formation of Part II of the Bill, that part concerned with water pollution.

30. Royal Commission on Environmental Pollution (1972) Chairman Sir Eric Asby. Second Report. Three issues in pollution control. Cmnd. 4894 HMSO.
31. National Water Council (1976) 'Paying for Water' NWC, London.
32. Northumbrian Water Authority. Annual Report and Accounts 1974/75 - 1977/78.
33. As an example of the practical problems involved, the N.W.A. took over responsibility for the operation and maintenance of sewage treatment plants previously controlled by 70 local authorities. There were thus considerable problems in achieving a uniform standard of practice when, inevitably, previous practices had varied considerably.
34. The main features of the 1973 Water Act are as follows
 1. Water authority income should meet outgoings properly chargeable to revenue account, taking one year with another (Section 29 (1)).
 2. A rate of return on the net assets used in the business can be specified by the Secretary of State for the authorities to achieve. (Section 29 (2)).
 3. Each water authority can fix charges as it thinks fit, but not later ^{than} April 1981, charges should be such as not to show undue preference to, or discriminate unfairly against, any class of persons, with the authorities being generally bound to have regard to costs in fixing charges (Section 30).

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Chemistry and Industry October 1976 pp. 839-841.

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APPENDICES

- A. Glossary.
- B. The General Theory of Charges : a comparison with control by regulation.
- C. Water industry organization and water pollution legislation.
- D. River Pollution Survey's Chemical Classification.
- E. The Consent system under the Control of Pollution Act 1974.
- F. National Water Council. Suggested classification of river quality in terms of current and potential use and maximum acceptable levels of contamination.
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- J. Trade Effluent Discharged to the Sewer. Recommended Guidelines for Control and Charging.
- K. Northumbrian Water Authority. Formula method of Charging.
- L. Northumbrian Water Authority. Allocation of Costs.
- M. Classification of effluents.

APPENDIX A. Glossary

B. Biological oxidation cost per cubic metre of average strength settled sewage including treatment and disposal of secondary sludge.

B.O.D. Biological Oxygen Demand. The amount of dissolved oxygen consumed by chemical and microbiological action when a sample is incubated for 5 days at 20°C (The BOD normally gives a rough indication of the organic matter present in the sample).

C.A.W.B. Central Advisory Water Board.

C.A.W.C. Central Advisory Water Council.

Catchment area (or catchment basin). The area draining naturally to a given point.

Cooling water. Water abstracted by industry for cooling purposes; normally used once and discharged to a watercourse, or to the sea, at an elevated temperature, but otherwise relatively unpolluted.

C.O.D. Chemical Oxygen Demand. The amount of oxygen used in chemical oxidation of the matter present in a sample by a specified oxidising agent under standard conditions.

Crude Sewage. Untreated sewage.

DATE. Date of commencement of operation.

DEBT. Debt charges, (p. per thousand cubic metres).

D.O.E. Department of the Environment.

Drainage area. The area actually draining to a given point, which may or may not coincide with the catchment area.

D.W.F. Dry weather flow. The rate of flow of sewage, together with infiltration, if any, in a sewer in dry weather (cubic metres per day).

Glossary (cont ..)

E.E.C. European Economic Community.

Effluent. Any liquid which flows out of a containing space, but more particularly the sewage or trade waste, partially or completely treated, which flows out of a treatment plant. For example, sewage effluent is the liquid finally discharged from a sewage treatment works.

Eutrophication. The enrichment of water in watercourses and lakes by chemical substances, especially compounds of nitrogen and phosphorous. It can greatly accelerate the growth of algae and higher forms of plant life.

G.D.P. Gross Domestic Product.

G.N.P. Gross National Product.

Groundwater. Water contained in the soil or rocks below the standing water level or water table.

G.W.C. Gross Works costs (p. per tcm).

Hydrological cycle. The full course of water movement, comprising evaporation from the sea, precipitation upon the land, percolation into underground strata etc, and the eventual flow of water back into the sea.

Industrial Effluent. Water-borne wastes from industry.

Influent. Water, sewage or other liquid, raw or partly treated, flowing into a reservoir, basin, or treatment plant.

M.A.F.F. Ministry of Agriculture, Fisheries and Food.

N.R.A. Northumbrian Water Authority.

N.S.C. Net Service costs (p. per tcm).

Glossary (cont ..)

- N.W.A. Northumbrian Water Authority.
- N.W.C. National Water Council.
- N.W.c. Net Works costs (p per tcm).
- O.E.C.D. Organization of Economic Co-operation and Development.
- os. Average strength of settled sewage (mg/l).
- ot. COD of trade effluent (in mg/l) after one hour quiescent settlement.
- Outfall. The point at which a sewer or land drainage channel discharges to the sea or to a river.
- Oxidation. The chemical change which a substance undergoes when it takes up oxygen.
- Pop. Population served.
- Potable. Water which has been treated so as to render it bacteriologically and chemically safe to drink, and which has no unpleasant taste or smell.
- R. Reception and conveyance, cost per cubic metre.
- R.C.S. Royal Commission Standard. The two standards proposed by the Royal Commission on Sewage disposal (1898-1915) for no more than 30 mg/l of suspended solids and 20 mg/l for BOD - a 30 : 20 effluent - are in general the normal minimum requirements for sewage effluents. It was envisaged that the effluent would be diluted with eight volumes of clean river water with a BOD of 2mg/l.
- R.W.A. Regional Water Authority.
- S. Treatment and disposal costs of primary sludges, per cubic metre of average strength sewage.

Satisfactory. An effluent is said to be satisfactory if it complies with conditions of its content. This can often imply the 30 : 20 Royal Commission Standard.

ss. Weighted average of suspended solids removed from crude sewage by primary settlement (in mg/l).

st. Total suspended solids (in mg/l) settleable in one hour from trade effluent.

Sewage. The contents of sewers carrying the water-borne wastes of a community.

Sludge. The accumulated solids produced during the treatment of sewage.

Suspended solids. The solids which are suspended in a sewage or effluent.

T.E. Trade effluent.

T.E.I. Trade effluent income.

T.S.F. Total sewage flow.

T.D.F. Total discharge flow.

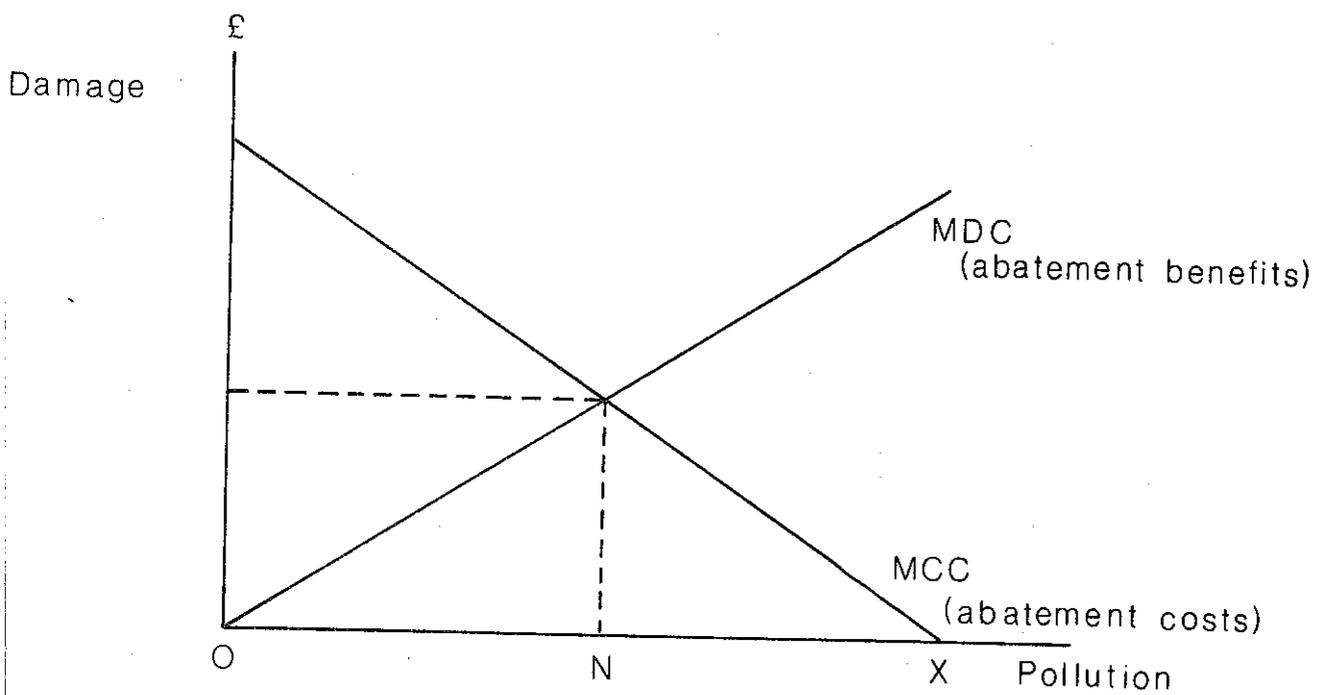
Water table. The level below which the soil or rocks are saturated with water; unlike the surface of water exposed to air a water table may be undulating.

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Units.

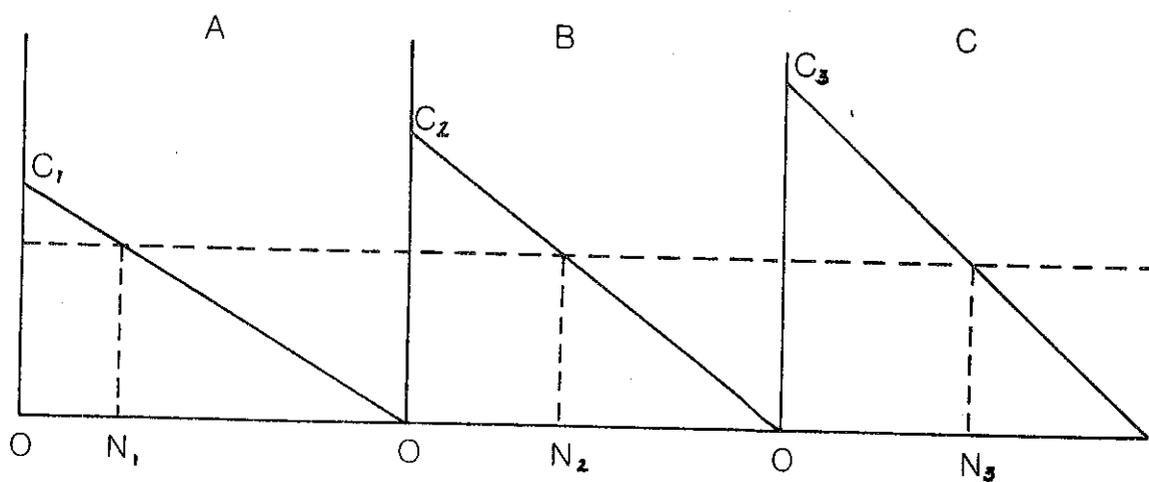
mil gal.	million gallons
l.	litres
m ³ .	cubic metres
mg.	milligrams
g.	grams
kg.	kilograms
tcmd.	thousand cubic metres per day
mcmd.	million cubic metres per day
p.	pence

FIG 13



MDC Marginal damage cost (external)

MCC Marginal control cost (internal)



ON Average required pollutant emission level

C Marginal abatement costs, where $C_1 < C_2 < C_3$

APPENDIX B The General Theory of Charges : a comparison with control by regulation.

The standard theory of charges is based on eliminating the discrepancy between private and social costs, in the most efficient and equitable way available. The argument for charging is as follows:- as pollution causes damage, every addition of a pollutant causes an increment in damage caused. Assuming that the amount of damage can be quantified in some way, it would, theoretically, be possible to draw a curve showing additional damage caused by additional pollution. (Figure 13.) This damage function is shown as the marginal damage cost curve (MDC). It would be expected that the more money spent on abating pollution the less pollution there should be. So for every £ spent, there must be marginally less pollution, this is shown by the marginal control cost curve (MCC).

At the point of intersection, the cost of abating an additional amount of pollution is equal to the cost of damage caused by that marginal unit. From 0 to N the cost of control exceeds the cost of damage, while to the right of N, the inverse is true. Accordingly, it is claimed that the cost to society as a whole (ie. damage cost plus control cost) is minimised if the polluter discharges an amount ON, ie. at the point of intersection. The costs to the firm outweigh the benefits to society of abating at an amount less than N, while discharging an amount greater than N, means the costs to society outweigh those of the firm (1.).

Economists, thus, aim to ensure that firms discharge this optimal quantity, and propose one of two methods to attain this end. Firstly, regulations can be set so as to fix the maximum amount permissible, at this point. Secondly, a firm can be made to pay an amount per unit of pollutant emitted. A polluter would therefore have an incentive to reduce his pollutant load, so reducing the charge he paid. This would occur up to the point when savings made equal the cost of bringing about that level of pollutant.

The unit charge would be so arranged, that it equalled the marginal pollution costs at optimum output, ie. charge at a rate OC. At this point a firm would prefer to abate its pollution as far as the point of intersection, rather than pay the additional charge, as at this point the abatement costs are lower than the unit charge (2.).

Thus by forcing firms to pay a charge per unit of pollution discharged, it effectively makes pollution costs a part of total production costs; thus internalization of the external diseconomy is achieved. Society, therefore, does not pay the full damage costs as the firm is forced to pay part of them.

APPENDIX B (cont ..)

It must be noted that pollution is not eradicated by this method, the aim is to produce an outcome of least cost and maximum benefit to society and industry. In general, the idea of charges supports the "polluter-pays" principle, which has the backing, at least in theory, of most ecologists and administrative/government bodies, such as the E.E.C. (2.).

Numerous advantages have been claimed for charges over regulations. (3.)

i) As an incentive. Charges take advantage of the firms profit maximization motive. By allowing choice, a firm will tend to abate up to the optimal point at which its own profits can be maximised. Further, it is claimed, that charges, unlike direct regulations or set standards, act as an incentive to introduce technologies which cut the cost of abatement.

ii) The charge is cost-effective. If the overall objective of a pollution control programme is to reduce total emission by, say, 45%, there are two possible ways of achieving this. Firstly, an emission standard could be imposed on each polluter, limiting tolerated emissions to 55% of present levels. Secondly, a charge could be levied at such a rate so that on average 45% abatement would be obtained. As different polluters have different treatment costs, it is argued that it is unfair to require every polluter to treat to a uniform 55% level. It would be more equitable to allow those with cheaper abatement costs to treat a greater percentage and those with higher costs to treat less, but on average achieving the required cut back in pollutant levels (Figure 13).

iii) Financial. This has two aspects. Firstly charges provide a fund from which money for pollution abatement projects can be raised. This may be paid either to a public body, or more controversially, to a polluter. This idea brings in the second financial aspect of charges, that of redistribution. This involves transferring funds raised from firms (such as C, Figure 13) with higher marginal abatement costs to firms with low costs so that further cutbacks can be achieved at minimum cost.

It must be noted that such redistribution and payment of subsidies infringes on the "polluter-pays" principle, in that society is making a payment to the polluter. However, in terms of achieving maximum benefit at least cost, it is perfectly justifiable.

APPENDIX B (cont ..)

iv) Administration. It is claimed that a charging system is cheaper and easier to run than any other. It is claimed that less information is required compared to other methods; for example nothing need be known about the control costs of individual firms, as at the margin, the costs of additional abatement for all firms are equal. It could, therefore, be regarded as being equitable in this respect. This is unlike the system presently operated by the Alkali Inspectorate in Great Britain (4.). This system tries to relate the amount of pollution reduction expected to the costs incurred by firms in abating a unit of pollutant.

By allowing firms choice in how much they wish to abate, this could be regarded as minimal interference in their internal workings. If quality objectives are not met the option is available to raise the unit charge to achieve these. Thus, instead of changing a major proportion of the conditions imposed on every individual firm, only one parameter is altered, leaving the appropriate adjustments up to the firms.

Notes for Appendix B.

- (1.) Marquand, J. (1976), Trade Effluents, costs, charges, and control. Chemistry and Industry 2.10.76.
- (2.) Organisation for Economic Co-operation and Development (1975). "The polluter-pays principle". (Paris)
- (3.) Royal Commission on Environmental Pollution. (Chairman: Sir Eric Asby) Third Report "Pollution of estuaries and coastal waters." Minority report. HMSO Cmnd 5054 Sept. 1972.
- (4.) Gunningham, N. (1974) "Pollution, Social Interest and the Law". (Law in Society Series) (Martin Robertson and Co., London).

APPENDIX C Water industry organization and water pollution legislation1848 Public Health Act

1. Created a 'national' General Board of Health.
2. Established local boards of health in borough and urban council areas. They were empowered to provide public water supplies (either through private companies or through direct municipal operations) and also to provide sewerage systems for the water-borne collection and disposal of domestic wastes.

1852 Metropolis Water Act

1. Prohibited water abstraction from tidal reaches of the Thames.
2. Compulsory water filtration.

1875 Public Health Act

1. Followed the recommendations of the Royal Sanitary Commission, 1869-71.
2. Adopted the local government framework as the most readily available and convenient framework for administering public health matters.
3. Applied new found knowledge of epidemiology and disease transmission.
4. Priority given to the provision of adequate water supplies and the collection and disposal of sewage over other uses of river water.
5. Succeeded in providing good piped water supplies to built-up areas.

1876 Rivers (Prevention of Pollution) Act

1. Passed to prohibit the pollution caused by the dumping of domestic, industrial and mining wastes, and the discharge or disposal of sewage into rivers.

1878 Public Health (Water) Act

1. Sought to provide piped water supplies to rural areas. It was largely unsuccessful due to prohibitive costs.

1903 Salmon and Freshwater Fisheries Act

1. Established fishery boards which were empowered to take action against pollution harmful to fish. It became an offence to (knowingly) discharge any solid or liquid material into waters where it might harm salmon or trout. With inadequate finance the boards were only effective in administering those waters that already had extensive fishing interests. The Act did nothing to improve polluted fishless water and specifically excluded the Thames and Lee, and the London excluded area.

APPENDIX C (cont ..)

1929 Local Government Act

This Act empowered Rural District Councils to contribute to the cost of providing piped water supplies to individual parishes.

1936 Public Health Act

This was the first major revision of the 1875 Public Health Act.

1. Confirmed the administration of water supply and sewage disposal by local authorities in England and Wales.
2. Provided a formal mechanism for amalgamating existing water supply undertakings under the control of a joint board. Little use was made of this provision.
3. Required local authorities to provide sewers and sewage disposal facilities for effectively draining their districts and dealing with domestic wastes and surface run-off. The occupier of any domestic premises was given the right to connect to public sewers within such a drainage area.
4. Industrial effluent could only be discharged into sewers with the consent of the local authority and provision was made to control such discharge by the Public Health (Drainage of Trade Premises) Act 1937.

1945 Water Act

1. The Act empowered the compulsory re-grouping of water undertakings into self-contained units for supply purposes. The whole, or parts, of local authority districts could be assigned for administration under a joint water board.
2. Established first time control of water abstraction from underground. Licences were required for new or extended abstractions.
3. It gave the minister power to control effluent discharges into water courses.
4. The Act allowed the minister to appoint a Central Advisory Water Committee; this was intended principally as a source of advice. In the regions the Act provided for joint advisory committees to be established.

1948 River Boards Act

This Act established 32 river boards, these had responsibility for land drainage, fisheries and control of river pollution. For the first time boundaries of administrative areas for water management had been defined in terms of the natural water environment ie. by enclosing whole catchment areas. As part of their duties, the boards were required to collect data on rainfall and river flow, and to determine the quantities of water abstracted and effluent discharged within their areas.

APPENDIX C (cont ..)

1951 The Rivers (Prevention of Pollution) Act

1. Confirmed the responsibility for the control of pollution with the river boards.
2. It became an offence to cause or knowingly permit any poisonous, noxious or polluting matter to enter a stream or otherwise impede its flow and worsen the consequences of pollution. Exeptions allowed for the continuance of existing discharges of sewage and trade wastes. New discharges were to be allowed by consent under conditions specified in relation to place, composition, temperature, volume and rate of discharge.

1960 Clean Rivers (Estuaries and Tidal Waters) Act

Extended the jurisdiction of the 1951 Act to estuaries and coastal waters associated with the river board areas.

1961 Rivers (Prevention of Pollution) Act

1. This Act specified that waste discharges existing before, and therefore uncontrolled by the 1951 statute, would in future require the consent of river boards if they were to continue.
2. It empowered the boards to review and revise their consent standards so as to bring about an improvement in river pollution levels.
3. For the first time, unsatisfactory effluent had to be treated, even though it might be impractical to do so. As sanctions, the closure of works or the imprisonment of those responsible, were possible.

1963 Water Resources Act

(i) Organizational Changes

1. Replacement of river boards by 27 river authorities, plus the Thames and Lee conservancies.
2. The duties of the responsible minister (now the Minister of Housing and Local Government) were extended so as to consider the augmentation of water resources and their possible redistribution throughout England and Wales.
3. Central control was to be provided by a new agency, the Water Resources Board.

(ii) The River Authorities

1. Took over all old duties of the river boards - land drainage, pollution regulation, administration of fisheries. They also were required to estimate current and future water requirements for their areas, and formulate proposals to meet expected demand.

APPENDIX C (cont ..)

2. They were required to determine the minimum acceptance flow to be left in rivers after water had been abstracted.
3. Action was to be taken in three areas:
 - a) Improve the quality of rivers by suitable works to augment the quantity of flow.
 - b) Prevent excessive abstraction from reducing the flow and adversely affecting quality.
 - c) Generally manage rivers in the best interests of the users (ie. industry, agriculture, water supply, land drainage and navigation).

(iii) The Water Resources Board

The Board was intended to be effective in four areas:

- a) To consider the procedures necessary to conserve, re-distribute, augment and secure the proper use of water resources in England and Wales.
- b) To review periodically the progress made towards optimizing the use of water resources.
- c) To provide, on request, technical information.
- d) To collate hydrometric data, and publish this information periodically to aid in the prediction of prospective water demands.

1973 Water Act

The Act is divided into four parts:

1. National policy and central and local organizations.
2. Functions of water authorities.
3. Financial provisions.
4. Miscellaneous provisions.
 - i) Ministerial responsibility was given to the Secretary of State and the Minister of Agriculture, Fisheries and Food, with the duty of promoting, jointly, a national policy for water in England and Wales.
 - ii) The Act established nine English water authorities and the Welsh National Water Development Agency. Under Schedule 3 of the Act, a water authority is defined as 'a body corporate' with power to do anything which in the opinion of the authority is calculated to facilitate, or is conducive or incidental to, the discharge of any of their functions.
 - iii) Section 4 established a National Water Council (NWC). Again it was to be an advisory body to government, but was also to co-ordinate regional planning.

APPENDIX C (cont ..)

- iv) Functions of the new water authorities:
 1. Water conservation
 2. Water supply
 3. Sewerage and sewage disposal
 4. Provision of domestic sewers
 5. Maintenance and improvement of fisheries
 6. Supervision of work on land drainage
 7. The provisions of the 1951 and 1961 Act were to apply to new or altered effluent discharges made by the water authorities.
- v) New functions of the water authorities:
 1. Development of water based recreational facilities
 2. To have regard for nature conservation and amenity.
- vi) The water authorities are required to carry out regular surveys of water resources in areas under their control. This information is to be used as the basis of plans to secure more efficient management of water while at the same time restoring and maintaining the wholesomeness of rivers and other waters.
- vii) The Act establishes the principle that water authorities are to be financially self-supporting. Revenue for most functions is to be raised by a system of charges on those who benefit from the services provided. The Secretary of State is given powers to direct the water authorities on the principles to be followed on raising revenue. A collective over-all maximum borrowing limit of £3,750 million is imposed.

1974 The Control of Pollution Act

Part 2, specific to water pollution, re-enacts with amendments the pollution control provisions of the Rivers (Prevention of Pollution) Acts 1951-61.

1. Control of pollution in rivers and coastal waters. A person is guilty of an offence if he causes or knowingly permits the entry of -
 - a) any poisonous, noxious or polluting matter
 - b) any matter which might separately or in combination, aggravate pollution or impede the water flow of a stream; or
 - c) any solid waste into a stream or certain tidal waters.

The exemptions allow for the entry of sewage or trade waste which are subject to consent procedures.

APPENDIX C (cont ..)

2. Consents to discharge (Section 34)

a) Consents may be granted subject to reasonable specified conditions with regard to:

- i) The place and outlet
- ii) The nature, composition, temperature, volume, duration and rate of discharge
- iii) The provision for taking samples
- iv) The installation, reading and maintenance of meters
- v) The keeping of appropriate records
- vi) The return of information to the water authority, and
- vii) The precautions to be taken to prevent the contamination of underground water.

b) A water authority must publish applications for consent to make a discharge. Any subsequent representations must be considered.

c) Section 37 imposes a continuing duty on a water authority to review from time to time consents, and the conditions attached to them. The intention is to bring about such continuing improvements to discharge conditions as may be allowed by changing circumstances and advances in technology.

d) Each permitted consent will normally continue unchanged for two years.

3. The duty to keep registers.

By Section 41, the water authorities are required to keep registers containing particulars of all discharge applications received, all consents granted, details of effluent samples taken and particulars of certificates given and notices served. Such registers are to be made freely available for public inspection.

Appendix E details possible reasons for exemptions.

4. Authority to forestall or remedy water pollution.

When it appears that a discharge is damaging flora or fauna of a stream, the water authority is required to exercise its powers to revoke or revise conditions of consent. Any costs incurred are to be recoverable from the polluter.

APPENDIX D River Pollution Survey's Chemical Classification

The various River Pollution surveys, have classified rivers by chemical criteria under the following general headings:

Class 1 Rivers unpolluted and recovered from pollution

Class 2 Rivers of doubtful quality and needing improvement

Class 3 Rivers of poor quality requiring improvement as a matter of urgency

Class 4 Grossly polluted rivers.

The borderline between Classes 1 and 2 is indistinct. Some degree of subjective judgement therefore is involved in the assessment between these two categories.

The classes are not based on a single criterion but are said to represent a practical compromise of several which, collectively, meet the general concepts of river quality. A fuller description of the chosen parameters is given below.

Class 1 Rivers unpolluted and recovered from pollution

1. All lengths of rivers whatever their composition, which are known to have received no significant polluting discharge.
2. All rivers which, though receiving some pollution, have a BOD less than 3 mg/l, are well oxygenated and are known to have received no significant discharges of toxic materials or of suspended matter which affects the condition of the river bed.
3. All rivers which are generally indistinguishable biologically from those in the area known to be quite unpolluted, even though the BOD may be somewhat greater than 3 mg/l.

Class 2 Rivers of doubtful quality and needing improvement

1. Rivers not in Class 1 on BOD grounds and which have a substantially reduced oxygen content at usual dry summer flows or at any other regular times.
2. Rivers, irrespective of BOD, which are known to have received significant toxic discharges which cannot be proved either to affect fish or to have been removed by natural processes.
3. Rivers which have received turbid discharges which have had an appreciable effect on the composition of the water or character of the bed but have had no great effect on the biology of the water.
4. Rivers which have been the subject of complaints which are not regarded as frivolous but which have not been substantiated.

APPENDIX D (cont ..)

Class 3 Rivers of poor quality requiring improvement as a matter of urgency

1. Rivers not in Class 4 on BOD grounds but which have a dissolved oxygen saturation, for considerable periods, below 50%.
2. Rivers containing substances which are suspected of being actively toxic at times.
3. Rivers which have been changed in character by discharge of solids in suspension but which do not justify being placed in Class 4.
4. Rivers which have been the subject of serious complaint accepted as well-founded.

Class 4 Grossly polluted rivers

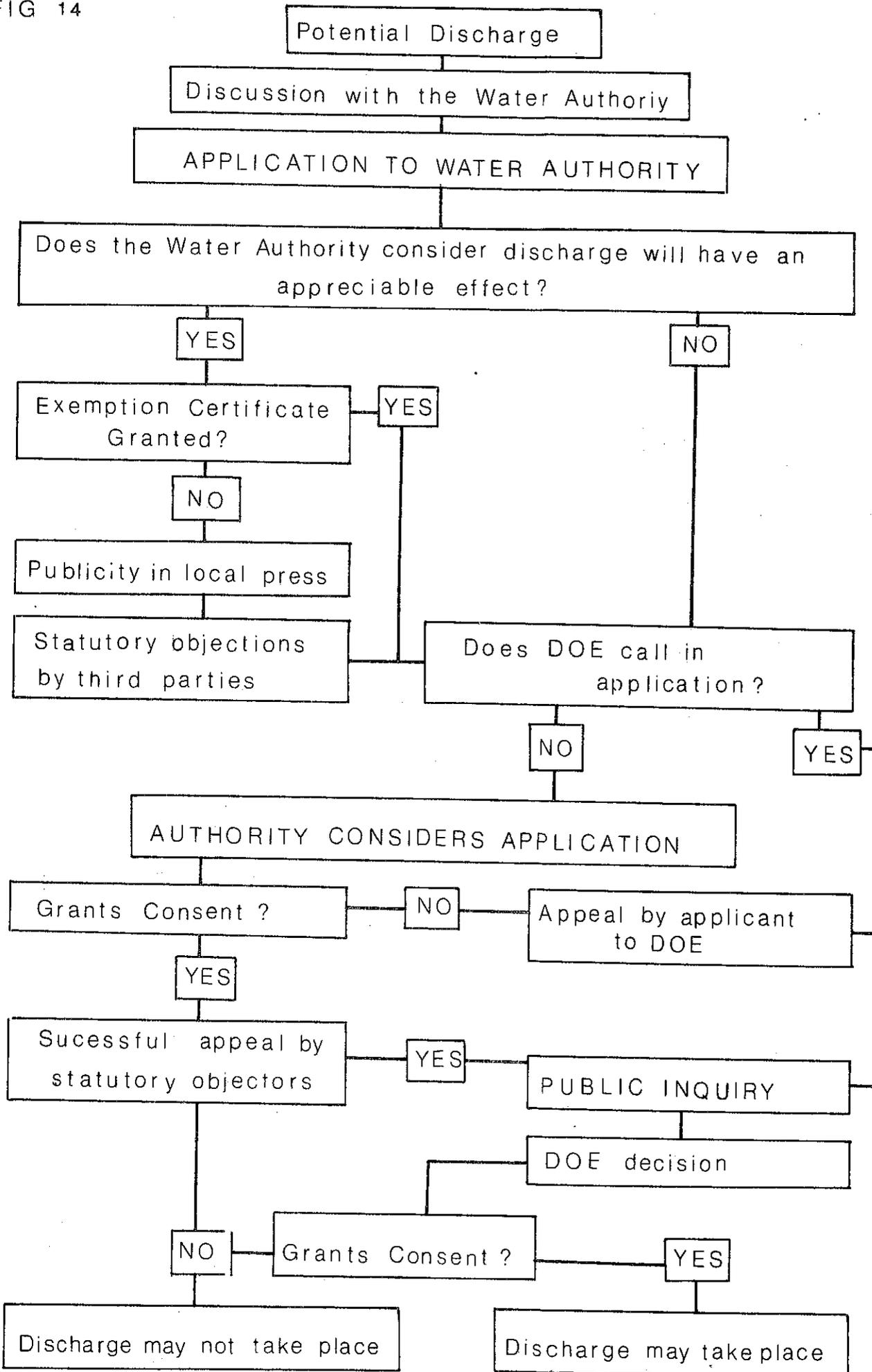
1. All rivers having a BOD of 12mg/l or more under average conditions.
2. All rivers known to be incapable of supporting fish life.
3. All rivers which are completely deoxygenated at any time, apart from times of exceptional drought.
4. All rivers which are the source of offensive smells.
5. All rivers which have an offensive appearance, neglecting for these purposes any rivers which would be included in this class solely because of the presence of detergent foam.

Source: Pg. 37. Technical Appendix 1

River Pollution Survey of England and Wales, updated 1975.

River Quality and Discharges of sewage and industrial effluent.

FIG 14



APPENDIX E The Consent system under the Control of Pollution Act 1974

Part 2 of the 1974 Act deals with two main sources of water pollution: discharges of poisonous matter or solid wastes and trade and sewage effluent. It covers the discharge effluent either directly to a water course or indirectly via the public sewer and treatment plant network. Normally (three minor exceptions are permitted) no offence is committed under the 1974 Act, provided that a consent has been obtained from the relevant water authority and its conditions observed. (Figure 14)

Applications A potential discharger should approach the relevant water authority for a consent to discharge. The authority will then consider the application and may grant the consent, subject to conditions if need be. In setting conditions the authority must have regard for the prevention of pollution and the attainment of water quality objectives. Usually any conditions relate to such matters as quality, quantity, rate of discharge, sampling and the keeping of records.

According to the terms of the 1974 Act all applications for consent must be displayed in a water register, available for public inspection. Applications must also be publicized for two consecutive weeks in the London Gazette or local press. In the following six weeks the authority must consider all representations made to them concerning an application.

No publicity will occur under the following two circumstances. Firstly, in a situation when the authority considers the proposed discharge will have no appreciable effect; however such an application must still appear in the register. Secondly, the Secretary of State for the Environment may grant an exemption certificate to an applicant on the grounds that publicity would be, either, contrary to the public interest, or would prejudice, to an unreasonable degree, some private interest by disclosing information on a trade secret. Such an application would not be placed in the register, although the exemption certificate would be.

Such exemptions prevent:

- i) publicity of application in the local press
- ii) placement of consent details in the water register
- iii) publicity of details of samples and analyses relating to consent discharges in the register.

APPENDIX E (Cont ..)

Public Inquiries A public inquiry may be held by the Secretary of State under three circumstances:

- i) "Called-in applications" - The Secretary of State may "call-in" an application for determination by himself, rather than by a water authority. He may call a local inquiry prior to announcing his final decision. At this stage, anyone who had made representations within the statutory six week period has the right to appear at the inquiry. This call-in procedure would normally occur when an application was a particularly difficult one, or may have more than local significance.
- ii) Appeals against refusals - An applicant has the right of appeal to the Secretary of State when an authority has either refused a consent, or, (in the opinion of the applicant) granted it subject to unreasonable conditions. Again all those making representations within the waiting period, must have their objections considered.

This is, by far, the most common source of local planning inquiries, and it is anticipated that the same probably will be true of applications for water consents. From the point of view of objectors it is important that all representations be made within the six week waiting period; if not, objections will only be heard at the discretion of the Secretary of State. Friends of the Earth (1) feel that, in most cases, it would be difficult to achieve a "call-in", given that the Department of the Environment will generally be loathe to interfere with water authority autonomy. To achieve a local inquiry they recommend that their members persuade the water authority to refuse a consent, since, on appeal, the final decision will be made by the Department of the Environment. In a controversial case, an authority may be only too glad to pass the responsibility for the decision on to Central Government.

- iii) Appeals by statutory objectors - If an objector makes a representation within the waiting period, a water authority must inform any such objectors of its decision to grant an application. The objectors then have a further three weeks in which to request a "call-in". This gives objectors a second chance to call a local inquiry, and is, in effect, a right of appeal, a unique right not granted elsewhere in other planning legislation.

The Public Register Under Section 41 each water authority has the duty to maintain a public register containing the following information:

- a) applications for consent

APPENDIX E (Cont ..)

- b) details of consents granted
- c) details of samples of effluent and water taken by the authority, and steps taken as a result of the information obtained from these samples.
- d) notices issued under Section 51 requesting the occupier to desist from an activity which would normally be considered to be good agricultural practice.
- e) certificates granted by the Secretary of State granting exemption from publicity.

These registers must be available for public inspection. Up until this section is implemented, the register of consents is open only "to persons appearing to the authority to be interested in the outlet", from which the effluent flowed, this being generally interpreted to mean persons with riparian rights on waters into which a discharge was made.

- a) Applications. All applications, with the exception of those with an exemption certificate, will be found in the register. Objections may only be made to those publicised. The policy on granting exemption certificates will therefore have implications for the availability of information, and the effectiveness of any protest campaign based on these data.
- b) Details of consents granted. The consent register should give an overall picture of the discharges in an area. It will give details of the conditions attached to each consent, and indicate whether the authority or the applicant is responsible for monitoring the discharge. It should also show a timetable for the review of each consent.

The present policy, within the NWA, might lead to some misinterpretation of the water register on consents granted. Prior to any formal consideration of an application informal discussions take place between a potential discharger and the authority. It is at this stage, rather than at the later more formal juncture that a decision is made whether a discharge would be acceptable. If it is considered to be so, an application form will be issued; thus practically all applications for a consent are successful.

- c) Details of samples taken by the water authority. A water authority is under no obligation to sample every stretch of river, but where it does so, the results must be published in the register. When a consent holder is permitted to monitor his own discharge, whilst he must pass the results on to the water authority, this information will not be placed in the register for public inspection. In the NWA at present, approximately 20% of all dischargers (by consent) monitor their own samples.

APPENDIX E (Cont ..)

There is a suspicion that for economic and other reasons, the water authorities will be tempted to pass on the bulk of responsibility to the dischargers, thereby decreasing the amount of information available.

d) Exemption certificates. These certificates are issued by the D.O.E. without prior publicity or consultation with interested bodies or objectors. The general policy in granting such exemptions is as yet unknown.

It seems likely that those discharging innocuous and/or small volumes of effluent are unlikely to want to apply for an exemption certificate. There is a danger that dischargers of effluents which are likely to have an appreciable effect on the environment will be able to circumnavigate any publicity by obtaining an exemption certificate on the grounds of potential jeopardisation of industrial secrecy. As the reasons for exemption are couched in very general terms, overall policy on this matter will be at the discretion of the water authorities.

e) Duty to review existing consents. All water authorities have a duty to review all existing consents from time to time and possess the power to issue notices, revoking or modifying the consent or imposing new conditions. However, for a period of two years no such notice may be issued without the permission of the consent holder. Similarly a notice may not be altered for at least two years without permission. In special circumstances the water authority may put aside this laying-off period, but may as a result be liable to pay compensation to the holder. In practice this laying-off period may extend far longer than the minimum two years. The policy in the NWA is very much a rule-of-thumb approach. Review of a consent will take place firstly, when a substantial change in the conditions of discharge have taken place, and secondly when it is felt that this altered discharge might have appreciable effects on the relevant water courses. As a result many innocuous discharges have not been reviewed since the initial consent was granted, often as far back as the early 1960's.

Notes for Appendix E

1. Macrory, R. and Zaba, B. (1978) 'Polluter Pay : The Control of Pollution Act explained.' Friends of the Earth Ltd., London.

Appendix F

Suggested Classification of River Quality in Terms of Current and Potential Use and Maximum Acceptable Levels of Contamination

River Class	Current or Potential Uses	Quality Criteria		Remarks
		Class Limiting Criteria (95 percentile)	Average Criteria	
1A	<ul style="list-style-type: none"> i Water of very high quality suitable for potable supply abstraction with minimal treatment and all other abstractions. ii Game and high-class coarse fisheries. iii High amenity value. 	<ul style="list-style-type: none"> i D.O. greater than 80% saturation (daytime). ii B.O.D. not greater than 4 mg/l. iii Ammonia not greater than 0.3 mg/l. iv Non Toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available). 	<ul style="list-style-type: none"> B.O.D. not greater than 2 mg/l. 	<ul style="list-style-type: none"> Physical evidence of pollution should be absent.
1B	<ul style="list-style-type: none"> i Water of less high quality than Class 1A but usable for substantially the same purposes. In the case of potable supply abstractions, conventional treatment is required. 	<ul style="list-style-type: none"> i D.C. greater than 60% saturation (daytime). ii B.O.D. not greater than 6 mg/l. iii Ammonia not greater than 0.6 mg/l. iv Non toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available). 	<ul style="list-style-type: none"> i B.O.D. not greater than 3 mg/l. ii Ammonia not greater than 0.3 mg/l. 	<ul style="list-style-type: none"> Physical evidence of pollution should be absent. ii Waters of high quality which cannot be placed in Class 1A because of high proportion of high quality effluent present or because of the effect of physical factors such as canalisation, low gradient or eutrophication. iii Class 1A and Class 1B are essentially the Class 1 of the R.F.S.

(Cont'd.)

Appendix F (Cont'd.)

River Class	Current or Potential Uses	Quality Criteria		Remarks
		Class Limiting Criteria (95 percentile)	Average Criteria	
2	Waters which are not clean enough for potable supply abstraction without advanced treatment, supporting reasonably good coarse fisheries. Moderate amenity value.	<ul style="list-style-type: none"> i D.O. greater than 40% saturation (daytime) ii B.O.D. not greater than 12 mg/l. iii Non toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available). 	<ul style="list-style-type: none"> B.O.D. not greater than 6 mg/l. B.O.D. not greater than 12 mg/l. * 	<ul style="list-style-type: none"> i Similar to Class 2 of R.P.S. ii Water not showing physical signs of pollution other than humic colouration and a little foaming below weirs.
3	Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for low grade industrial abstraction potential for further use if cleaned up.	<ul style="list-style-type: none"> D.O. greater than 10% Sat. (daytime and not likely to go anaerobic). 		Similar to Class 3 of R.P.S.
4	Waters which are grossly polluted, and are likely to cause nuisance.	D.C. Inferior to Class 3, and likely to be anaerobic at times.		Similar to Class 4 of R.P.S.
X	Insignificant watercourses and ditches not usable where objective is simply to prevent nuisance developing.	D.O. greater than 10%.		

* This may not apply if there is a high degree of re-aeration.

- Note: 1. For classes 1A and 1B, and 2 where applicable, and until standards for raw water for public supply are nationally adopted, it is recommended that W.H.O. Standards of quality for drinking water should be applied.
2. Under extreme weather conditions (e.g. flood, drought, freeze-up), or when dominated by plant growth or by aquatic plant decay, rivers usually in Classes 1, 2 and 3 may have B.O.D.'s and dissolved oxygen levels, or ammonia content outside the stated levels for those Classes. When this occurs the cause should be stated along with analytical results.
3. The B.O.D. determination refer to 5-day uninhibited B.O.D., however, it is expected that 5.O.D. (A.T.U.) will replace this as soon as practicable, when revised figures will be necessary.
4. Each class is valid only if the stream has a biota appropriate to the observed chemical and physical characteristics.

Appendix G

Northumbrian Water Authority
River Water Quality Classification

River Class	Quality Criteria	Remarks	Current Potential Uses
	<u>Class Limiting Criteria (95 percentile)</u>		
1A	<ul style="list-style-type: none"> i Dissolved oxygen saturation greater than 80%. ii Biochemical oxygen demand not greater than 3 mg/l. iii Ammonia not greater than 0.4 mg/l. iv Where the water is abstracted for drinking water, it complies with requirements for A2** water. v Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available). 	<ul style="list-style-type: none"> i Average BOD probably not greater than 1.5 mg/l. ii Visible evidence of pollution should be absent. 	<ul style="list-style-type: none"> i Water of high quality suitable for potable supply abstractions and for all other abstractions. ii Game or other high class fisheries. iii High amenity value.
1B	<ul style="list-style-type: none"> i DO greater than 60% saturation. ii BOD not greater than 5 mg/l. iii Ammonia not greater than 0.9 mg/l. iv Where water is abstracted for drinking water, it complies with the requirements for A2** water. v Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available). 	<ul style="list-style-type: none"> i Average BOD probably not greater than 2 mg/l. ii Average ammonia probably not greater than 0.5 mg/l. iii Visible evidence of pollution should be absent. iv Waters of high quality which cannot be placed in Class 1A because of high proportion of high quality effluent present or because of the effect of physical factors such as canalisation, low gradient or eutrophication. v Class 1A and Class 1B together are essentially the Class 1 of the River Pollution Survey. 	<ul style="list-style-type: none"> Water of less high quality than Class 1A but usable for substantially the same purposes.

(Cont'd.)

Appendix G (Cont'd.)

River Class	Quality Criteria	Remarks	Current Potential Uses
	Class Limiting Criteria (95 percentile)		
2A	i DO greater than 60% saturation. ii BOD not greater than 7 mg/l. iii Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	Water not showing physical signs of pollution.	i Waters suitable for potable supply after advanced treatment. ii Supporting game and good coarse fisheries. iii Substantial amenity value.
2B	i DO greater than 40% saturation. ii BOD not greater than 9 mg/l. iii Where water is abstracted for drinking water, it complies with the requirements for A3** water. iv Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	i Average BOD probably not greater than 5 mg/l. ii Similar to Class 2 of RPS. iii Water not showing physical signs of pollution other than humic colouration and a little foaming below weirs.	i Waters suitable for potable supply after advanced treatment. ii Supporting reasonably good coarse fisheries. iii Moderate amenity value.
3	i DO greater than 10% saturation. ii Not likely to be anaerobic. iii BOD not greater than 17 mg/l.	Similar to Class 3 of RPS.	Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for low grade industrial abstraction purposes. Considerable potential for further use if cleaned up.
4	Waters which are inferior to Class 3 in terms of dissolved oxygen and likely to be anaerobic at times.	Similar to Class 4 of RPS.	Waters which are grossly polluted and are likely to cause nuisance.
X	DO greater than 10% saturation.		Insignificant watercourses and ditches not usable, where objective is simply to prevent nuisance developing.
Note (a)	Under extreme weather conditions (e.g. flood, drought, freeze-up), or when dominated by plant growth, or by aquatic plant decay, rivers usually in Classes 1,2 and 3 may have BODs and dissolved oxygen levels, or ammonia content outside the stated levels for those Classes. When this occurs the cause should be stated along with analytical results.		
(b)	The BOD determinations refer to 5 day carbonaceous BOD (ATU). Ammonia figures are expressed as NH ₄ .		

(Cont'd.)

Appendix G (Cont'd.)

- Note (c) In most instances the chemical classification given above will be suitable. However, the basis of the classification is restricted to a finite number of chemical determinands and there may be a few cases where the presence of a chemical substance other than those used in the classification markedly reduces the quality of the water. In such cases, the quality classification of the water should be downgraded on the basis of the biota actually present, and the reasons stated.
- (d) EIFAC (European Inland Fisheries Advisory Commission) limits should be expressed as 95% percentile limits.
- * This may not apply if there is a high degree of re-aeration.
- ** EEC category A2 and A3 requirements are those specified in the EEC Council Directive of 16 June 1975 concerning the Quality of Surface Water intended for Abstraction of Drinking Water in the Member States.

Appendix HNorthumbrian Water AuthorityImplementation of Control of Pollution Act 1974Note Concerning : Review of Effluent Consent Conditions

1. This note applies only to those discharges of effluents that are already subject to a consent given under the Rivers (Prevention of Pollution) Acts 1951 to 1961.
It does not apply to:-
 - a) Trade effluents discharged to public sewerage systems
 - b) Effluents - and certain other classes of discharges - that are at present lawfully being made without consent (e.g. pre-1960 discharges of effluents to estuaries)
2. If you suspect that your organisation is making a discharge of effluent that should have been consented under the Rivers (Prevention of Pollution) Acts 1961, but has not been so consented, you should contact me without delay. It is not too late to regularise the situation.
3. The Authority already has full powers to review - and vary or revoke as appropriate - any condition of any consent granted to any outside person or body. These powers derive from the existing Rivers (Prevention of Pollution) Acts 1951 to 1961. In the time available before the Control of Pollution Act 1974 comes into force, it will not be possible to review all existing consents. Priority will be given to consents relating to effluents having a dry weather flow of at least 5,000 gallons per day (approximately 0.02 tcmd, where tcmd = thousands of cubic metres per day). Other consents will be subject to a subsequent review exercise scheduled for 1980-81.

4. The Control of Pollution Act 1974 will give unrestricted powers of prosecution in cases of alleged infringement of the Act. Many dischargers - including the Authority, who must obtain the approval of the Secretary of State for the Environment for any variation to the terms of consent appropriate to their own discharges of effluent - will therefore be vulnerable to prosecution for non-compliance with effluent consents.
5. A majority of existing consents are not consistently complied with. Hence the need - in view of the new powers of prosecution as mentioned in item 4 above - to carry out the review exercise in advance of the full implementation of the 1974 Act.
6. The fact that an effluent does not comply with its existing consent conditions does not necessarily mean that it is having an unacceptable effect upon the quality of the receiving river. A new river water quality classification system has been developed since 1974 for fresh waters, relating river water quality to the uses that are made of rivers, and forming a sound basis for the planning of river water quality and the related determination of effluent discharge consent conditions. This classification system, which has been widely accepted throughout the UK, has been adopted by this Authority, subject to minor amendments appropriate to local conditions. It makes use of 95 percentile values in respect of river water quality chemical criteria in order to recognise the need to take into account the variations - natural as well as man-made - that occur in river water quality. (A 95 percentile value is one which is attained or bettered for 95% of time).
7. The Authority has used the river water quality classification system to define for all major non-tidal rivers in its area:-

- a) Current river water qualities
- b) Long-term target river water qualities

Current river water qualities have been adopted as short-term target river water qualities; in other words, the immediate task is to ensure that no deterioration in river water quality will occur. This attitude is consistent with the Minister of State's undertaking that the review of discharge consent conditions will be carried out consistent with maintaining existing river water qualities.

Naturally, some rivers will need to be improved if their long-term targets are to be attained; in other cases, the short-term and long-term targets are coincident.

8. Current effluent quality is one factor that contributes to existing river water quality. Hence many consents will be reviewed and varied so that for the immediate future their new consent conditions will be derived from records of actual effluent quality obtained from sampling and analyses over the last few years. In this way the short-term targets will be maintained.
9. It is recognised that treated effluents, like rivers, are subject to fluctuations in quality. Hence varied consent conditions will normally be based upon the recorded 95 percentile performance figures. In addition to enabling short-term targets to be maintained for non-tidal rivers and streams, this approach will also ensure that no deterioration will occur in the quality of estuaries and coastal waters - for which no classification system has yet been adopted on a national basis.

In order, however, to be able to administer its pollution prevention responsibilities in an unambiguous manner, the Authority

must continue to express effluent consent conditions in terms of fixed limiting values. There will thus be a 5% period of time when effluents will fail to comply with their varied consent conditions, but the Authority will not normally be recommended to consider legal action for breach of consent conditions provided that an individual sample does not show such a degree of non-compliance as to indicate negligence or any abuse of effluent treatment facilities.

(Incidentally, I intend to keep consents - or varied consents - as simple as possible, and to limit separate conditions to the smallest practical number. Complications with overall percentile compliance will inevitably occur where more than one quality parameter is specified; rather than deal with that subject, and produce a note of inordinate length, I hope that it can be deferred for consideration at any technical meeting that may be arranged).

There remains the possibility that parties other than the Water Authority may instigate proceedings in respect of a sample taken during the 5% period when consent conditions may reasonably be exceeded. The Authority also faces this possibility in respect of its numerous effluents (principally sewage effluents), but it has to be accepted that some element of risk will remain because future consents will be based upon statistical appraisals of effluent performance; to set consent conditions at 100% safety level so that they were never exceeded would be well-nigh impossible. Moreover, values beyond the 95 percentile point become increasingly difficult to determine accurately because such data become scarce.

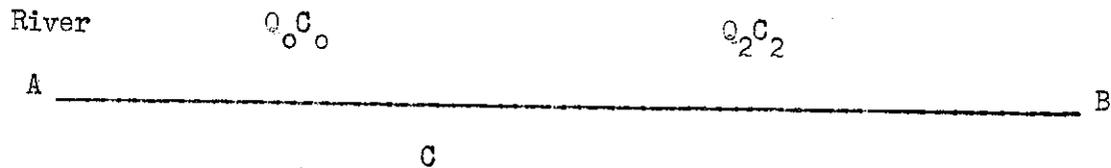
Furthermore, the current interpretation of the relevant legislation

should be borne in mind. This is that prosecution of industrialists or other non-Water Authority dischargers for non-compliance with consent conditions may only be pursued on the basis of tripartite samples taken as required by Section 113(2) of the Water Resources Act 1963.

10. A summary sheet giving brief particulars of your organisation's consented effluent(s) is forwarded with this note.

THE FOLLOWING POINTS ARE NOW SUGGESTED FOR ACTION:-

- a) Please provide confirmation that all relevant effluents have been identified in so far as your Organisation's responsibilities are concerned, and that consent particulars agree with your own records.
 - b) Please indicate whether or not you have records of effluent quality obtained from your own analyses during the last two to three years, say, and whether you wish any such records to be taken into account - together with the Water Authority's own records - for purposes of evaluating relevant 95 percentile effluent quality criteria.
 - c) Please let me know whether you wish to arrange a meeting with me or my staff (appropriate contacts Mr. R. G. Stead or Mr. M. Helm, on Extensions 277 and 294, respectively) to discuss any of the legal or technical details arising from the review exercise.
11. I would particularly welcome a response by 25 May 1979 in order to enable me to plan and implement the review procedure well in advance of the end of this year. As you will appreciate from the covering letter to this note, and your general knowledge of the implications of the Control of Pollution Act 1974, the topic at present under consideration is only one aspect of the veritable mountain of work entailed in the implementation of the Act.

Appendix ICalculation of Consent Conditions for Effluent Discharges

This schematic represents the mass balance of an effluent C, discharging into a river, AB.

Q_0 = 95 percentile low flow upstream of the discharge

C_0 = mean concentration

Q_1 = average effluent flow

C_1 = maximum concentration permissible in the discharge

$Q_2 = Q_0 + Q_1$

Reading sewage works discharges to the River Kennet via a short stretch (0.5 km) of the Foudry Brook. After another 4-5 km the River Kennet meets the River Thames. The downstream water quality objectives for the River Kennet is class 1B. River flow information for 1961-70 and quality information for 1972-75 yield the following:-

$$\text{B.O.D. } Q_0 = 3.87 \text{ M}^3/\text{sec} \quad C_0 = 1.75 \text{ mg/}$$

$$Q_1 = 0.53 \text{ m}^3/\text{sec}$$

$$Q_2 = 4.40 \text{ m}^3/\text{sec} \quad C_2 = 6 \text{ mg/}$$

Therefore a simple mass balance gives $C_1 = \underline{37 \text{ mg/}}$ as the maximum B.O.D. concentration permissible in the discharge. The equivalent mean value, assuming a coefficient of variation of 0.3 as observed at Reading for 1972-74, is 24 mg/. It should be noted that for a Summer quarter, when the river may be flowing at not much more than Q_0 , if the effluent discharge conforms to the required mean level of 24 mg/ B.O.D., the river quality downstream may not conform to the required mean level of 3 mg/

B.O.D., the river quality downstream may not conform to the required level of 3 mg/ B.O.D.

$$\begin{aligned} \text{Ammoniacal Nitrogen } Q_0 &= 3.87 \text{ m}^3/\text{sec} & C_0 &= 0.07 \text{ mg/} \\ Q_1 &= 0.53 \text{ m}^3/\text{sec} \\ Q_2 &= 4.40 \text{ m}^3/\text{sec} & C_2 &= 0.60 \text{ mg/} \end{aligned}$$

Therefore $C_1 = 4.5 \text{ mg/}$

The equivalent mean value, assuming a coefficient of variation of 1.0 as observed at Reading for 1972-74, is 1.6 mg/.

Under Summer conditions of high temperature and pH in the river less ammonia can be tolerated for fishery protection. Then $C_2 = 0.30 \text{ mg/}$ and the corresponding values of C_1 and the equivalent mean value are 2.0 mg/ and 0.7 mg/ respectively.

	Observed in 1974 mg/	Calculated Effluent Standard for River 13 mg/
Mean B.O.D.	19.7	24
Maximum B.O.D.	27.1	37
Mean Amm. N.	1.34	1.6
Maximum Amm. N.	4.40	4.5

It can therefore be seen that the Reading effluent discharge satisfies the requirement for maintaining the river in Class 1B.

The River Hogsmill, a tributary of the River Thames just above Teddington, functions substantially as a carrier of effluent from the Hogsmill sewage works. For most of the Summer the river flow above the effluent discharge point is negligible for dilution purposes.

Thus $Q_0 = 0$ and the mass balance become trivial.

The target classification for the River Hogsmill is 2. Considering the standards required to upgrade the River Hogsmill to Class 2 gives:

$$\text{B.O.D.} \quad Q_0 = 0$$

$$Q_1 = 0.64 \text{ m}^3/\text{sec} \quad C_2 = 12 \text{ mg/}$$

$$Q_2 = 0.64 \text{ m}^3/\text{sec}$$

Therefore $C_1 = \underline{12 \text{ mg/}}$ and the equivalent mean value, assuming a coefficient of variation of 0.6 as observed at Hogsmill for 1972-75, is 5.6 mg/.

Ammoniacal Nitrogen For fishery protection in E.I.F.A.C. terms

$C_2 = 1.29$ in Summer and 2.32 in Winter are required.

Therefore $C_1 = \underline{1.29 \text{ mg/}}$ in Summer and 2.32 mg/ in Winter. The equivalent mean values, assuming a coefficient of variation of 1.0 as observed at Hogsmill for 1972-75, are 0.46 mg/ and 0.83 mg/.

	Observed in 1974 mg/	Calculated Effluent Standard for River Class 2 mg/	
Mean B.O.D.	14.3	5.6	
Maximum B.O.D.	32.6	12.0	
Mean Amm. N.	2.02	0.46 Summer	0.83 Winter
Maximum Amm. N.	7.6	1.29 Summer	2.32 Winter

The dominance of the Hogsmill effluent causes the river to be in Class 4 at present. The above table shows how far the effluent quality needs to be improved for the river to achieve Class 2 status.

Appendix J

Trade Effluent Discharged to the Sewer

Recommended Guidelines for Control and Charging

Following the reorganisation of the water industry under the Water Act 1973, the new Regional Water Authorities (RWA's) became responsible, inter alia, for charging for discharges of trade effluent to the public sewer.

The CBI felt there was some merit in having discussions with the RWA's collectively on those aspects of charging schemes which would apply to industry in general. A joint CBI/RWA Working Party was set up for this purpose and has agreed the Recommended Guidelines which are described below:

OBJECTIVES OF TRADE EFFLUENT CONTROL

1. To prevent trade effluent discharge to sewers causing:
 - (a) damage or harm to the sewerage system and the personnel employed therein.
 - (b) interference with the effective and economic treatment of the mixed sewage by the processes employed at the sewage works.
 - (c) the products of that treatment, in the form of effluents or residues, to have unacceptable effects on water resources or the environment generally.
 - (d) unacceptable storm sewage discharges to watercourses.
- The achievement of these first objectives might require segregation of noxious process streams or pretreatment of the effluent to be undertaken by the trader, before discharge to the sewer, to reduce the concentrations of certain substances.
2. To provide data regarding the volume, rate of discharge, nature and composition of trade effluent discharges to sewers for use in the design of future sewerage and sewage treatment works and in ensuring

the proper management of the quality of water resources.

3. To ensure that the trader pays a fair charge for the services rendered for the reception, conveyance, treatment and disposal of his effluent.

Operation of Scheme of Control

4. All trade effluents discharged to sewer should be controlled in accordance with these Guidelines, with the following exceptions:

- (a) Discharges under existing Agreements until such times as these may be superseded.
- (b) Discharges under existing Consents. The recommended procedure should be adopted in these cases as far as possible until such time as a new Consent or Direction can be issued.
- (c) Premises which have the benefit of Crown privilege should be requested to comply with the normal Consent Conditions as if they were subject to the general trade effluent control legislation.
- (d) Discharges of radio-active substances controlled by the provisions of the Radio-active substances Act 1960. A system of notification of emergency discharges to sewers will be necessary to prevent hazards to personnel employed in sewers.

Consent conditions

5. Such limitations as are imposed by the Water Authority should be to ensure that no hazard occurs in the sewer or neighbouring premises, that no damage can be caused to the sewer, that the waste can be treated properly at the sewage works without deleterious effects and that any products of treatment (e.g. effluents, sludges) should not have unacceptable effects on water resources or the environment generally. The Authority must be aware of its own responsibilities under Common Law and, depending upon its sludge disposal practices,

to agriculture and under international conventions such as those covered by the Dumping at Sea Act 1974. Particular regard must be had to the Health and Safety at Work etc. Act 1974.

6. All practical means of reducing at source the volume and polluting characteristics of trade effluents should be encouraged, but the consent conditions applied should be only to the degree necessary to ensure compliance with the principles outlined in the preceding paragraph or where there is no early possibility of providing adequate sewerage or treatment capacity.

7. This does not preclude the trader from giving further pretreatment than actually required to meet the conditions imposed by the Authority, e.g. in those circumstances where he considers it economical to reduce the Authority's charges for subsequent treatment.

Directions

8. Directions are of two kinds: those issued to vary the conditions laid down in a Consent or previous Direction and those issued to control discharges previously exempt from the requirements of a Consent under Section 44 of the Public Health (Drainage of Trade Premises) Act 1937. Under Section 44 of the Control of Pollution Act 1974, these latter discharges will become subject to 'deemed' and, subsequently 'actual' Consents.

9. (a) Directions varying the conditions laid down in a Consent or previous Direction without the trader's written consent. When Section 45 of the 1974 Act is in force, for the protection of persons likely to be affected by the discharge, the Authority may consider it urgently necessary to vary conditions, in which case compensation might then become payable by the Authority.
- (b) Each consent should, therefore, be regularly reviewed in sufficient time to enable any appropriate Direction to be issued every two years.

10. Directions controlling discharges previously exempted by the 1937 Act are superseded by the 'deemed' consent procedure of Sections 43 and 44 of the 1974 Act, and subsequently are to be subject to an 'actual' consent.

Charging for Trade Effluents

11. The concept of marginal cost pricing is not sufficiently developed to recommend its implementation at this stage.

12. Charges are to be calculated on the basis of estimates of relevant expenditure. Furthermore costings used in the formula may be regionally based or on other areas of a WA depending on need and availability of data.

13. Positive measurement of the volume of trade effluent discharge is generally required. In cases where this is not immediately possible, and domestic consumption is not otherwise assessed, allowances of 25 litres per day without a canteen and 50 litres per day with a canteen for each employee, should be used when such flows are included in the total metered volume. Other allowances may also be appropriate but arrangements based on allowances should be considered only as interim arrangements.

14. The oxidation charge should be based on COD (Chemical Oxygen Demand from acidified dichromate). In some cases use may also be necessary of a biological oxidation factor following appropriate joint investigation. Charges may be made for either oxidation or removal of nitrogen, or other residuals in those cases where this is being performed at a sewage works by plant installed for that purpose.

15. The biological oxidation process produces, from soluble constituents of the sewage, secondary sludges in quantities related to the oxidation load on the plant and the cost of treatment and disposal of these sludges should be allocated to the oxidation load.

It will generally be necessary to apportion the total cost of sludge treatment in relation to the proportions of primary and secondary sludge solids produced during the whole sewage treatment process and if separate costings for secondary sludge treatment are not available, one-third of the sludge costs should be allocated to the biological charge.

16. There should be no charge for toxic constituents as their concentrations should be so limited by the Consent conditions as to render the waste capable of satisfactory treatment and disposal by the Authority.

17. Trade effluents should be charged on the following type of formula using average flow conditions:

$$C = R + V + \frac{O_t}{O_s}B + \frac{S_t}{S_s}S$$

Where

C = Total charge per cubic metre of trade effluent.

R = Reception and conveyance charge per cubic metre.

V = Volumetric and primary treatment cost per cubic metre.

O_t = the COD (in mg/l) of the trade effluent after one hour quiescent settlement at pH7.

O_s = The COD (in mg/l) of settled sewage.

B = Biological oxidation cost per cubic metre of settled sewage.

S_t = The total suspended solids in mg/l of the trade effluent at pH7.

S_s = The total suspended solids in mg/l of crude sewage.

S = Treatment and disposal costs of primary sludges per cubic metre of sewage.

18. It is recommended that, in order to assess the total flow and pollutional load of mixed sewage received at the Authority's treatment works, a two year 'moving average' be used, based on the two previous years' actual data.

19. The unit cost for item 'R' (reception and conveyance) should be calculated by taking a proportion of the net annual revenue expenditure, including financing charges on capital, on all sewers and pumping stations in the Authority's area or in a Divisional catchment area, other than those used solely for surface water and those pumping stations with rising mains discharging directly to sewage treatment works. It is suggested that the proportion taken be one third, divided by the average flow as determined in paragraph 18.
20. The unit cost for the term 'V' (volumetric and primary treatment) should be derived from the net annual revenue expenditure including financing charges on capital on:
- (a) all pumping stations with rising mains discharging directly to sewage treatment works,
 - (b) all inlet works, including screenings, comminution, grit removal and pre-aeration.
 - (c) all primary settlement units other than storm treatment works
 - (d) tertiary treatment for reduction of the concentration of residual suspended solids.
 - (e) all outfalls for treated sewage.
21. The unit cost for term 'B' (biological treatment) should be derived from the net annual revenue expenditure including financing charges on capital on:
- (a) Biological filtration plants and humus tanks, including recirculation, alternating double filtration and humus sludge pumping.
 - (b) Activated sludge plants and final settling tanks, including returned sludge pumping.
 - (c) the proportion of total sludge treatment and disposal costs associated with secondary sludge treatment and disposal.
22. The unit cost for term 'S' (primary sludge treatment and dis-

posal only: see paragraph 15) should be derived from that portion of the total net annual revenue expenditure including, financing charges on capital related to primary sludges on:

- (a) pumping or otherwise conveying (e.g. by tanker) sludge to treatment and disposal,
- (b) sludge dewatering and treatment, including digestion, conditioning, consolidation, drying, storage, incineration and disposal.

23. Otherwise unallocated charges, such as site charges, Headquarters and other central costs should be allocated over the treatment stages in proportion to the expenditure under each heading.

24. With relatively small or weak discharges a scheme of 'minimum charges' may be instituted:

- (a) where the product of flow and unit charge (calculated from the above formula) is less than a figure to be decided by each Authority from time to time, the larger figure should be applied.
- (b) for weak trade effluents which still have to be passed through the oxidation plant, a minimum biological oxidation charge may be applied. This should be derived from the annual financing charges on capital on the appropriate items given in paragraph 21(a) and (b) above based on the volumetric proportion borne by the trade effluent.

25. Charges will be made only for those elements of the formula applicable to the reception and disposal of the discharge relating to the type of treatment actually given to the trade effluent.

26. In circumstances in which a capital contribution is obtained from the trader a reduction in the normal trade effluent charges would be appropriate related to the circumstances of the case.

27. It is recognised that the implementation of s.52 of the Control of Pollution Act 1974 (applying to trade effluent discharges the

provisions of s.30 of the Water Act 1973) could have an impact on the future assessment of charges.

28. In following these Guidelines, Water Authorities may find it appropriate to make changes. Such changes would be made after consultation with local representation of industry.

APPENDIX K Northumbrian Water Authority. Formula method of Charging

Source: pp 2-3. Part Two. Corporate Management Report. Report of Trade Effluent Working Party on Charging Policy. in (1)

$$C = R + V + B \frac{ot}{os} + S \frac{st}{ss}$$

Where:-

- C Total charge per m³ of trade effluent
- R Regional reception and conveyance cost per m³
- V Regional volumetric and primary treatment cost per m³
- B Regional biological oxidation cost per m³ of average strength settled sewage including treatment and disposal of secondary sludge
- ot The COD of the trade effluent (in mg/l) after one hour quiescent settlement. In rare cases where COD is not applicable an alternative oxidation parameter will be applied
- os The regional weighted average COD of settled sewage (in mg/l). In rare cases where COD is not applicable an alternative oxidation parameter will be applied
- S Regional treatment and disposal costs of primary sludges per m³ of average strength sewage
- st The total suspended solids (in mg/l) settleable in one hour from the trade effluent
- ss Regional weighted average of suspended solids removed from crude sewage by primary settlement (mg/l)

The Working Party also recommended that a minimum charge be introduced to cover the authority's expenditure, for example, on the administration of the system. This charge was set at £20.00 per annum on 1st October 1975. Other water authorities have introduced a similar charge of equivalent order of magnitude.

APPENDIX L Northumbrian Water Authority. Allocation of Costs

Source: App. J. NWA. Trade effluent discharges to public sewers.

The Working Party felt that it was important that all the N.W.A's costs be taken into account in assessing the various unit costs required to apply the formula. They were to include not only direct expenditure, such as on chemicals, but also indirect expenditure relating to employees, premises, general supplies, transport, establishment charges, divisional and headquarters overheads and financing charges.

1. Financing Charges

Using data from the selected sample stations reinforced by information available from some of the constituent local authorities, financing charges for sewerage and sewage treatment and disposal were allocated as follows:

Sewerage 55% = (1) 60% foul and combined sewers (33% of total)
 (2) 40% surface water sewers (22% of total)

Sewage treatment and disposal 45%
 = (1) 31% volumetric treatment 'V' (14% of total)
 (2) 39% biological treatment 'B' (17.5% of total)
 (3) 30% sludge treatment and disposal 'S' (13.5% of total)

2. Operating Costs

The authority's operating costs on surface water sewers were excluded and the remainder of the operating costs allocated over the elements of the formula, overhead expenditure was allocated in proportion to direct expenditure.

a) Reception and Conveyance 'R'

Costs for 'R' include direct and indirect expenditure on all sewers and pumping stations including outfalls for crude sewage, with the exception of those used solely for surface water and pumping stations with rising mains discharging directly to sewage treatment works.

$$'R' = \frac{\text{Estimated loan charges} + \text{Estimated Revenue Expenditure}}{\text{Estimated Total Sewage Flow to Works or Outfall}}$$

b) Volumetric and Primary Treatment Costs 'V'

The cost of 'V' include direct and indirect expenditure on:

- i) all pumping stations not included in 'R'
- ii) all inlet work
- iii) all primary and storm sewage settlement units
- iv) all outfalls for treated sewage and long sea outfall for crude sewage

APPENDIX L (cont ..)

c) Biological treatment costs 'B'

The cost of 'B' include direct and indirect expenditure on:

- i) biological filtration plants and humus tanks, including recirculation, alternating double filtration and humus sludge pumping
- ii) activated sludge plants and final settling tanks including returned sludge pumping
- iii) the proportion of total sludge treatment and disposal cost associated with secondary sludge treatment and disposal
- iv) tertiary treatment for reduction of the concentration of residual suspended solids

d) Sludge treatment and disposal 'S'

The costs of 'S' include direct and indirect expenditure on:

- i) pumping or otherwise conveying (eg. by tanker) sludge for treatment and disposal
- ii) sludge dewatering and treatment (including digestion conditioning, consolidation, drying, storage, incineration and disposal)

'V', 'B' and 'S' are each calculated as follows:

$$V/B/S = \frac{\text{Estimated loan charges} + \text{estimated revenue expenditure}}{\text{Estimated total sewage flow through works}}$$

Any income from any of the processes, for example revenue from the sale of sludge, is deducted from expenditure before calculating the unit costs.

Example of cost allocation

1975/76 Estimated outturn

<u>Element</u>	<u>Financing</u>		<u>Operating</u>		<u>Total</u>	
	£'000	%	£'000	%	£'000	%
R	2,652	42.3	2,099	27.5	4,751	34.2
V	1,122	17.9	2,472	32.4	3,594	25.9
B	1,411	22.5	2,096	27.5	3,507	25.2
S	1,085	17.3	960	12.6	2,045	14.7
	<u>6,270</u>	<u>100.0</u>	<u>7,627</u>	<u>100.0</u>	<u>13,897</u>	<u>100.0</u>

APPENDIX L (cont ..)

1976/77 Provisional estimate

Element	Financing		Operating		Total	
	£'000	%	£'000	%	£'000	%
R	3,526	42.3	2,668	26.6	6,194	33.8
V	1,490	17.9	3,278	32.8	4,768	26.0
B	1,875	22.5	2,778	27.8	4,653	25.3
S	1,442	17.3	1,285	12.8	2,727	14.9
	<u>8,333</u>	<u>100.0</u>	<u>10,009</u>	<u>100.0</u>	<u>18,342</u>	<u>100.0</u>

To derive unit costs, each division estimates the discharges to foul/combined sewers of effluent and stormwater and the flow to treatment works, in the above case, for the year 1975/76.

<u>Division</u>	<u>Northumberland and Tyne</u>	<u>Wear</u>	<u>Tees</u>	<u>Total</u>
Reception 'R'	79	59	132	270
Treatment and Sludge disposal 'V', 'B', and 'S'	26	27	44	97
Estimated flows in 10^6 m^3				

As. Costs = volume x unit charge

$$\text{Unit charge (p/m}^3\text{)} = \frac{\text{Costs (£'000)}}{\text{Volume (10}^6\text{ m}^3\text{)}}$$

The unit cost derived therefore as follows:

	1975/76
Reception 'R'	1.75
Volumetric Treatment 'V'	3.70
Biological Treatment 'B'	3.60
Sludge Disposal 'S'	2.10
	<u>11.15</u>

APPENDIX L (cont ..)

Assuming that this procedure had been split between the three divisions, the unit charges would have been as follows:-

	<u>Northumberland and Tyne</u>	<u>Wear</u>	<u>Tees</u>
'R'	1.72	1.88	1.73
'V'	3.95	3.11	3.92
'B'	3.86	3.04	3.83
'S'	2.25	1.77	2.22

Re-assessment of flows is made each year along with the updated costs, to arrive at the next year's unit costs.

APPENDIX M Classification of Effluents

For the purposes of the various river pollution surveys five categories of effluent were defined.

1. Sewage effluent

This contains varying proportions of waste from domestic and industrial properties and receives at least a minimum treatment in the form of settlement before discharge depending on local circumstances.

2. Crude sewage

Untreated sewage effluent.

3. Industrial effluent

This may or may not receive treatment before discharge, it does not include effluents in categories 4 and 5 below.

4. Cooling water only

Large quantities of water are used for direct cooling purposes, especially by power generating plants. Unless mixed with other effluents it is largely free of chemical pollutants, it may, however, cause local thermal pollution.

5. Minewater

Discharges from mines present water quality problems in some areas, because they may be acid in character, carry heavy loads of suspended solids and have high concentrations of metals and other dissolved solids.

Table 1 Percentage of river lengths by quality class, and total lengths (10³ km), in the 5 river pollution surveys England and Wales.

Class	Non Tidal Rivers					Tidal Rivers					All Rivers				
	1958	1970	1971	1972	1975	1958	1970	1971	1972	1975	1958	1970	1971	1972	1975
1	73	70.2	77.4	78.1	77.6	41	48.1	49.4	50.1	49.6	70	74.1	75.4	76.1	75.6
2	15	14.7	14.7	14.1	15.1	33	23.4	23.2	22.5	25.1	16	15.4	15.3	14.7	15.8
3	6	4.8	4.2	4.3	4.0	14	16.8	14.2	14.8	14.8	7	5.7	4.9	5.0	4.8
4	6	4.3	3.7	3.5	3.3	12	11.7	13.2	12.6	10.5	7	4.8	4.4	4.2	3.8
5	32.4	35.9	23.5	9.3	35.9	43.6	12.2	2.8	2.8	2.8	37.3	23.8	38.8	38.8	38.9

1 Unpolluted % 2 Doubtful 3 Poor 4 Grossly Polluted 5 Lengths (10³ km)

Source: Table S1, River Pollution Surveys, Update 1975 (28)

Table 2 Percentage of river lengths by quality class, and total lengths (10³ km) in the 1970, 1972 and 1975 river pollution survey's. Northumbrian Water Authority.

Class	Non Tidal			Tidal			All Rivers		
	1970	1972	1975	1970	1972	1975	1970	1972	1975
1 Unpolluted %	83.1	84.2	84.2	20.4	21.3	19.3	80.3	81.3	81.2
2 Doubtful	12.3	12.5	12.4	14.5	13.6	20.8	12.4	12.6	12.8
3 Poor	3.8	2.9	2.9	26.5	25.0	20.0	4.8	3.9	3.7
4 Grossly Polluted	0.8	0.4	0.5	38.6	40.1	39.8	2.5	2.2	2.3
Lengths (km)	1,734	2,779	2,779	.83	132	134	1,817	2,911	2,913

Source: Table 2.4 River Pollution Surveys 1975 (28).

Table 3 Percentage of lengths of non-tidal rivers in various classes of quality and quantity for 1972 and 1975, England and Wales.

Class	1972						1975						
	Volume	I	II	III	IV	V	Total	I	II	III	IV	V	Total
1 Unpolluted		45.3	22.6	7.5	1.5	1.3	78.1	45.2	22.2	7.2	1.5	1.4	77.6
2 Doubtful		8.9	3.5	1.2	.5	2	14.1	9.1	3.9	1.4	.3	.3	15.1
3 Poor		2.4	1.2	.5	-	.1	4.3	2.4	1.0	.5	-	.1	4.0
4 Grossly Polluted		1.5	1.3	.6	.1	-	3.5	1.5	1.0	.6	.2	-	3.3
TOTAL		58.1	28.5	9.9	1.9	1.6	100	58.2	28.3	9.7	2.0	1.8	100

Source Table 2.8 River Pollution Survey Update 1975 (28).

Table 4 Percentage of lengths of non-tidal rivers in various classes of quality and quantity for 1975, Northumbrian Water Authority.

Class Volume	I	II	III	IV	V	TOTAL
1 Unpolluted	54.2	16.3	11.8	1.0	.9	84.2
2 Doubtful	9.6	1.5	-	1.1		12.4
3 Poor	2.0	.8	N/A			2.8
4 Grossly Polluted	.5	-	N/A			.5
Total	66.3	18.6	12.1	2.1	.9	100

Notes

- I 0.62 cumecs
- II .62 5.0 cumecs
- III 5.0 20.0 cumecs
- IV 20.0 40.0 cumecs
- V 40.0 cumecs

Source River Pollution Survey Update 1975 (29)

Table 5 Population estimates and projections, percentage change
1971-75.

	1961	1971	1974	1975	1981	% Change
England & Wales (10^3 's)	46299	48854	49201	49219	49334	+6.31
N.W.A. (10^3 's)	2663	2684	2672	2673	2623	+0.37

Source Data provided by the N.W.A.

Table 6 Metered, unmetered, and per capita unmetered water consumption ($10^3\text{m}^3/\text{d}$) 1961-74, England and Wales and Northumbrian Water Authority.

England & Wales (1)				N.W.A. (2)			
Metered	Unmetered	Total	Per Capita	Metered	Unmetered	Total	Per Capita
(1)	(2)	(1)&(2)	Unmetered	(1)	(2)	(1)&(2)	Unmetered
1961 3,800	6,700	10,510	145	296	337	663	119
1962 3,880	6,920	10,800	148	327	342	669	120
1963 3,960	7,320	11,280	156	336	352	688	126
1964 4,090	7,400	11,490	156	339	379	718	125
1965 4,180	7,410	11,590	155	338	423	761	129
1966 4,260	7,700	11,960	161	338	431	769	131
1967 4,340	7,910	12,250	164	353	463	818	136
1968 4,500	8,090	12,590	167	370	495	865	139
1969 4,710	8,470	13,180	174	390	527	917	146
1970 4,790	8,690	13,480	178	400	535	935	151
1971 4,730	8,880	13,610	182	411	524	935	154
1972 4,700	9,130	13,830	186	427	532	959	162
1973 4,870	9,350	14,220	190	416	571	987	158
1974 4,800	9,560	14,360	194	441	552	993	166

Source (1) Analysis of trends in public water supply. Central Water Planning Unit 1976.

(2) N.W.A. data.

Notes Non-potable supplies not included.

Table 7 Non-potable water consumption, England and Wales ($10^3\text{m}^3/\text{d}$)

	E.W	N.W.A.	NWA/EW x 100%
1961	216.3	61.4	28.4
1962	227.7	61.1	26.8
1963	287.0	70.0	24.3
1964	320.3	96.3	30.0
1965	357.1	108.4	30.3
1966	322.0	61.4	19.0
1967	339.5	61.9	18.2
1968	-	-	
1969	-	-	
1970	570.7	198.8	34.8
1971	577.5	204.3	35.4
1972	614.8	206.0	33.5
1973	622.6	220.1	35.3
1974	577.4	210.1	36.3

Source Analysis of trends in public water supply Central Water Planning Unit 1976.

Notes No statistics were collected 1968 and 1969.

Table 8 Sample of 100 sewage treatment works average annual effluent flows.

	Date	Pop.	DWF	TE	TSF	TDF	TEI
1964-65	1946	71,407	17.04	5.40	21.08	3.08	11,649
1965-66	1948	74,679	18.40	5.27	24.81	6.81	13,980
1966-67	1949	142,152	38.62	9.15	47.85	7.08	14,135
1967-68	1950	142,014	38.71	8.68	46.39	7.18	15,880
1968-69	1950	152,846	40.39	7.86	49.17	7.27	27,499
1969-70	1953	145,659	40.53	8.27	48.30	6.27	33,612
1970-71	1954	148,201	31.94	5.86	49.30	4.54	28,977
1971-72	1955	140,715	27.90	5.45	31.80	3.13	31,166

Source Sewage purification and disposal statistics (23)

- Notes
1. Date Date of commencement or major reconstruction.
 2. DWF Dry weather flow (tcmd).
 3. Pop. Population
 4. TE Trade effluent flow (tcmd).
 5. TSF Total sewage flow (tcmd).
 6. TDF TSF-DWF (tcmd).
 7. TEI Trade effluent income (e).

Table 9 Sample of 100 sewage treatment works. Average annual operating costs.

	G.W.C.	N.W.C.	N.S.C.	N.W.C. Pop	Debt
1964-65	37.7	58.6	57.3	3795.1	27.2
1965-66	60.4	58.6	76.3	4359.0	28.6
1966-67	67.7	64.1	65.4	4860.2	34.1
1967-68	75.8	70.4	69.5	5199.6	35.4
1968-69	80.4	74.5	69.9	5749.0	38.1
1969-70	85.8	80.4	66.3	6402.9	44.5
1970-71	39.4	37.1	32.7	7605.4	19.9
1971-72	44.9	41.8	35.4	7956.1	21.3
1972-73	51.3	46.8	38.1	8697.6	24.1

Source Sewage purification and disposal statistics.

- Notes
1. G.W.C. Gross works cost (p per $10^3 m^3$)
 2. N.W.C. Net works cost (p per $10^3 m^3$)
 3. N.S.C. Net service cost (p per $10^3 m^3$)
 4. N.W.C. Pop Net works cost per 1000 people served (p per $10^3 m^3$ per 1000 people)
 5. DEBT Debt charges (p per $10^3 m^3$)

Table 10 Sample of 100 sewage treatment works, average annual influent and effluent quality, and standard applied.

	Influent (p.p.m)		Standard (p.p.m)		Effluent (p.p.m)	
	BOD	S.S	BOD	S.S	BOD	S.S
1964-65	385	351	22	31	48	43
1965-66	355	350	23	33	34	38
1966-67	353	350	23	33	36	35
1967-68	405	350	24	33	38	35
1968-69	337	343	24	33	34	34
1969-70	336	346	24	34	34	33
1970-71	342	358	23	31	32	30
1971-72	336	346	20	29	32	31
1972-73	334	341	23	31	25	28
MEAN	354	348	23	32	35	34

Source Sewage purification and disposal statistics (23) 1964/5 - 1972/3.

Table 11 Percentage of 100 sample treatment works by date of commencement.

	Pre-1950	1950-1959	1960-1969	1970-1979
1964-65	36.3	30.8	32.9	-
1965-66	35.7	26.3	38.0	-
1966-67	28.3	23.5	48.2	-
1967-68	22.9	20.3	56.8	-
1968-69	24.9	18.7	56.4	-
1969-70	18.3	16.7	60.4	4.2
1970-71	18.6	16.7	59.6	5.1
1971-72	15.3	16.7	52.2	15.8
1972-73	13.4	14.6	50.3	21.7

Table 12 Percentage of 100 sample treatment works by size of population served.

	0- 10,000	10,000- 50,000	50,000- 100,000	100,000- 250,000	250,000- 500,000	500,000- 750,000	1,000,000-
1964-65	9.5	51.2	20.2	14.3	3.6	1.2	-
1965-66	7.2	51.8	21.7	13.3	2.4	3.6	-
1966-67	7.7	48.4	20.9	15.4	2.2	3.3	2.1
1967-68	8.3	47.9	19.8	15.6	2.1	4.2	2.1
1968-69	8.4	47.4	20.0	15.8	2.1	4.2	2.1
1969-70	9.6	42.6	22.3	17.0	2.1	4.3	2.1
1970-71	9.5	42.4	22.4	16.2	3.9	3.5	2.1
1971-71	9.6	42.6	22.3	16.0	4.3	3.2	2.1
1972-73	9.0	41.0	24.4	16.7	3.8	2.6	2.6

Source Sewage purification and disposal statistics 1964/65-1972/73.

Table 13 Capital and Revenue expenditure on sewage collection, treatment and disposal, and pollution prevention.

	Revenue Expenditure				Capital Expenditure			
	EW		NWA		EW		NWA	
	1974-75	1977-78	1974-75	1977-78	1974-75	1977-78	1974-75	1977-78
Sew. (£'000)(1)	319,192	368,250	11,499	19,652	277,967	261,225	17,481	27,999
NWA as % of EW			3.6	3.4			6.2	10.7
Poll. preven.(2)	4,659	1,455	136	1	276	297	12	-
NWA as % of EW			2.9	-			4.2	
Tot. expend. (3)	620,055	1,109,896	23,229	39,426	422,132	463,008	24,409	51,413
NWA as % of EW			3.7	3.6			5.8	11.1
(1)/(3) x 100%	81.5	51.2	49.5	49.8	65.8	56.4	71.6	54.5
(2)/(3) x 100%	0.7	0.13	0.6	-	0.06	-	0.05	-

Source National Water Council, annual reports and accounts, 1974-75 and 1977-78.

Table 14 Expenditure per '1000 head of resident population.

	1974-75		1977-78	
	EW	NWA	EW	NWA
Resident population (10 ³ 's)	49,195	2,672	49,120	2,662
Revenue expenditure				
1. Sewage expenditure (£)	319,192	11,499	568,250	19,652
2. Sewage expenditure per 1000	6.49	4.30	1,157	7.38
3. Prevention of pollution	4,659	136	1,455	1
4. Prevention per 1000	.09	.05	.02	
Capital expenditure				
1. Sewage expenditure	277,967	17,481	261,225	27,999
2. Sewage expenditure per 1000	5.65	6.54	5.32	10.5
3. Prevention of pollution	276	12	297	-
4. Prevention per 1000				

Source National Water Council, Annual Report and Accounts
1974-75, 1977-78.

Table 15 The State of Pollution Control in Four Countries.

	France	Belgium(1)	Netherlands	U.K.
Population connected to a system and treatment works (%).	40	5	80	90
Industrial pollution, treatment by public system (%).	50	5	50(2)	70(3)

Source 'Agence de l'Eau Artois Picardie (1976) (10).

- Notes
1. Planned effort 1977-80.
 2. Remainder associated with sugar production.
 3. Applies only where quality objectives have been fixed (i.e. non-tidal rivers).

Table 16 Unit charges and average strengths.

Source Water Authority documentation CBI data.

		1975/76	1976/77	1977/78	1978/79	1979/80
Anglian	R	1.97	2.32	2.80	3.11	3.11
	V	1.03	1.21	1.46	1.62	1.62
	B	1.42	1.67	2.02	2.24	2.24
	S	1.54	1.81	2.19	2.43	2.43
	T	5.96	7.01	8.47	9.40	9.40
	O _s	572	572	572	572	
	S _s	337	337	337	337	337
North West	R	1.09	1.22	1.16	1.33	1.38
	V	1.91	1.98	2.27	2.40	2.28
	B	2.05	2.34	2.69	2.93	2.84
	S	0.95	1.22	1.43	1.64	1.64
	T	6.00	6.76	7.55	8.30	8.14
	O _s	NA	NA	404	370	371
	S _s	NA	NA	270	275	275
Northumbrian	R	1.75	1.88	1.88	2.44	3.14
	V	3.70	4.31	4.31	2.53	3.25
	B	3.60	3.49	3.49	4.32	5.26
	S	2.10	3.15	3.15	3.33	2.95
	T	11.15	12.83	12.83	12.62	14.60
	O _s	417	417	364	372	372
	S _s	193	193	173	164	164
Severn-Trent	R	1.01	1.19	1.38	1.38	1.63
	V	2.45	3.28	3.90	2.54	2.69
	B	1.97	2.64	3.13	3.81	4.04
	S	0.91	1.21	1.44	2.12	2.24
	T	6.34	8.32	9.85	9.85	10.60
	O _s	450	440	424	403	379
	S _s	400	370	347	342	332
Southern	R					
	V			3.73	4.10	4.22
	B			3.08	3.39	3.48
	S			2.52	2.77	2.84
	T			9.32	10.26	10.54
	O _s			569	397	388
	S _s			535	354	365

Table 16 (Cont'd.)

South West	R	1975/76	1976/77	1977/78	1978/79	1979/80
South West	R			3.09	3.09	3.50
	V			1.72	1.72	1.93
	B			3.14	3.14	3.27
	S			2.35	2.35	2.34
	T			10.30	10.30	11.04
	O _s			245	280	301
	S _s			158	178	155
Thames	R	1.17	1.37	1.58	1.62	1.73
	V	0.92	1.19	1.32	1.36	1.46
	B	1.43	1.50	1.85	1.83	1.96
	S	1.11	1.54	1.82	2.00	2.07
	T	4.63	5.60	6.57	6.81	7.22
	O _s	412	349	320	298	292
	S _s	244	233	238	228	221
Wessex	R			1.39	1.60	1.60
	V			2.31	2.66	2.66
	B			2.31	2.66	2.66
	SS			3.24	3.72	3.72
	T			9.25	10.64	10.64
	O _s			400	400	400
	S _s			350	350	350
Yorkshire	R	0.94	1.10	1.09	1.12	1.18
	V	1.35	1.87	1.79	1.77	2.04
	B	1.80	2.77	2.73	2.67	2.77
	S	1.59	1.80	1.79	1.84	1.65
	T _s	5.68	7.54	7.40	7.40	7.64
	O _s	NA	218	216	203	200

- Notes R Reception and conveyance cost (p) per cubic metre.
V Volumetric and primary treatment cost (p) per m³.
B Biological oxidation cost (p) per cubic metre.
S Treatment and disposal costs of primary sludges per m³.
T Total treatment costs (R+V+B+S) p per cubic m.
O_s Average COD of settled sewage (mg/l).
S_s Average suspended solids (mg/l).

Table 17 Hypothetical Total Charge (£).

	1975/76	1976/77	1977/78	1978/79	1979/80	Mean
Anglian	£586	639	833	924	924	791
N-W	NA	NA	900	1027	1004	977 *
NWA	1389	1610	1740	1802	2026	1713
S-T	676	905	1095	1145	1273	1019
S			839	1157	1193	
S-W			1696	1549	1647	
T	553	712	866	929	1002	812
W			994	1143	1143	
Y	NA	842	822	858	887	852
Mean			1087	1170	1233	

Notes

Calculated thus $C = R + V + B \frac{O_t}{O_s} + S \frac{st}{S_s}$

assuming

$$\text{volume of flow} = 10,000 \text{ m}^3$$

$$O_t = 600 \text{ mg/l}$$

$$S_t = 300 \text{ mg/l}$$

using R,V,B,S, O_s and ss values as in Table A.

Table 18 Source River Pollution Survey 1970 (22)

ENGLAND AND WALES 1970	NON-TIDAL										TIDAL										ALL RIVERS																								
	SEWAGE TREATMENT WORKS										TOTAL										TOTAL										TOTAL														
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10					
1 Total no. of discharges,	2938	655	227	227	4047	141	65	70	30	306	3079	720	297	257	4353	184	68	74	30	336	3419	788	297	257	4353	184	68	74	30	336	3419	788	297	257	4353										
2 % considered satisfactory	68	60	46	40	64	68	58	49	63	61	61	60	46	42	63	68	60	46	40	64	68	60	46	40	64	68	60	46	40	64	68	60	46	40	64	68	60	46	40	64					
3 Tot. population served (10 ³)	101182	51774	3432	8502	77692	953	1190	845	837	10936	11135	6965	11887	8639	38628	101182	51774	3432	8502	77692	953	1190	845	837	10936	11135	6965	11887	8639	38628	101182	51774	3432	8502	77692	953	1190	845	837	10936	11135	6965	11887	8639	38628
4 % served by works satisfac.	57	62	36	38	50	68	40	23	62	30	57	58	26	30	44	57	62	36	38	50	68	40	23	62	30	57	58	26	30	44	57	62	36	38	50	68	40	23	62	30	57	58	26	30	44
5 Tot. D F of sew. eff. (10 ⁶)	327.6	319.7	202.5	526.1	1576.0	46.1	61.5	514.3	15.6	637.7	573.7	381.3	716.8	541.8	22138	327.6	319.7	202.5	526.1	1576.0	46.1	61.5	514.3	15.6	637.7	573.7	381.3	716.8	541.8	22138	327.6	319.7	202.5	526.1	1576.0	46.1	61.5	514.3	15.6	637.7	573.7	381.3	716.8	541.8	22138
6 % dischgd. from works satis.	52	61	32	36	46	62	38	22	61	27	53	57	25	37	40	52	61	32	36	46	62	38	22	61	27	53	57	25	37	40	52	61	32	36	46	62	38	22	61	27	53	57	25	37	40
7 Tot. no. dis. complying to	2669	600	211	204	3684	89	38	43	16	186	2758	638	254	220	3570	2669	600	211	204	3684	89	38	43	16	186	2758	638	254	220	3570	2669	600	211	204	3684	89	38	43	16	186	2758	638	254	220	3570
8 RCS, % satisfactory	67	59	47	40	63	76	58	44	63	64	67	59	46	42	63	67	59	47	40	63	76	58	44	63	64	67	59	46	42	63	67	59	47	40	63	76	58	44	63	64	67	59	46	42	63
9 Tot. no. discharges com-	243	50	14	10	317	0	3	4	0	7	243	53	18	10	324	243	50	14	10	317	0	3	4	0	7	243	53	18	10	324	243	50	14	10	317	0	3	4	0	7	243	53	18	10	324
10 plying to RCS, % Satis.	76	76	36	60	74	67	67	50	50	57	76	75	39	60	73	76	76	36	60	74	67	67	50	50	57	76	75	39	60	73	76	76	36	60	74	67	67	50	50	57	76	75	39	60	73
11 Tot. no. dis. complying to	25	5	2	13	45	52	22	22	12	108	77	27	24	25	153	25	5	2	13	45	52	22	22	12	108	77	27	24	25	153	25	5	2	13	45	52	22	22	12	108	77	27	24	25	153
12 RCS, % satisfactory	52	60	0	15	40	54	55	59	75	57	53	55	54	44	52	52	60	0	15	40	54	55	59	75	57	53	55	54	44	52	52	60	0	15	40	54	55	59	75	57	53	55	54	44	52
13 Tot. pop. served to RCS	7762	4185	3229	7149	22327	409	332	4778	43	3784	8171	4738	8008	7192.7	281111	7762	4185	3229	7149	22327	409	332	4778	43	3784	8171	4738	8008	7192.7	281111	7762	4185	3229	7149	22327	409	332	4778	43	3784	8171	4738	8008	7192.7	281111
14 % satisfactory	54	57	37	35	46	80	39	5	35	14	55	55	18	35	40	54	57	37	35	46	80	39	5	35	14	55	55	18	35	40	54	57	37	35	46	80	39	5	35	14	55	55	18	35	40
15 Tot. pop. served to RCS	2119	1117	201	700	4139	0	4162	3112	0	3116	2119	1122	3314	700	7256	2119	1117	201	700	4139	0	4162	3112	0	3116	2119	1122	3314	700	7256	2119	1117	201	700	4139	0	4162	3112	0	3116	2119	1122	3314	700	7256
16 % satisfactory	39	66	27	86	64	64	81	48	48	48	59	66	47	86	57	39	66	27	86	64	64	81	48	48	48	59	66	47	86	57	39	66	27	86	64	64	81	48	48	48					
17 Tot. pop. served to RCS	298	470	1	452	1222	544	631	557	220	1953	842	1102	559	672	3176	298	470	1	452	1222	544	631	557	220	1953	842	1102	559	672	3176	298	470	1	452	1222	544	631	557	220	1953	842	1102	559	672	3176
18 % satisfactory	96	99	0	12	66	58	40	26	89	47	72	65	26	37	54	96	99	0	12	66	58	40	26	89	47	72	65	26	37	54	96	99	0	12	66	58	40	26	89	47	72	65	26	37	54
19 Tot. DMF complying to RCS	397	216	104	459	1267	21	29	299	1	351	419	246	493	460	1619	397	216	104	459	1267	21	29	299	1	351	419	246	493	460	1619	397	216	104	459	1267	21	29	299	1	351	419	246	493	460	1619
20 % satisfactory	50	58	32	33	42	75	38	4	38	11	51	55	15	34	36	50	58	32	33	42	75	38	4	38	11	51	55	15	34	36	50	58	32	33	42	75	38	4	38	11	51	55	15	34	36
21 Tot. DMF complying to RCS	117	71	8	39	235	0	186	0	186	0	117	71	194	39	422	117	71	8	39	235	0	186	0	186	0	117	71	194	39	422	117	71	8	39	235	0	186	0	186	0	117	71	8	39	235
22 % satisfactory	56	52	26	84	58	58	49	49	10	95	56	52	48	84	54	56	52	26	84	58	58	49	49	10	95	56	52	48	84	54	56	52	26	84	58	58	49	49	10	95	56	52	48	84	54
23 Tot. DMF complying to RCS	13	31	28	28	73	24	32	28	10	95	37	63	28	38	167	13	31	28	28	73	24	32	28	10	95	37	63	28	38	167	13	31	28	28	73	24	32	28	10	95	37	63	28	38	167
24 % satisfactory	9	100	14	14	66	50	38	27	87	43	67	69	27	34	53	9	100	14	14	66	50	38	27	87	43	67	69	27	34	53	9	100	14	14	66	50	38	27	87	43	67	69	27	34	53

Table 19 Source River Pollution Survey 1970 (22)

SEWAGE TREATMENT WORKS	NORTHUMBRIAN RIVER AUTHORITY 1970 NON TIDAL RIVERS				TIDAL RIVERS				ALL RIVERS						
	1	2	3	4	TOTAL 1	2	3	4	TOTAL 1	2	3	4	TOTAL		
1. Total no. of discharges	147	42	10	4	203	4	3	1	1	9	151	45	11	5	212
2. % considered satisfactory	73	74	40	50	71	75	67	100	0	67	73	73	45	40	71
3. Tot. Pop. served (10^3)	319.0	231.8	182.7	26.4	760.1	12.8	9.5	25.2	21.5	69.1	331.9	241.4	207.9	48.0	829.2
4. % served by wks con. sat.	63	63	22	11	51	95	35	100	0	59	64	62	31	6	52
5. Tot. DWF of sew. eff. (10^6)	13.2	9.8	8.2	1.0	32.4	.6	.3	.6	1.2	2.8	13.8	10.1	8.9	2.3	35.2
6. % dis. from works satis.	57	67	14	9	48	97	39	100	0	48	59	66	20	4	47
7. Tot. no. dis. complying to RCS stan., % satis.	143	40	10	3	196	3	2	0	0	5	146	42	10	3	201
8. Tot. no. dis. complying to RCS, % satisfactory	73	78	40	67	72	67	50	100	0	60	73	76	40	67	72
9. Tot. no. dis. complying to RCS, % satisfactory	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
10. Tot. no. dis. complying to RCS, % satisfactory	100	3	2	0	6	1	1	1	1	4	4	3	1	2	10
11. Tot. no. dis. complying to RCS, % satisfactory	35	0	0	0	17	100	100	100	0	75	50	33	100	0	40
12. Tot. pop. served to RCS (10^3)	298.9	226.5	182.7	23.9	732.1	3.6	7.0	0	0	10.7	302.5	233.6	182.7	23.9	742.8
13. % satisfactory	62	65	22	12	51	83	12	100	0	36	62	63	22	12	51
14. Tot. pop. served to RCS, % satisfactory	14.0	0	0	0	14.0	0	0	0	0	0	14.0	0	0	0	14.0
15. % satisfactory	100	3	0	0	100	9.1	2.5	25.2	21.5	58.4	15.2	7.8	25.2	24.0	72.3
16. Tot. pop. served to RCS, % satisfactory	6.1	5.2	0	25	13.8	1	100	100	0	63	61	32	100	0	51
17. % satisfactory	3	0	0	0	1	.1	.2	0	0	.3	12.5	9.9	8.2	.8	31.6
18. Tot. DWF complying to RCS, % satisfactory	12.4	9.7	8.2	.8	31.2	89	18	100	0	44	56	67	14	11	47
19. % satisfactory	55	68	14	11	47	0	0	0	0	0	.6	0	0	0	.6
20. Tot. DWF complying to RCS, % satisfactory	.6	0	0	0	.6	0	0	0	0	0	.6	0	0	0	.6
21. % satisfactory	100	.1	.2	0	.5	.6	.1	.7	1.3	2.7	.7	.3	.7	1.5	3.2
22. Tot. DWF complying to RCS, % satisfactory	3	0	0	0	1	100	100	100	0	48	73	39	100	0	40
23. % satisfactory	3	0	0	0	1	100	100	100	0	48	73	39	100	0	40

Table 20 Numbers and volumes of satisfactory and unsatisfactory sewage effluents discharges to all rivers, 1972 and 1975, England and Wales and Northumbrian Water Authority.

		ENGLAND & WALES		N.W.A.	
		NO/VOL.	%	NO/VOL	%
Satisfactory in 1975					
Satisfactory 1972	NO	2135	77.2	152	80.9
	VOL	4,195,989	60.6	138,803	81.4
Unsatisfactory 1972	NO	375	13.3	20	10.6
	VOL	2,469,286	35.7	16,392	9.6
New discharge 1975	NO	269	9.5	16	8.5
	VOL	259,220	3.7	15,348	9.0
Unsatisfactory in 1975					
Unsatisfactory 1972	NO	318	51.9	24	77.4
	VOL	2,959,742	69.6	38,195	74.3
Satisfactory 1972	NO	649	41.2	6	19.4
	VOL	1,078,473	25.4	10,088	19.6
New discharge 1975	NO	108	6.9	1	3.2
	VOL	212,502	5.0	3,140	6.1
Unsatisfactory 1975	NO	1,575	35.7	31	14.2
	VOL	4,250,717	38.0	51,423	23.2
Satisfactory 1975	NO	2,829	64.3	188	85.8
	VOL	6,924,495	62.0	170,543	76.8
Total	NO	4,404		219	
	VOL	11,175,212		221,966	

Source Table 3.9.4 River Pollution Survey, Update 1975 (26)

Table 21 Numbers and volumes of satisfactory sewage effluent discharges by effluent standard, 1972 and 1975. England and Wales.

		NON TIDAL RIVERS				TIDAL RIVERS				ALL RIVERS AND CANALS			
EFFLUENT STANDARD	ROD	NO. SAT	VOL SAT 10 ³ m ³ /d	% NO. SAT.	% VOL SAT.	NO. SAT.	VOL SAT.	% NO. SAT.	% VOL SAT.	NO. SAT.	VOL SAT.	% NO. SAT.	% VOL SAT.
SS		1970	45	40		108		57		153		52	
30	20	1972	236	823.1	76	4	413.9	50	47	240	1237.0	76	61
		1975	228	917.0	65	6	1747.9	75	100	234	1664.9	65	54
		1970	3684		63	186		64		3870		65	
30	20	1972	2457	2087.2	68	124	243.4	68	15	2581	3130.7	68	43
		1975	2296	3363.4	64	124	356.5	63	43	2420	3719.9	65	54
		1970	317		74	7		57		324		73	
30	20	1972	29	33.6	30	71	232.4	56	45	100	266.0	45	32
		1975	32	182.5	48	89	313.7	62	40	141	496.3	56	49
30	20	1970											
	OR	1972	33	186.4	70	0	0	-	-	33	186.4	70	69
		1975	33	43.1	63	1	.2	100	100	34	43.2	64	24
TOTAL SATISFACTORY		1970 (4046)				(301)				(4347)			
		1972	2755	3930.3		199	889.7			2954	4820.1		
		1975	2589	4506		220	2418.3			2829	6924.3		
TOTAL		1970 (4047)				(306)				(4553)			
		1972	4031	7409.7		316	3012.7			4347	10422.4		
		1975	4056	7817.0		348	3358.1			4404	11175.1		

Source Tables 3.9, 3.9.1 and 3.9.2 River Pollution Survey Update 1975 (26).

Notes 1. 'All rivers' does not include data on canals for the year 1970.

2. Does not include data for works serving less than 200 people.

Table 22 Numbers and volumes of sewage effluent discharges exceeding standard. Sample of 100 sewage treatment works.

		SUSPENDED SOLIDS			B.O.D.			S.S. OR B.O.D.		
		EFFLUENT		STANDARD	EFF		STANDARD	EFF		STANDARD
DWF	VOL 10^3 m ³ /d	%NO	%VOL	VOL	%NO	%VOL	VOL.	%NO	%VOL	
1964-65	1584.9	550.9	37	34.8	665.2	43	42.0	697.6	48	44.0
1965-66	1475.3	456.4	27	30.9	576.6	34	39.1	598.1	39	40.5
1966-67	3835.2	1910.0	31	49.8	2154.9	36	56.2	2219.8	42	57.9
1967-68	3875.9	1489.7	30	38.4	1614.1	37	41.6	1636.9	42	42.2
1968-69	4041.9	1663.6	33	41.2	1628.1	33	40.3	1769.8	39	43.8
1969-70	3967.5	1795.5	29	45.3	1752.3	33	44.2	1951.7	37	49.2
1970-71	3100.2	915.0	30	29.5	1108.1	36	35.7	1182.1	40	38.1
1971-72	2706.8	870.3	28	32.2	1155.4	35	42.7	1222.4	39	45.2
1972-73	3371.6	1851.3	21	54.9	704.1	24	20.9	2063.5	31	61.2
Mean	3106.5	1278.0	29	39	1262	34	40	1482.4	39	47

Source Sewage disposal, purification and disposal statistics
1964-65 - 1972-73.

Table 23 Number and volumes of sewage discharges exceeding Royal Commission Standard. Sample of 100 sewage treatment works.

SUSPENDED SOLIDS B.O.D.												
	DWF	VOL	%NO	% VOL	VOL	%	NO	%VOL	VOL	%	NO	% VOL
1964-65	1584.9	319.6	23	32.8	1044.1	60	65.9	1058.7	21	66.8		
1965-66	1475.3	554.9	17	37.6	1101.6	50	74.7	1129.1	15	76.4		
1966-67	3835.2	2164.3	19	36.4	2655.1	57	69.2	2653.9	19	69.2		
1967-68	3875.9	1626.8	19	42.0	2310.5	56	59.6	3876.5	18	59.8		
1968-69	4041.9	1538.8	18	38.1	2250.6	54	55.7	2295.8	17	56.8		
1969-70	3967.5	1486.1	16	37.5	2361.1	51	59.5	2404.3	15	60.6		
1970-71	3100.2	786.9	20	25.4	1505.1	52	48.5	1578.0	17	50.9		
1971-72	2706.8	603.8	18	22.3	1397.7	54	51.6	1445.4	17	53.4		
1972-73	3371.6	316.1	7	9.4	2186.8	42	64.9	2188.1	7	64.9		
Mean	3106.5	1044	17	33.5	186 ^s	52	61.0	2069.7	16	62		

Source Sewage disposal, purification and disposal statistics
1964/65 - 1972/73.

Table 24 Total number of discharges, percentage satisfactory, for four river pollution surveys England and Wales.

Discharge	1970	1971	1972	1975
Sewage effluent	4379	4376	4374	4429
% satisfactory	63	67	68	64
Crude sewage	484	465	437	414
Industrial effluent	2449	2372	2221	2077
% satisfactory	44	47	48	52
Cooling water	1067	1016	1008	882
% satisfactory	86	86	86	89
Mine discharge	398	401	394	366
Total	8777	8630	8434	8168

Source River Pollution Survey Update 1975 (26) Table 3.2.

Table 25 Number and percentage satisfactory discharges by type of discharge. England and Wales, Northumbrian Water Authority.

RIVERS DISCHARGE	ENGLAND AND WALES						N.W.A.						
	NONTIDAL		TIDAL		ALL		NONTIDAL		TIDAL		ALL		
	NO.	%SAT	NO.	%SAT	NO.	%SAT	NO.	%SAT	NO.	%SAT	NO.	%SAT	
SEWAGE EFF.	1972	4031	68.3	316	63.0	4347	68.0	200	77.0	9	66.7	209	70.6
	1975	4056	64.3	348	63.2	4404	64.2	208	85.6	11	90.9	219	85.8
CRUDE SEWAGE	1972	36	0.0	401	0.0	437	0.0	0		53	0.0	53	0.0
	1975	22	0.0	392	0.0	414	0.0	0		40	0.0	40	0.0
INDUSTRIAL EFFLUENT	1972	1842	49.9	317	38.8	2159	48.3	39	59.0	38	34.2	77	46.8
	1975	1692	54.3	319	38.2	2011	51.7	36	77.8	47	27.7	83	49.4
COOLING WATER	1972	705	86.7	138	70.6	843	87.3	5	100.0	7	100.0	12	100.0
	1975	607	88.6	135	92.6	742	89.4	5	100.0	4	100.0	9	100.0
MINE DISCHARGE	1972	376	0.0	8	0.0	384	0.0	82	0.0	7	0.0	89	0.0
	1975	346	0.0	10	0.0	356	0.0	72	0.0	9	0.0	81	0.0
TOTAL	1972	6990		1180		8170		326		114		440	
	1975	6723		1204		7927		321		111		432	

Source Tables 3.1 and 3.1.2 River Pollution Survey Update 1975 (26).

Notes Excludes canals.

Table 26 Numbers and volumes of industrial discharges, percentages considered satisfactory 1975.

	ENGLAND AND WALES				N.W.A.			
	TOTAL NO.	% SAT	TOTAL VOL. (1)	% VOL SAT	TOTAL NO.	% SAT	TOTAL VOL. (1)	%VOL SAT
Process Water Only								
Non Tidal	1479	54	2454.3	73	33	76	54.9	74
Tidal	223	41	1172.2	47	30	40	71.0	60
Cooling Water Only								
Non Tidal	607	89	18086.4	98	5	100	4.2	100
Tidal	135	93	40586.3	100	4	100	1692.3	100
Process(+Some Cooling)								
Non Tidal	213	58	1322.1	45	3	100	16.3	100
Tidal	96	31	4158.4	61	17	6	1234.8	0
Totals all Rivers								
(2) Non Tidal	2299		21862.9	92				
Tidal	454		45917.0	95				
Minewater								
Non Tidal	346	NA	826.6	NA	72	NA	207.5	NA
Tidal	10	NA	36.9	NA	9	NA	29.0	NA

Source River Pollution Survey Update 1975 (26) Tables 3.11 and 3.11.2.

Notes 1. Total volume $10^3 \text{ m}^3/\text{d}$.

2. Excludes data for canals.

