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Proceedings of Symposium on Engineering and the Environment: Harmony or Conflict?

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SYMPOSIUM ON ENGINEERING AND THE ENVIRONMENT: HARMONY OR CONFLICT?

PROCEEDINGS OF SYMPOSIUM HELD IN
LONDON, ENGLAND, on 6th and 7th DECEMBER 1978

ANY CORRESPONDENCE relating to the papers appearing in this publication should be addressed to the Secretary, The Institution of Water Engineers and Scientists, 6-8 Sackville Street, London W1X 1DD, England. (Telephone: 01-734 5422.)

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PREFACE

The general theme of this Symposium is the environmental and sociological implications of major engineering works and how these influence the promotion, design, construction, and operation of such works. Within this theme an attempt is made to identify the role which is or should be played by the water services industry and to illustrate this by examples from overseas and the United Kingdom. Thereafter, an attempt is made to examine the way ahead.

Problems and public concern relating to pollution of the environment are not new and it could be said that the water industry has a long history of concern for the environment. Be that as it may there have been rapid and dramatic changes in our life style in recent years and the public generally now have a greater awareness and interest in the impact of change and development on the environment which is resulting from the increasingly complex society in which we live.

The authors of the papers have been widely drawn, and their deliberations have promoted an interesting and worthwhile Symposium.

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OPENING OF THE SYMPOSIUM

The Rev. the Lord Sandford, DSC.

The President, Mr. K.J.H.Saxton, introduced Lord Sandford as President of the Council for Environmental Education, a former Minister in the Department of the Environment, and one who was keenly interested in all environmental issues.

Lord Sandford acknowledged his introduction; he had been responsible for the passage of the Water Act 1973 in the House of Lords and he had felt a parental interest in the water industry ever since.

He believed that this Act had given members of the Institution in England and Wales the best and most comprehensive structure for managing water of any country in the world. Whether they had yet made it the best structure for satisfying customers was another question.

Before he turned to the impact of the water industry on the environment, he wished to speak as a member of the House of Lords Select Committee on Europe, and on Europe's environment in particular. He thanked those many members of the water industry who had helped the Select Committee to deal first with the less well conceived suggestions from Brussels about water pollution control and then to start the long term process of educating the Commission and the other eight members of the EEC in the virtues of dealing with pollution "by the best practicable means".

Lord Sandford then turned to the main topic of the symposium. Between 1970 and 1973 he had been the Minister responsible for dealing with planning cases in the Department of the Environment. He mentioned a number of the cases with which he had been concerned; these included the Third London Airport (whose enquiry alone cost £1.3m.) and proposals for reservoirs at Swincombe and Empingham.

He recalled no case in which he or his advisers in the Department were in doubt that sufficient relevant data had been assembled to enable an informed judgment to be made. In the case of the Third London Airport, what had been much more apparent was the ludicrous waste of money spent on spurious cost benefit analyses in areas quite inappropriate for such treatment.

The British planning system was not of course perfect but it had been grossly abused of late by those who should have known better.

Mr. Thirlwall had rightly said in his paper that the first question to be asked was whether there was a case for introducing Environmental Impact Analysis in the United Kingdom. Lord Sandford was against it, unless the object was to find lucrative employment for more planning barristers and academic consultants.

The House of Lords Select Committee on Europe was now retraining its guns from pollution directives on to that part of the horizon over which the EEC directive on EIA was expected to emerge; it would save a lot of trouble if the directive could be sunk with the first few salvoes. He hoped that those in the water industry would demonstrate clearly their ability to provide acceptable proposals from the outset, as Mr. Oldfield had indicated in his

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"Four Site Saga".

It was important always to seek the largest amount of common ground with potential opponents. In the St. Katherine's Docks case, a director of the contracting firm had worked to this end full time for nearly a year and the effort had been well worth while.

The point was clearly made in St. Matthew's Gospel in chapter 5, verses 25 and 26:

"Agree with thine adversary quickly, whiles thou art in the way with him; lest at any time the adversary deliver thee to the judge, and the judge deliver thee to the officer, and thou be cast into prison.

Verily I say unto thee, Thou shalt by no means come out thence, till thou hast paid the uttermost farthing."

Instead of EIA, it would be far better to encourage a breed of imaginative, sensitive, responsive designers, engineers and managers. They could make EIA redundant in the United Kingdom. If EIA were imposed, it would not be for lack of any such managers - it would be because they had failed to make their influence felt soon enough. He hoped that the symposium would promote that influencing process.

1. HARMONY OR CONFLICT? - A MANAGERIAL VIEW

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INTRODUCTION

Public Perception of Environmental Issues

Problems and public concern relating to pollution of the environment are not new. As long ago as A.D. 61 the Roman poet Seneca wrote "As soon as I had got out of the heavy air of Rome and from the stink of the smokey chimneys thereof, which, being stirred, poured forth whatever pestilent vapours and soot held enclosed in them, I felt an alteration to my disposition".

In 1357 King Edward III observed as he rode along the Thames "that dung and other filth had accumulated in divers places upon the banks of the river and that fumes and other abominable stenches arose therefrom". In more recent times expressions of environmental concern have been numerous, covering all aspects of what has become a common subject of interest amongst all kinds of people.

Steady progress has however been made recently towards alleviating the widespread disquiet which has become particularly evident in the second half of the twentieth century; indeed the water industry has behind it achievement of which it can be justly proud. However, lest we should be tempted to rest on our laurels, we need to remind ourselves that the environmental movement has so alerted public interest to the issues at stake that the perception of the person in the street has sharpened. Official campaigns, such as European Conservation Year, and the efforts of a veritable army of articulate pressure groups have combined to produce a sharp lowering in the threshold of unease and protest.

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Thus we are faced, and are likely to continue to be faced in the foreseeable future, with an escalation of conservatism and public unease concerning quality of life. We may see this as derived on the one hand from the real environmental deterioration liable to arise from increasing population and urbanisation, technological advance and the generally increased level and complexity of industrial activity, and on the other hand from the increasing awareness of the public to their environment and its impact on day to day living.

Consequently we also face an advancing tide of demand for public consultation in depth, particularly in relation to environmental impact. Our response to these factors is crucial to our success in the eyes of the public since this depends not only on physical achievement but also on public perception of that achievement. Hence the importance of this symposium in highlighting for us all the pertinent issues of what continues to be a subject very much in the public eye.

An Environmental Perspective

The subject of this symposium was suggested by our President whose inaugural address in Cardiff last May began with reference to an associated theme - a tribute to people, their attributes and contributions within our industry.

Our subject today takes us outside the water industry, but is still very much concerned with people: our customers and the community as a whole. It extends into a consideration of what people consider to be important, their perceptions and their priorities. We are of course in a difficult area in which opinions differ and feelings run high, and where attempts to identify significant parameters for objective measurement are not always profitable.

Environmental impact is about the total effect of man's activities on human life as perceived by individuals. The emphasis is on quality of life rather than on those aspects which, at least in developed countries, are generally accepted as essential to the normal requirements of everyday living. The demands of an increasingly complex society for improvement of everyday physical conditions result in ever increasing conflicts with aesthetic and social priorities.

We need to be aware of the important distinction between perception and actuality, and that objective measurement of actuality in the environmental field is far from the answer to the manager's prayer. Opinions count, some far more than others, the perception of individual persons is important, and in the end we must listen carefully to public opinion and conclusions before making our managerial decisions.

Public authorities may be more vulnerable at the environmental fringe of their activities as regards image and reputation than in the central activity of providing essential services to the public. This is particularly important in relation to incidents and emergency situations which bring an authority into the public eye and which commonly have an environmental component of major proportions. Articulate pressure groups are certain to ensure that a controversial decision or incident with environ-

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mental implications does not evade the public's closest scrutiny.

The issues relevant to environmental impact and the techniques for evaluation of the various aspects are dealt with admirably in the Department of the Environmental Research Report No. II, and I do not propose to repeat them here. The title of my paper leads me into a consideration of the value of Environmental Impact Analysis (EIA) as a system for improving decision making, and its relationship with existing procedures with particular reference to the water industry.

Although the techniques and methodologies of EIA are generally designed for application to major development projects it is by no means true that environmental impact need not otherwise be considered. Proposals to alter existing operational methods, expand or extend existing installations or change the purpose for which land is used may all be appropriate subjects for analysis. There may also be a case in some instances for considering the environmental implications of not proceeding with a project.

The Water Industry and the Environment

The water industry is designated by Government in Britain as 'an environmental service' for very obvious reasons. The various services provided by the industry are now categorised for accounting purposes as follows:

	Revenue expenditure by water authorities (% by 1976/77 service)
1. Water resources	2.9
2. Water supply	40.3
3. Sewerage	23.1
4. Sewage treatment and disposal	28.3
5. Water quality regulation and pollution alleviation	1.0
6. Recreation and amenity	0.2
7. Navigation	0.2
8. Fisheries	0.3
9. Land drainage and flood protection	3.7

The provision of piped water supply and disposal services, flood prevention and land drainage, as represented by the first four and the last of the foregoing headings, to an acceptable standard is regarded in developed countries as being essential to normal requirements of everyday living. At the very least, these services are important factors in public health or safety; in the limit they are vital to survival. But equally they are essential to the preservation of quality of life; a substantial component of the expenditure involved may certainly be regarded as for environmental purposes.

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The level of service offered in these areas is relatively easily quantifiable and, although its value in absolute terms may be suppositional, there is general agreement amongst practising water engineers in this country about acceptable levels of service having regard to statute. It is not however the 'essential' aspects of these services with which we are primarily concerned at this symposium, although we are interested in their environmental components. We may conveniently divide our interests into three categories;

1. Incidental impact - general and incidental impact, adverse or otherwise, of our activities on the quality of life enjoyed by the community.
2. Environmental services - those services offered by the industry, as represented by headings 5 - 8 above, which are primarily environmental in nature.
3. Non-essential aspects of 'essential' water services - the environmental component of these services, including secondary aspects of aesthetic and social significance.

By way of examples of incidental impact, we are interested in noise levels from our construction sites, odour from our treatment works, and the impact of our large water resource schemes on flora, fauna and aquatics. On a slightly different tack we may consider the employment opportunities offered by our offices, depots, etc., the recreational amenities incidentally associated with features and installations in the water cycle, and the historical interest arising from some of our ancient buildings, installations and machinery. Quantification of adverse impact or of benefits of these sorts is difficult owing to variation between individuals of opinion and perception. Any costs incurred in these areas are recovered as part of the appropriate charges, but generally we have little idea of how much they amount to.

Water industry services which are primarily environmental in nature, contributing to quality of life rather than to essentials, include water quality regulation, pollution alleviation, navigation, recreation, amenity and fisheries. There is recognition of the nature of this sub-set of services in charging schemes whereby net expenditure is raised by an environmental services charge, which may be levied as a percentage addition to other charges made.

As regards the environmental component of essential services, we may cite that portion of domestic water supply used in garden watering and car washing, and the component of sewage treatment which is aimed at ensuring river quality of a higher standard than that required for essential purposes dictated by for example public health and water supply considerations. My colleague, Hugh Fish, in his paper to the Institution's Symposium on Water Services: Financial, Engineering and Scientific Planning, identified four clearly defined surface water quality states ranging from a state of 'causing public nuisance', through being 'substantially fishless' and 'supporting a diversity of fish life' to a state of 'outstanding natural beauty.' Somewhere between the second and third of these four states, depending upon the use to which the water is

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being put, we pass from the essential into the environmental so far as the sewage treatment function is concerned.

Within this same environmental component heading there also falls such considerations as the aesthetic acceptability of our water supplies and the social implications of, for example, fluoridation. Some attempt is made to isolate costs and charges of certain environmental components of our essential services, but it is of course far from comprehensive, - again, we have generally little idea what the costs incurred are.

Incidental environmental problems may not generally be so severe in the water industry as in many heavy engineering, chemical and petro-chemical industries. We are, however, as an industry responsible for the provision of some services which are primarily environmental in nature, and there is a significant environmental component in our other services. Accordingly, environmental considerations play a most important part in policy formulation and day to day management in the industry.

Finally in this introduction it is appropriate to draw attention to the broad outlook which is required by all parties if environmental problems are to be tackled satisfactorily. The effects of the activities of large public and private undertakings are widespread and have an impact on a broad front; many and varied interests are affected. Adequate recognition of the broad implications of the issues is required of all parties, including the many pressure groups active in this field, if genuine progress is to be made. Conservation should not be regarded narrowly as merely the protection of an existing feature, but should provide for such utilisation as is desirable and consistent with the protection of existing positive contributions to the environment.

Environmental impact analysis, in which we are particularly interested at this symposium, seeks to identify the issues systematically and reduce them to manageable proportions. Perhaps the fundamental problem for management is to distinguish private wants from public needs, and if impact analysis assists in this objective, it will be fulfilling a useful function.

THE PAST - A HISTORY OF ACHIEVEMENT

An Early Example of Environmental Impact

One of the first environmental impact analyses of a water supply scheme was initiated by Queen Elizabeth I who, in 1602, directed the Sheriffs of Hertfordshire and Middlesex to inquire whether the proposed construction of an aqueduct now known as the New River 'would injure the inhabitants of the two counties, and whether it would diminish the flow of any navigable river'.

The answer proffered to Her Majesty was that the inhabitants would not suffer, provided compensation was paid to those whose lands were to be cut and sufficient bridges were constructed and maintained. In due course Parliament passed the enabling legislation. Sir Hugh Myddelton, following his appointment as the City's lawful deputy in the matter, began construction works on the New River in the Spring of 1609, but work was brought to an abrupt halt early in 1610 by determined opposition. Attempts were

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made in Parliament to repeal the enabling legislation although by this time the stream 'hath ben already brought onwards about tenn miles at the Charges of Mr. Hugh Midleton amounting to the some of three thowsand pownds'.

It appears that the earlier 'analysis' had not achieved its objective, at least in the eyes of those who now objected on grounds which were almost identical with those originally mentioned in the brief of Queen Elizabeth I although reworded as follows: (a) against the diversion of the springs. (b) against bringing the river through many men's lands.

But Sir Hugh was a determined gentleman. He sought and obtained royal support for his venture, which proceeded after a stoppage of some 21 months and was duly completed in 1613. Small wonder that later in his life Sir Hugh advised a friend with reference to the promotion of another large engineering project: 'first of all his Majesty's interest must be got'.

Such expedients are not available to us now and perhaps this is just as well! We in our situation do well to remember the words of Abraham Lincoln 'Nothing can be accomplished without public support'. But there is more we can learn from Sir Hugh Myddelton's venture. In the first place environmental impact is preferably assessed in advance of the commitment of funds, especially when recourse to the favours of royalty and the treasury coffers is not available as an option! Secondly if the initiative and drive of individual managers is not allowed to come to fruition at any cost and in a reasonably timely manner, we are all liable to be losers.

Promotion of Major Engineering Projects

The promotion of so many engineering projects has in the past relied upon the imagination, confidence and even the daring of individuals with sufficient foresight to look beyond the bounds of a limited, orthodox solution to the initiation of a completely new type of engineering achievement. If at times this has led to the accusation that engineers are contemptuous of aesthetics and other environmental considerations, it is nevertheless a fact that time and time again their initiatives have proved worthy in the long term.

The contributions to our heritage of individual geniuses such as Myddelton, Stephenson, Locke, Brunel, Telford, Bazalgette, and many others who deserve mention, were not subject to environmental impact analysis or other multi-disciplinary consultation procedures. These people no more consulted before creating than would any artist worth his salt; however their achievements have stood the test of time both directly in their contributions to essential services and also in many cases from the environmental point of view.

Sir Hugh Myddelton's New River, if it were ever abandoned as a water supply aqueduct, would undoubtedly be retained now as an environmental feature valued beyond measure by the inhabitants of North London. Sir Joseph Bazalgette's interceptor sewer system in London was a prerequisite to the recent clean-up of the tidal Thames, now internationally recognised as the cleanest metropolitan estuary in the world. Telford's Pont-y-Cysylltau aqueduct and

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Stephenson's Britannia bridge, which may well not have survived an E.I.A., now stand as monuments to their designers; their very grandeur is seen to enhance the landscape against which we view them.

One possible danger of E.I.A. and similar techniques is that individual genius and initiative can be suppressed in favour of solutions, colourless by comparison, resulting from public or multi-disciplinary consultation. It is possible this way to end up with a solution which is less than elegant; it has been observed that; 'a camel is a horse designed by a Committee'.

We must be aware that there are projects, which are now appreciated by all for their contribution to the environment in its widest sense, which may never have got off the ground if they had been subjected to E.I.A. However by way of redressing the balance in the argument we must also be aware of schemes which should not have been carried out, and which would not have seen the light of day if they had been considered thoroughly from the point of view of environmental impact.

THE PRESENT - A MANAGERIAL VIEW

Environmental Impact in the Twentieth Century

The manager in both the private and public sector faces increasing problems relating to environmental impact as the size, scope and technological complexity of industrial development projects and operating activities increase. His difficulties are further complicated by the increased public awareness already mentioned and the embodiment into statute of a number of environmental considerations, together with more recently an economic climate which demands the most careful appraisal of all investment and operating methods.

As far as development projects are concerned we think of the social and aesthetic implications of tower blocks and new towns, the impact on employment and the noise nuisance of the Concorde project, the risk of pollution and of disturbance to recreational facilities associated with the North Sea oil and gas development. Finally coming nearer home we may consider the impact of major civil engineering developments; for example in our own industry projects like Keilder are of tremendous significance in relation to the natural environment and also in terms of disturbance during the construction period and possibly, despite our best efforts in dam safety, through public apprehension of hazard. The four items mentioned in this paragraph have between them major implications throughout the range of possible environmental impact; indeed each one would in itself need to be analysed across the whole range.

Neither dare we forget the possible implications of many day to day operating activities in a technological society. The use of pesticides and herbicides and intensive farming methods, the operation of high pressure oil and gas pipelines, the transportation of dangerous substances by road or rail, the dedication of large tracts of otherwise attractive countryside or coastline to military training purposes, and the operation of giant tankers and juggernauts come to mind. In our own industry we must consider

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the impact of service installation and maintenance especially in urban areas, the influence on the environment of our ground and surface water abstractions, and the potential utilisation of derelict works which may otherwise become a permanent scar on the landscape. These are but some of the practical aspects of which the manager must be aware, but perhaps his biggest headaches arise in the administrative and economic spheres to which we now turn.

Environmental Legislation in Britain

Consistent with the escalation of interest in the subject as a whole there has recently been a substantial increase in the quantity of legislation covering environmental aspects, much of it updating earlier statute and consolidating it in more comprehensive terms. It may be useful to list some of the recent important Acts relevant to the water industry which have significant environmental components.

Countryside Act, 1968
Water Act, 1973, especially Sections 20 - 23
Control of Pollution Act, Part II, 1974.
Health and Safety at Work, etc. Act, 1974.
Reservoirs Act, 1975.

In the background, but nevertheless of considerable significance in relation to the environment, are the Public Health and Town and Country Planning Acts and the remainder of the Control of Pollution Act, 1974.

Additionally we now have a plethora of legislation arising out of the European Environmental Action Programme initiated at a summit conference in Paris in October 1972. E.E.C. Directives on a wide variety of environmental issues are in various stages of implementation; those directly relevant to the water industry which have so far been adopted are as follows:-

Quality of surface water intended for the abstraction of drinking water, June, 1975.

Quality of bathing water, December, 1975

Pollution caused by certain dangerous substances discharged into the aquatic environment, May 1976.

Quality requirements for fresh waters suitable for fish life, July 1978.

Several other Directives already adopted relate to the disposal of specific types of waste including detergents, polychlorinated biphenyls and terphenyls, and waste from the titanium dioxide industry.

The E.E.C. continues to produce Directives, of which some of the most important relating to water in draft form or under consideration include:

Pollution caused by certain dangerous substances discharged into ground water.

Quality of water for human consumption.

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Quality objectives for water used for agricultural purposes.
Quality of water for industry.
Quality objectives for aquatic life.
Water pollution charging systems.
Quality requirements for waters favourable to shellfish growth.
Dumping of wastes at sea.

Section II of the Countryside Act requires Ministers, and Departments of Public Bodies carrying out development, to have regard to the environment, specifically any impact upon the natural beauty of the countryside and upon flora, fauna, geological or physiographical features, historic buildings and archaeological features.

The Water Act, 1973, Section 22 applies similar requirements specifically to water authorities and the appropriate Ministers in the formulation or consideration of any proposals relating to the discharge of the functions of water authorities, and in addition requires them to have regard to the desirability of preserving public rights of access to areas of mountains, moor, heath, down, cliff and foreshore and other places of natural beauty. It becomes the duty of the Nature Conservancy Council to notify water authorities of any effects of schemes or operations on any of the aforementioned aspects.

Section 23 of the same Act sets up the Water Space Amenity Commission whose duties are to advise on the formulation, promotion and execution of the national policy for water so far as relating to recreation and amenity in England. Section 20 requires water authorities and all other statutory water undertakers to take such steps as are reasonably practicable to putting their rights to the use of water and land associated with water to the best use for purposes of recreation. Section 21 deals with similar matters in Wales.

Part II of the Control of Pollution Act relates to the control of entry of polluting matter and effluents, including trade and sewage effluents, into rivers and coastal waters, etc. Other parts relate to waste on land, noise, and pollution of the atmosphere. Under this Act water authorities are responsible for sewage effluents both as discharger and receiver.

The Health and Safety at Work, etc. Act sets up the Health and Safety Commission and the Health and Safety Executive which brings factories, explosives, alkali and nuclear inspectorates into one organisation. Work is in hand on the replacement of existing statutory codes relating to health, safety and welfare at work, protection of the public against risks arising from the activities of people at work, and other areas, by more up-to-date regulations and codes of practice. Whilst in the water industry high standards were adopted voluntarily in the past, now they can be enforced through the Health and Safety Executive.

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Much has been written about the implications of the various E.E.C. Directives and their compatibility with the expressed intent of the Environmental Action Programme: "Protection of the environment and improvement of the quality of life at the lowest cost to the community". In the United Kingdom concern has been expressed that adequate account should be taken in the Directives of the varying physical circumstances which pertain, such as the ability of individual receiving waters to absorb or naturally purify potentially dangerous substances. Some movement does appear to be occurring towards the U.K. view, away from the fixed standard concept favoured by other E.E.C. states; furthermore where appropriate there is provision in the Directives for waivers to cover exceptional physical conditions and these seem to be reasonably easily obtainable.

Impact Analysis in the Water Industry

I wish to emphasise that, in adopting the above title for this section of my paper, I am not advocating adoption of American impact analysis procedures for projects in the water industry in Britain. Consideration of environmental factors is already an accepted procedure in the industry during the appraisal stage of capital projects. Whilst no doubt there is scope for improvement of methodology, it is doubtful if there is any adequate reason for disturbing present procedures by separating out environmental issues from other aspects of project appraisal. Environmental aspects should certainly continue to be evaluated alongside political, technical and economic issues, with which they are almost always closely associated and interwoven.

Indeed there would appear to be a number of disadvantages in carrying out environmental analysis as a separate exercise. In the first place, whilst no doubt some would have us regard environmental issues as of supreme importance, in practice the environmental perspective is but one aspect only of project appraisal. Secondly, separate consideration of environmental impact carries with it the twofold risk that important environmental issues arising in smaller projects may be neglected, and environmental implications of larger projects subject to a full analysis will be given greater prominence than they deserve. Thirdly, it is with some trepidation that we would encourage the formation of a new army of specialists whom we would call upon to analyse our major development proposals from the environmental point of view, in isolation from prime purpose considerations and the practical requirements and problems of the industry.

The general and incidental impact of development projects is probably the most important single area of environmental significance in the industry. Good practice requires all projects of significance to be appraised during what may be termed the planning stage. Such appraisal consists of four identifiable elements.

1. Identification of need and consequent justification of investment.
2. Definition of output required from the project.
3. Establishment of relative priority against other projects competing for limited resources.
4. Selection of the preferred scheme from alternatives.

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Some may prefer to summarise these four elements as the 'Why?', 'What?', 'When?' and 'How?' of project appraisal.

Environmental considerations are not generally critical in relation to the second and third of the foregoing elements of project appraisal, except of course where the scheme and/or its competitors have a prime purpose which is specifically environmental. However with regard to identification of need, environmental aspects are very often a factor and here we are most commonly concerned with the impact of not proceeding with a project, rather than vice-versa. Again, when it comes to selection of a preferred scheme from alternatives environmental impact is often a most important consideration.

Thames Water recently accepted in principle a project to relieve the seriously overloaded 100 year old brick trunk foul sewer which serves as the main outfall to one of our ancient university cities. As well as the prime purpose of the scheme, which relates to maintenance and improvement of 'essential' sewerage services including relief of foul flooding, there were a number of environmental factors in both the justification of the project and the selection of the preferred scheme from alternatives.

Surcharging of the existing sewer causes foul sewage to enter the surface water system and hence to enter a tributary of the Thames. As a consequence a public bathing place was closed in 1970 and has not since been reopened. Ground flooding occurs in residential areas, but also in important tourists areas in the city; this latter aspect is of considerable environmental significance.

A large section of the "heritage" area of the city has a combined or partly combined drainage system. Separation of drainage within the curtilage of colleges and other institutions and the laying of surface water sewers within busy city streets are highly undesirable options environmentally, as well as being costly and impracticable. The existing trunk sewer crosses an area which has already some years ago established its fame as an environmentally sensitive area as a result of certain highway proposals! We propose to drive a new trunk sewer in deep tunnel within the clay underlying the city; this, as well as being economical and speedy, is environmentally preferable to any form of shallow surface construction, and provides adequate capacity such that the surface water component of the combined flows from the heritage area will be acceptable.

It is doubtful whether a project such as this, valued at around £2 million, would fall within the criteria suggested for identifying large-scale and complex projects requiring full analysis. However environmental aspects were important both in relation to justification and to selection of the preferred scheme, and following consideration along with other aspects at the appraisal stage, played an important part in the ultimate decisions regarding the project.

There is however undoubtedly a need to move forward from relatively subjective methods of assessing benefits both in

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prime purpose and environmental spheres: having regard to variations in public perception this is an aspect of methodology which needs to be looked at carefully. Only when we can begin to define benefits more precisely can the cost implications of environmental factors be meaningfully appraised.

THE FUTURE - THE INCREASING IMPORTANCE OF ENVIRONMENTAL ISSUES.

Impact Analysis and Public Consultation

There may not be the same intense demand for public participation in Britain as in the United States, where the advent of the 'citizen activist' is little short of a nightmare to the public authority manager who is required to achieve and maintain acceptable levels of service for the public as a whole.

One is aware, even in Great Britain, of the influence of vociferous environmental opposition to reservoir schemes having had serious consequences as regards the levels of service it was possible to maintain during the 1976 drought. The impression gained from a recent Anglo-American seminar on the water service is that in the face of a demand for public consultation such as prevails in the United States, we in the Thames basin would be hard pressed to maintain the high standards of service in the water supply field to which our consumers have become accustomed.

Perhaps the key point in respect of both public consultation and E.I.A. is that the input and the analysis must take place at a sufficiently early stage to allow adequate consideration of the issues, and a proper opportunity for the results to be fed into the planning stage of the project without disrupting schedules or incurring unnecessary cost penalties. Projects are required to achieve objectives which are time dependent; untoward delay means failure in some measure to meet those objectives.

The aim of public consultation and any associated E.I.A. must in the end be to secure a satisfactory outcome for the community at large. The opportunity is presented for input from all interests and disciplines. Whilst it is a matter of judgement as to whether the citizen activist generally assists in the achievement of this aim, there is undoubtedly a need to ensure that his efforts do not work out to the overall disbenefit of the majority. A properly conducted E.I.A. may be an aid to the achievement of a publicly acceptable and equitable solution, which will include, where appropriate, adequate compensation for minority interests.

The Responsibility For and Role Of E.I.A.

I have indicated earlier that environmental considerations already form an integral part of the project appraisal process in the water industry. To this extent, it might be considered reasonable that the promoting authority should carry out a study of environmental implications. However, it by no means follows that only one analysis should be carried out in respect of each project; other interested parties may wish to carry out their own studies and the information necessary for them to do so must accordingly be made available.

The way to harmony in this sort of field is not via the institutionalisation of consultation procedures to such an extent

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that the public become suspicious of the techniques utilised, and our last state becomes consequently worse than our first. With regard to a major project it might be considered eminently sensible for all genuinely interested parties to demonstrate the strength of their case by themselves producing analyses incorporating their appreciation of the environmental implications. This approach certainly has the advantage of bringing to the fore genuine and strongly held viewpoints only. It makes available to pressure groups an analytical tool with which to press their case on a comparable basis with the public authority. If both speak the same language the outcome is less likely to be conflict.

What then do we aim to achieve by E.I.A.? It must first of all identify the issues which are of concern to the public and the consumer, having regard to both perception and actuality. It must establish the relative significance of these issues and orientate the solution away from the environmentally harmful. Ideally it should identify the cost of implementation of its recommendations, and finally it must demonstrate a real concern on the part of the promoting authority for quality of life as well as for the provision of primary essential services.

CONCLUSION - HARMONY OR CONFLICT?

Harmony or Conflict?

My objective has not been to come up with firm conclusions, but rather to persuade my readers into an enquiring frame of mind and to inspire consideration of the issues for the benefit of all concerned, including those who do not have a direct managerial role in the water industry.

We may end up with harmony or conflict in a number of ways in the use of techniques of environmental impact analysis, and by way of a summary of the issues arising I propose to conclude by mentioning some of these areas for consideration in relation to the other papers, and in order hopefully to stimulate contributions to the discussion.

Firstly is there a risk that the application of E.I.A. could lead to a suppression of engineering imagination and initiative leading to orthodox and inelegant solutions to problems? Hopefully not and we shall instead, utilizing E.I.A., succeed in eliminating environmental mistakes arising from the implementation of significant new concepts in engineering design.

Secondly do we consider that the time required to carry out an E.I.A. and the associated public consultation, together with any consequential delays arising, could result in a risk to the achievement of managerial objectives, or can we devise procedures which will avoid undue delay in the implementation of development projects?

Will E.I.A. increase public confidence in the decision making processes of Government, public authorities and private industry, or will it arouse suspicion as an unduly intellectual and theoretical approach far removed from the problems of the very people whose quality of life it is designed to safeguard?

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Can we avoid the disadvantages of institutionalisation inherent in the E.I.A. approach by encouraging its proper utilization by external pressure groups?

Lastly can E.I.A. respond to the requirement to take account of public perception of environmental issues, as well as providing a sensibly objective method of quantifying actuality? Can it be developed as a mechanism which is respected by political and social groups, whilst at the same time serving to broaden their appreciation of the issues involved,

CONCLUSION

Ultimately it is the task of the manager to get on with the job and achieve the various objectives set for him by society through statute "or by his peers". This can seldom be done without the need to resolve some potential conflicts of priorities and interests.

In the end it must rest with the manager to ensure as best he can that his objectives are met; any tendency for public participators and specialist advisors to confuse their roles with the decision maker must always be identified.

Whilst we must always be prepared to listen to the waves of public feeling on environmental issues, nevertheless the answers are unlikely to come from that direction. It is for the manager to exercise judgement and foresight with a view to arriving at a solution which preserves harmony in the long term and on as broad a front as possible; there are times unfortunately when conflict inevitably arises in the short term and on a narrow front. This must not however deter our best efforts to achieve objectives, for in the end the buck stops with the manager and not with the citizen activist.

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DISCUSSION

Author's Introduction

MR. E. C. REED, in introducing his paper, said that he would not be alone in mentioning Environmental Impact Analysis at the conference, and he was conscious that there were people who had made the environment a central priority in their lives. We owed something to opinion formers in this field, who had from time to time turned managers down new tracks - and he hoped that as enlightened consultation procedures and new methodologies developed the overall result would be more harmony and less conflict.

But his job, in preparing the paper, had been to present a managerial view - a doer's view - and he assured the audience that he would stick to this in the sure knowledge that others would be unlikely to be slow in coming forward with other opinions. The manager responsible for the implementation of installations these days must give consideration firstly to people, and the effect that the achievement of his objectives would have on them. He must have regard for, among other things: health; safety; security; economy in construction and operation; reliability; energy conservation; and of course the environment. They all had an impact on people. Where did the manager's priorities lay, and if any one of these aspects was to be qualified - which?

His paper was to consider the public perception of environmental issues. He thought that perhaps his subject could be summarized by an equation devised by Paul Erlich who expressed the environmental impact of humanity as being "the product of population, affluence and technology". He himself hoped to emphasize how much these varied with time.

People needed water - and produced sewage - this was the bread and butter (not necessarily in that order!) of the water business. Affluence led to increased water demands and more sewage disposal. Technology added to our problems. Increasing pollution was a major concern: on the other hand, technological advances, if allowed to proceed, could improve the environment and soften the impact of our operations.

As people increased their dependence on domestic appliances in the home, demands rose. Consider waste disposal units; they not only increased the quantity, but also the strength, of sewage. Sewage, its treatment and disposal, were significant environmental talking points. However, the disposal unit reduced the demand for domestic waste rubbish tips - another environmental factor. These were alternatives to analyze.

The net result of increasing affluence was a requirement for additional capacity of one kind or another. What he had called in the paper the "incidental impact" of this requirement was a source of potential conflict between environmental interests. The balance between harmony and conflict rested on our success in meeting public needs without transgressing that standard, which the majority of the population perceived to be of value to their quality of life and, indeed, as far as possible achieving an environmentally acceptable solution.

He highlighted some of the points made in the paper by the use of illustrations. About 1850 in the House of Lords, the Earl of Hardwicke said the Thames had been "made the main sewer for the whole of London and had been converted into a most abominable ditch". Sheets soaked in

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disinfectant were hung up over the windows of the Houses of Parliament to offset the smell. It was Sir Joseph Bazalgette who, in the 19th Century, as engineer to the Metropolitan Board of Works, laid the foundation of what was now, in the 20th Century, an environmental success story. London's sewage was taken eastwards in a system of intercepting sewers, and since the early 1960s these sewers, in conjunction with massive investment in sewage treatment facilities in London, had led to a startling improvement in the quality of life in the river (as evidenced by the return of fish), a substantial rise in the oxygen sag curve, and a drop in the sulphide content. Contrary to the situation in 1957, when parts of the tidal river were dead, it could be claimed now that the Thames was the cleanest metropolitan estuary in the world. It was very doubtful if Sir Joseph's achievements could be managed now with such speed, efficiency, and lack of public controversy - the variation with time factor.

The non-tidal Thames, despite receiving 220 mgd of treated sewage effluent, was clean throughout its length with a standard for dissolved oxygen of 60 per cent. The river probably supported more angling and pleasure navigation than any other river of comparable size in the world, as well as providing a water supply for up to seven million people.

It was the job of the water industry to provide these services and to account for the direct and indirect environmental impact of our activities. One of his greatest concerns as a manager was that a result of the application of EIA and escalating public consultation in depth could be the suppression of engineering initiative and enterprise, which had a proven record of environmental success. We must, however, acknowledge the potential input of interested parties on all aspects of our work. He declared that his plea was that these inputs were put forward honestly, and resolved at a sufficiently early stage to allow the engineer and manager to proceed unfettered through the detailed preparation and construction of projects deemed necessary to meet objectives.

There were many things that could and had been done in the water industry to alleviate adverse impact of our activities, and indeed to ensure a positive contribution to the environment.

We were proud of our buildings, old and new. Abbey Mills sewage pumping station, in East London, constructed in 1869 as part of the interceptor sewer system already mentioned, was a good example. Datchet raw water pumping station was completed in 1970 and had been designed to lift up to 500 mgd of water from the Thames into storage reservoirs for continual supply to Londoners. It was now said by some villagers to have "put Datchet on the map" - Environmental Impact!

At Kew we provided assistance towards the public enjoyment of some of the water industry's monuments of industrial archaeology. Beam engines which had pumped water into the taps of millions of people for up to 70 years were still working, thanks to the keen activity of the Kew Bridge Engines Trust.

Many of our installations had become oases of green and open space in urban areas, where such features were of particular value. For example, two massive concrete service reservoirs, buried in clearings on the edge of Epping Forest, had been landscaped to preserve and indeed enhance the value of the area as an amenity. At a large sewage treatment

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works in Middlesex we had established an arboretum within the works. Open storage reservoirs built in the period when reservoirs were publicly acceptable, were recognized now as important units in the structure of the Lea Valley Regional Park. Were it not for them the whole of the area might look like an industrial scrap yard as opposed to the scenic waterscape which was observed by turning through 180 degrees.

He had referred in the paper to the problems of disturbance in urban streets caused by the replacement of large mains and sewers. In practice, by tunnelling several miles across urban areas without surface disturbance in order to distribute water to consumers in an economic and environmentally acceptable manner, we had protected the environment!

In order to return to the role of the manager in achieving objectives and in particular his duties to take a broad view, he referred his audience to the example in the paper of the work of Sir Hugh Myddelton, who met intensive opposition to his scheme for constructing the river to serve London in the early 1600s. This river was 40 miles long and a private army had had to be formed to protect the workers. Today the river was recognized as a work of environmental beauty. To consider abandoning now, it would raise a public outcry!

Who would say now that Sir Hugh was wrong to proceed? He had brought water to millions of people over the years and had provided an amenity which was now of great value in itself as anyone who walked its banks could see.

Sir Hugh knew something of the "citizen activist", a term coined in America. Quite recently we had seen examples in this country as illustrated on the slide (not reproduced) of a demonstration against a motorway project at Bromley, Kent. Others, meanwhile, were demonstrating elsewhere in favour of the same project!

Who was to say that those who so strenuously objected to construction projects would see the situation in the same way in years to come? For that matter those who approved a scheme might ultimately be proved wrong: tower blocks were an **opposite** example. History demonstrated that opinions changed, particularly with **reservoirs**. He believed that there were powerful arguments for further **reservoirs** in the Thames region which, aside from instant benefits, could enable us in the long term to restore Central London and other areas to artesian conditions whereby, for example, Stow in the late 16th Century was able to describe "the fair wells and fresh springs in every street and land of London".

Finally, he said he was looking forward with hope and expectancy to the techniques of Environmental Impact Analysis, provided that they were available to all parties, be they promoters, planning authorities, or citizen activities, as a means by which the issues, both positive and negative, might be properly identified and quantified. Each should be required to produce his own, and as with Mr. Oldfield's study, costs could lay where they fell. If such analysis had merit it would reveal viewpoints which were really in the best interests of the mass of the population and highlight limited and narrow views. Then and only then the conflicts would dissipate and harmony would flourish.

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Verbal Discussion

DR. J. G. COLLINGWOOD (Royal Commission on Environmental Pollution) said that the Symposium was evidence of the water authority's care to exercise rightly their responsibility for the environment, on which they had such a powerful and wide-ranging effect. Affluent and peaceful populations showed intense interest in the quality of life. Whilst this had meant different things to different people, some aspects of it were common to most people. The need for beauty or amenity, the need for new experience, including the improvement of what already existed, and freedom from fear. Freedom from fear had unfortunately been responsible for resistance to change, which had often been necessary to achieve beauty, amenity, and improvement. Conflict had therefore been inevitable unless full disclosure of all plans had been made. Full communication with all people was an impossibility, so harmony could only be achieved if all parties concerned were convinced that only the best of all possible methods had been chosen when engineering work or changes in methods of operating were undertaken.

The first point to be underlined in the author's paper was that formal Environmental Impact Analysis could never replace a management hierarchy until the assessment of needs was delegated to a local level, at which needs could be assessed and satisfied. Indeed, confidence would usually be given to teams who produced healthy amenities, provided always that they did not fail in the basic needs of output with safety. His implication was that every undertaking of significance should be subject to an internal EIA. Most of these would be too small for public debate but should be available for public disclosure either spontaneously or on demand. Experience with the Royal Commission confirmed the belief that most people were reasonable and responded well to having information available about public works of all sorts.

The second point to be underlined was that the best solutions were not always easy to see, and so the freedom to search by experiment must not be hampered. Unfortunately, this could be stifled when every idea was subject to public scrutiny before being tried out, which made doubly important the confidence which could be inspired by making it known that internal EIAs had been properly prepared and acted upon. The author had emphasized that EIAs should be presented in a simplified form and quantified where possible for two reasons:-

- (a) they would engender suspicion if they could not be understood;
- (b) they must be capable of comparison.

Finally, EIAs should not be used for enforcement purposes, and should furthermore only be used for purposes of comparison. There were already many excellent methods to protect the public from unwanted hazard, many of which were outlined in the paper, and the use of EIAs for control purposes would be both too cumbersome and too easily manipulated. One should never say "had such and such a project passed the EIA test", but rather "did EIAs show the project to be the best of the possible solutions to a problem".

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MR. J. A. YOUNG (Wessex Water Authority) thought that it was fair to say that much of the conservation interest had been aroused by the media who tended to sensationalize issues in black and white terms, when, as usual, they were better expressed in infinite shades of grey. There was a tendency to import environmental issues from the USA where terrible crimes, like the fate of the Colorado river, had caused - in many cases, over-reaction. Imparted hysteria could often be counter-productive, preventing real progress in standards from being made.

In the South West, where systematic opposition to decades of reservoir proposals had led to two serious shortages of water in two years, it was doubtful if the "silent majority" preferred "conservation" to "water". He asked how did you canvas the views of the majority instead of just the articulate few if you informed just a few of what that view might be?

In Wessex, they were involved in a controversy over the disposal of sewage on the south coasts. All solutions were very expensive - the pros and cons of choice between sea disposal and treated discharges to rivers with inadequate dilutions were complex technically and economically. How could the public be properly consulted on such issues? After extensive consultations with local bodies and open days at works in the area where the issues were demonstrated, they had issued press advertisements asking for comment. From a catchment population of 380,000, 61 individual replies were received and 8 from bodies wishing to be consulted further. This seemed a limited response. It was interesting that the majority of the publicity opposition had been to sea disposal, and although these replies were in no sense a "Gallup Poll" the replies indicated a majority of 5:1 in favour of sea disposal.

How far could one go with consultation and what could be achieved? One thing was certain, in the case of sewage disposal the proposals, whichever way the final scheme went, would satisfy one set of objectors and enrage another.

His views, like those of others, had changed over the years to give more weight to conservation issues, but the delays and costs were very significant.

Already schemes to satisfy these issues for which he had been responsible had increased in real costs by at least 25 per cent and he felt that there was a real danger of pricing schemes needed to maintain and improve basic services, out of reach.

The NEDC Report "Design and Export" stated "... the main preparation period (for road contracts) has increased in the last decade by a factor of 3 and the trend is increasing ... the main preparation period ... to completion now takes 10 - 15 or more years. A long period of preparation increases planning blight and means that activities undertaken in the early years are to a great extent based on information which could be out of date by the time construction begins. This reduces the chance that the right priorities are given to schemes."

This was written about road schemes but applied equally to water schemes, clean or dirty, and it had ensured that, in sensitive areas, resources never caught up with consumption and the supply was always at risk. With prices doubling in four years, its effect on costs could be imagined in the eyes of the public and politicians, if not in the eyes

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of economists.

Most people, if asked about the building of a new reservoir, would say - "But I'm not using any more water. I don't understand why we need these extra reservoirs", forgetting that their son just bought a new car that he cleaned every week and that the wife had just changed her twin-tub washing machine for an automatic one, which used five times as much water as previously. This relationship between higher living standards and new resources needed to be much better established.

He himself had no glib solutions but, felt that there was a need to demonstrate the cause and effect relationship of higher living standards, promoting tourism, etc., on demand for water services, and hoped that the public would realise that if they were honest to enjoy the one, they must accept the other. It should also be remembered that the environmental affront of today would in a century be a jealously guarded relic of the descendents of the original protestors, as the canals were today!

MR. J.S.M. WILLIS (Severn-Trent Water Authority) felt that the words "public perception of environmental issues" was the nub, because in environmental questions the perception was the problem. It had little to do with facts, and efforts to quantify environmental factors had failed to change this. Conflict arose when water managers, using their logical and numerate approach to schemes, met opposition which was subjective and largely emotional. It was almost like facing people from a different culture speaking a strange tongue.

Why had this arisen? Why were public enquiries disrupted by demonstrators - so much so that genuine objectors could not obtain a hearing? He referred to Lord Sandford's rather dismissive allusion to these demonstrators, as "people who should know better". He himself felt that rather than dismissing the problem, we should ask why did otherwise reasonable people behave in this way. It seemed to be owing to frustration at their apparent inability to communicate with, let alone influence, remote and impersonal authority. It was highly significant that, in the same week as the Symposium, the Secretary of State for the Environment had announced that he did not feel that his Department was the right body to plan new roads in the urban area of London, and he was asking the Greater London Council to accept this responsibility. After the recent disruption of public enquiries into these roads, this was surely an admission that centralized co-ordination and planning, however desirable on technical grounds, could lead to such a feeling of remoteness that it produced an opposition of frustrated fury. Perhaps this lesson would not be lost upon those who proposed further centralization in the water industry.

To speak of improving the methodology of the analysis in environmental effects against this background was likely to be counter-productive. The water industry already made excellent cases for its projects in technical terms; it must learn to make a more positive promotion in terms that non-technical people would appreciate, even if this meant a more subjective and emotional approach.

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BRIGADIER C.C. PARKMAN (Ward, Ashcroft and Parkman) felt that the aim must be Harmony, but in his opinion engineering proposals would not escape some conflict from some minority groups - every man-in-the-street's idea was so different on what was good or bad environment.

In general, however, he endorsed the author's comments as a fellow engineer and felt that the originator of the proposal, having dealt sympathetically with all the various environmental points, was the man who should make the decision. Practically, however, in this era of minority groups, and the general lack of a sense of discipline in taking truly democratic decisions, the final decision must be made from outside either of the interested parties. However carefully the manager considered the various factors it would be difficult for the minority opposition groups to accept his decision as completely impartial. He was also of the opinion that one EIA should be sufficient, provided that it produced and considered the various factors and could not be construed as an advocacy for any one line of thinking. If EIA were an exact numerical science it could be done by both parties and compared and checked, but in the world of the subjective the only defence was of complete impartiality. Who, however, was going to take the inevitable decision that must eventually be made? As was the case with Public Inquiries this must rest with the Minister, i.e. with the politician who had a definite function of representing the interests of the community at large. How well they did this must depend to a large extent on the analysis they were given by the EIA and the degree to which they felt that it was an impartial analysis.

In order, however, to give the impression that justice had been done, considerable delays in coming to decisions on major projects were now accepted because of minority groups. This was typical of minority views today and surely must be wrong, because somehow, somewhere, somebody, sometime, had to make a decision on the facts as presented, so that the time factor in coming to a decision must be limited.

Author's Reply to the Discussion

MR. E.C. REED, in replying to the discussion, said that firstly he considered the establishment of the ten Regional Water Authorities to have been one of the finest ever technically orientated achievements of Parliament. It was perhaps worth noting that if the minority were always right, as some in the environmental field appeared to be saying, then there would not be any Regional Water Authorities, to the detriment of the community as a whole.

He agreed with Dr. Collingwood that it was essential that public confidence in engineering and management decision-making be maintained. Thus, environmental impact must be evaluated alongside other aspects of all schemes of significance, and this, he contended, was normal practice in the water industry. So far as public disclosure was concerned, the industry had little to fear, but with certain notable exceptions the level of public interest tended to be low as witnessed by Mr. Young. Environmental factors often formed a component of need for projects in the industry, but probably it was true that their greatest relevance was to the selection of the best engineering solutions.

Perhaps the important point about the public consultation carried out by the Wessex Water Authority, and described by Mr. Young, was that the public were offered the opportunity to participate on an important

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point of principle regarding the engineering solution of a problem. However, delays arising from protracted public consultation procedures, or from intervention by minority groups at an unduly late stage in the preparation of a project, were a matter for concern, and could play havoc with priorities and the maintenance of satisfactory levels of service.

Both Mr. Willis and Dr. Collingwood had referred to the need for environmental assessment at the local level and the dangers of the image of remoteness liable to be created by large authorities. The answer he had put forward was to invite local environmental lobbies themselves to express their views in the form of an analysis of their own. This should serve the dual purpose of allaying public suspicion of allegedly sophisticated techniques, as well as providing a vehicle for local views to be heard and local experience to be taken into account.

It had been his intention to focus thoughts on public perception of environmental issues, and he considered it appropriate that all the contributors had referred in some degree to this matter. He agreed with Mr. Willis that this was indeed the nub of the issue. He reminded the Symposium of his definition of environmental impact as being about the total effect of man's activities on human life as perceived by individuals. Brigadier Parkman had pointed out that every man-in-the-street's idea was so different on what was good or bad environment. To this he added that even the views of individuals varied with time, hence on two counts they could not be regarded as infallible. The manager who allowed himself to be blown off course by a local squall might one day be seen, with the benefit of hindsight and a broader view, to have failed in his duty to the community as a whole.

2. ENVIRONMENTAL IMPACT ANALYSIS - SETTING THE SCENE

C. G. Thirlwall, C.B.E., M.Eng., M.I.C.E., M.I. Struct.E.*

INTRODUCTION

Environmental Impact Analysis (E.I.A.) or environmental impact assessment is a term which has come to be applied to a system or process for determining, evaluating and reporting on the environmental effects which could be expected to result from carrying out a proposal. The word proposal is used because E.I.A. has been applied not only for specific developments involving civil engineering and building works, and plant installations and processes but also for policies, plans and programmes which, if adopted, could have significant environmental effects whether or not they lead in due course to specific developments. Examples of such policies might include a decision about the employment of the Fast Breeder Reactor as a principal means for the generation of electricity or a decision to provide large scale subsidies for freight transport by rail.

A definition of environmental impact analysis also involves a determination of what one means by environment. A dictionary definition is "surrounding, surrounding objects, region or circumstances" which could be interpreted in various ways. For E.I.A. it could be considered narrowly as being concerned with the natural physical environment and the environmental impacts to be considered would then be changes in landscape and the enjoyment to be derived from it together with changes in flora and fauna which contribute to the physical environment. A wider interpretation relating to the human environment is the whole picture of the surroundings and conditions in which people live and work including changes which might hazard life and property or might affect health, comfort and convenience and economic and social conditions. Whether a narrower or a wider interpretation is used it is clear that there may be many and diverse environmental changes resulting from some proposals, that some of these changes might be beneficial and others adverse and that they might affect different people or communities in different ways and to different extents.

Concern for the environment has a long history in this country. It has been an influence on more enlightened designers who have sought both to make their constructions aesthetically pleasing and to avoid or mitigate the harmful effects of development. It has influenced reformers and led to laws for the regulation of housing, pollution and town and country planning, and we now have a Department of the Environment and local authorities and other statutory bodies with important and wide-ranging functions for the protection and improvement of the environment. Under the system of development control instituted by the Town & Country Planning statutes the effect of a proposed development upon the environment is a material factor in the determination of applications for planning consent. For those public sector developments which are exempt from the normal process of development control it is usual to find provision for consultation with the local planning authority and often a statutory requirement to have regard to the environment in carrying out such developments.

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Thus for proposed developments, although not for proposed policies, there is a well-established obligation in this country to make some appraisal of the environmental consequences of a proposal. It is broadly left to the discretion of the local planning authority and/or the developer to determine how extensive and thorough such an appraisal should be although their discretion may sometimes be qualified because of pressures arising before or during a public inquiry and sometimes through the intervention of a Government Minister. In a few public sector areas (trunk road schemes are a good example) a more formalised method and techniques for environmental appraisal have been adopted and there have been individual cases where it has been recognised that the potential environmental consequences are so diverse and substantial that environmental studies have been commissioned.

ENVIRONMENTAL IMPACT ANALYSIS IN AMERICA

Environmental Impact Analysis as defined above originated in the United States of America where, in 1969, Congress passed the National Environmental Policy Act. The objective as stated was "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich understanding of the ecological systems and natural resources important to the nation and to establish a Council on Environmental Quality". It was a requirement of the Act that all Federal agencies should include as part of future reports or recommendations on actions significantly affecting the quality of the human environment an environmental impact statement covering:-

- (i) the environmental impact of the proposed action;
- (ii) any adverse effects which cannot be avoided should the proposal be implemented;
- (iii) alternatives to the proposed action;
- (iv) the relationship between local short term uses of man's environment and the maintenance of long term productivity;
- (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

It will be seen that the Act is so worded that it required impact statements in respect of actions "in the pipeline" and also that it calls for impact statements not only in respect of projects proposed to be carried out by or on behalf of a Federal agency but also for activities such as regulations, grant allocations and policies and programmes not involving capital expenditure incurred directly by the agency.

There were initial setbacks to the concept as stated in the Act. These were caused partly through lack of knowledge and experience in the application of techniques for impact appraisal and evaluation and partly by the urgent need to prepare a large number of environmental impact statements for projects in an advanced state of preparation. In consequence statements were in some cases superficial and more concerned to avoid actions in the Courts for due performance than to explain the environmental impacts. A capacity for healthy constructive criticism combined with the preparation and periodic revision of guidelines by the Council on Environmental Quality has led to a great improvement in environmental impact statements and there has been a

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considerable advance in techniques through the work carried out by research institutes and universities.

The principal features of the system as developed in the United States are first that it applies only to actions "significantly affecting the quality of the human environment" and so far as the National Environmental Policy Act is concerned, it is necessarily restricted to Federal agencies. Although, clearly, statements were intended to be prepared for a relatively limited number of actions there is an obvious imprecision due to possible variations in the interpretation of the word significance. The responsibility for making the decision on whether to have an environmental impact analysis is left with the agency but they do consult the Council on Environmental Quality and other bodies and there is an ever present risk that a decision not to have an E.I.A. may be challenged in the Courts with consequent delay. The application of the system has since been extended to other public sector developments and to the private sector through legislation by individual States.

Secondly, it is a requirement that alternatives to the proposed action should be considered; this is beneficial in that it forces systematic attention to the possibility that there may be realistic alternatives which could have environmental advantages. Thirdly, the requirement that an environmental impact statement should be prepared encourages a logical and comprehensive approach to impact analysis employing a wide range of professional disciplines working together and recognising the interactions which take place between one environmental effect and another.

Lastly, the process is carried out openly with opportunities for other bodies and for the general public to give their views. The procedure involves the preparation of a draft impact statement which must be available for public comment and also submitted for comment to any other Federal or local agency having responsibility or knowledge of any relevant environmental effects. The draft statement must be available for 90 days and the final statement for 30 days before initiating any action, although the two periods can run concurrently. The final statement is a public document and is submitted to the President and to the Council on Environmental Quality. Final statements which the author has studied have all incorporated the whole of the comments received on the draft and the further comments or decisions of the initiating agency.

RESEARCH REPORT NO. 11 - A PROPOSED SYSTEM OF E.I.A. FOR THE UNITED KINGDOM

In 1974 Mr. John Catlow and the author were appointed by the Secretary of State for the Environment and the Secretaries of State for Scotland and Wales to make a study of E.I.A. and their report was published in March 1977 as Research Report No. 11. The terms of reference for the study were:-

- (a) to survey the techniques now being used or developed to measure the environmental impact of large-scale projects;
- (b) to consider the circumstances in which development proposals would give rise to the need for environmental impact analysis;
- (c) to consider the ground to be covered in such an analysis and whether any standardised method of presenting the required information is appropriate;

- (d) who should prepare and pay for the analysis;
- (e) to make recommendations as to further research, codification or technical presentation as thought appropriate.

It seems likely that this was considered an appropriate time for such a study for a number of reasons. There had been in recent years a growth of interest in and concern for the environment embracing many shades of opinion. People increasingly question whether the major advances in technology and consequent increase in the rate of consumption of finite basic resources are of real benefit to humanity in the long run and also whether they may be providing an improved material standard of living at the expense of an erosion of the things we value in the urban and rural environment. Others are concerned that with some developments and for some manufacturing or extractive processes man is operating too close to the limits of human knowledge to be fully aware of the long term consequences of what is being done or of the potential hazards. Yet others consider that man has a duty to the whole of nature, not only to protect endangered species and conserve that which is of particular environmental benefit of man, but the whole order and balance of nature. They feel that this duty is being overlooked through greed for economic advancement.

Along with what might be called the environmental movement there are the pressures exerted by those who are dissatisfied with the way in which representative government is working. They distrust the decisions and motives of those elected to make decisions about development; they want more say in the making of such decisions, more and better information about a proposal and its consequences. In particular they seek a much greater voice for those who appear to suffer most of the environmental disadvantages of proposals for which the benefits accrue to much larger and more remote populations. The combination of the various pressure groups has resulted in active questioning of proposed developments, demands for public inquiries, where pressure can be exerted to obtain the information which they believe has been denied to them, and occasionally the active disruption of inquiries.

If such pressures made it desirable to have a look at the way in which account is taken of the environmental consequences of proposals the time was also ripe because developments of an unusual nature had arisen in the United Kingdom. This had occurred partly because of increases in scale and complexity over what had been experienced before such as larger power stations, larger scale quarrying and mining operations, larger and also more unusual water supply and water regulation schemes; partly it occurred because of new types of development such as those associated with North Sea Oil and the development of atomic power. Some of these developments were also unusual because of their intended location in predominantly rural areas where they would bring problems for existing communities and place exceptional demands upon the services on which the communities depended.

It was perhaps also the time to take account of the work being done in other countries for the protection of the environment, and the assessment of the effects of development. Apart from information becoming available about the American E.T.A. system, including some pressure from the Institution of Civil Engineers to consider the adoption of such a system here, other countries had also adopted or were considering the adoption of more comprehensive methods of impact assessment and pollution control. There was also recognition that environmental protection might require international action; the World Health Authority and the E.E.C. were becoming involved and there had

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been international conferences in Strasbourg and Stockholm.

A great deal of information and comment was made available during the course of the recent study. As Research Report No. 11 shows, there was access to a large number of environmental impact statements prepared for a wide range of developments and proposals and to many technical papers and proceedings of conferences and seminars held in the United States; in this country there was also a considerable amount of written material relevant to the study including a number of recent environmental studies and the reports of public inquiries. Informal evidence and submissions were invited from organisations and associations in this country and helpful discussions were initiated with developers, manufacturers' associations, statutory undertakers, local authorities, engineers, architects and town planners and with scientists working in government departments, research institutes and in the universities. An interim report was prepared in July 1975 and preliminary conclusions were put forward for discussion at a PATRAC seminar at the University of Kent. The final report was submitted in March 1976 and printed as Research Report No. 11.

The study raised a number of questions and factors which would have to be taken into account in formulating any proposals. First, although strictly outside the terms of reference, was the question of whether there was a need for environmental impact analysis in this country. We have a very different system of town planning from that which prevails in other countries including the control of virtually all development and also a more precise system of land use planning. We also have a number of statutes for the control of pollution and authorities and agencies to administer them including the Health & Safety Executive and Water Authorities and also the environmental health functions vested in local authorities. Is the present practice in control of development sufficiently effective to make it unnecessary to introduce environmental impact analysis either on the American model or in some other way more suited to our needs and capable of being incorporated in the planning control system? If there are difficulties in control at present do they arise mainly from the multiplicity of authorities and perhaps a failure on the part of one authority to inform and take advice from others?

Secondly, if there is to be E.I.A., there is the question of determining to what sort of developments it should apply out of the 650,000 developments which each year are the subject of planning applications. If it should be applied only to those developments which significantly affect the environment how can a more effective definition be suggested and if discretion is to be allowed in selection of projects for analysis who should make the choice?

Thirdly, there is the purpose of environmental impact analysis to be considered. Should it, in the tradition of development control, be employed as a test of a proposal so that the report either informs the decision of the authority responsible for the planning decision or is in effect the planning decision only requiring confirmation by the appropriate local authority or government minister? Alternatively, should impact analysis be considered not as a test but as a design tool forming part of the feasibility investigation and influencing the developer and his designers on the choice of location and the preparation of detailed design and plans for structures and processes as well as providing an information document to be taken into account by the authority responsible for the planning decision? Considerations of timing and the most advantageous use of manpower are also linked with consideration of the intended purpose of E.I.A. If the analysis is to contribute to the project design process and also if it is to provide effective scope for the consideration of alternatives must it not be commenced early in project

preparation even if this means accepting that the E.I.A. has to be carried out in stages as project design work progresses? Early commencement would be likely to make the most economic use of manpower, to reduce or avoid abortive work and to reduce the lead time required for the project. It would, however, require closer co-operation between developer and planning authority and a risk of commitment of local authority resources on some projects which might not reach the planning application stage. Conversely to regard the E.I.A. only as a test of a proposal when it had been prepared in sufficient detail for a planning submission would be likely to lead to duplication of work and lengthen the time for its consideration.

Fourthly, there is the consideration of the way in which limitations in techniques may influence any proposals for E.I.A. Although a great deal of work has been done in recent years progress has been uneven, partly because of the impossibility of applying numerical analysis to some impacts and also because work on techniques has proceeded for the satisfaction of needs other than environmental impact analysis. The inability to make a numerical analysis for many of the environmental impacts, still less to arrive at an acceptable monetary evaluation means that qualitative analysis must be accepted and that great care must be exercised in evaluating the impacts which arise. It is easy to fall into the trap of allocating numerical values or proxy values which convey a misleading impression of accuracy but which in fact only represent a subjective view of an order of rank.

Fifthly, there is the question of provision for public consultation and participation. Consultation can relate to one or a series of decisions and effective consultation implies providing the public with all the necessary information for each decision and affording reasonable time for comment or representation before the decision is made. For E.I.A. consultation could apply consecutively to:-

- (i) the decision to have an E.I.A. in any particular case;
- (ii) the environmental issues to be investigated;
- (iii) the alternatives to be examined;
- (iv) the decision to permit the development to proceed.

Participation could involve active engagement by the public in the environmental studies and a direct contribution to any or all of the decisions to be made possibly by referendum or sample survey. Several considerations need to be taken into account including the importance to be attributed to upholding the right and duty of elected representatives to make such decisions in what they believe to be the best public interest. Account must also be taken of the widespread belief that the public are either insufficiently informed or informed too late; that they often have to resort to protest or to energetic demands at public inquiries to force disclosure of information; the belief that the public should have knowledge of all the material on which their representatives will have to rely in coming to a decision. It is desirable to recognise that there are likely to be individuals within the community who may have special knowledge either about existing environmental conditions or about elements of the environment which are likely to be at risk if a proposed development does take place or if any particular alternative is to be considered. The case for a watchdog role for the public is probably strengthened to the extent that E.I.A. calls for closer co-operation between developer and planning authority. From the developer's point of view

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early disclosure of information to the general public may sometimes be regarded as undesirable either because it leads to the formation of powerful pressure groups before a full case can be put forward, or because it discloses intentions or details of manufacturing processes, general knowledge of which may, in the opinion of the developer, put him at a commercial or technical disadvantage with his competitors.

Finally there is the question of who should pay for the analysis. At the present time developer and planning authority each pay their own costs but some would argue that the developer should pay, on the grounds that it is part of the feasibility investigation. If the developer were to be required to pay the full costs could there be cases where the planning authority acted unreasonably either in calling for an E.I.A. at all or in requiring more intensive investigation of environmental effects than was justified or perhaps for the additional study of unrealistic alternatives? Conversely, if the cost were to fall on the local authority might there be cases where the developer would act unreasonably possibly in putting forward speculative developments which were unlikely to be carried out? Would different considerations apply for public sector development and what arrangements ought to be made in cases where the Secretary of State intervened either to require an E.I.A. or to require some additional alternative to be examined?

Research Report No. 11 - Considerations and Conclusions

The first and most important issue for consideration in the study was whether there was a case for introducing E.I.A. in the United Kingdom and, if so, under what circumstances should it apply. Although it was felt that the planning system produces broadly satisfactory decisions in the great majority of planning applications dealt with each year it was considered that its operation is not geared to providing the decision makers with all the information they need to make considered decisions on those development proposals which are likely to have large scale and complex impacts upon the environment. In such cases the impacts can be many and diverse; they are often direct but may also be indirect in that a development may cause changes in the physical environment which in turn will produce secondary impacts. The impacts may be short term or long term and they may affect different communities and geographic areas in different ways. It was considered that in these complex situations planning authorities often lack the material which they need both about the project itself and about the environmental effects to reach an informed decision. In the first place they will often have too little information about the existing environment, the land, the water and the atmosphere and the ways in which they are used at present and also about the conditions under which people live and work in the area. Such data as they have will be too limited and under the present system they will often have insufficient time or professional resources to remedy this situation and provide the environmental base from which there can be a consideration of environmental change, whether beneficial or adverse. Secondly, they will need to have detailed information about the project, what it is intended to achieve, what resources of all types it will require in initial construction and in operation. They will need technical advice on the useful outputs of the project and the waste materials including discharges to the atmosphere or into sewers and water courses. Information in sufficient detail is rarely supplied and although the planning authority could no doubt ask for it the pressures involved in dealing with a large volume of applications and the time constraints often preclude such a request. Thirdly, it is to be doubted whether planning authorities have the manpower resources including the specialists in the various sciences to make a thorough

and logical study of the many elements of the development which will have environmental effects and to trace these through so that they can identify and assess the environmental impacts and evaluate them. The study suggested that there might be some 25 to 50 projects each year which would justify E.I.A. and it seems clear that few authorities could retain permanent staff to meet a variable workload on such analysis work. Thus it would be likely that in carrying out E.I.A. authorities would need more time, would have to adopt a systematic approach and would need to call in specialists some of whom might come from other authorities (e.g. water authorities or environmental health authorities) or from research institutes and universities or from consultants.

The planning system is also inadequate in that it offers insufficient scope for the consideration of alternatives. The development control system is geared to the making of a decision in relation to a specific development in a specific area. The choice of site lies mainly with the developer who has to satisfy requirements on technical feasibility economic advantage and site availability. He will have committed considerable resources to the development of his proposal and will often be reluctant to consider alternatives even at the risk of a refusal of his application. It can perhaps be argued that it is not essential to have an E.I.A. for the consideration of alternatives and that effective consideration can result from informal inquiry by the developer and discussions during the course of project preparation. Circumstances, however, often preclude effective discussions sometimes because questions of confidentiality arise in the mind of the developer, sometimes because local authority officers are reluctant to be giving the appearance of committing their authority to a decision in advance of formal consideration by the authority and sometimes because pressure of work on staff make it impracticable to devote sufficient resources to an effective consideration of alternatives.

The conclusion from the Study was that there is a need for environmental impact analysis in the United Kingdom both for public and private sector projects. It was felt that its use must be selective being confined to a limited number of developments where there is a likelihood of large scale and complex environmental effects which would be difficult to comprehend and analyse except by a systematic process in which the necessary specialist skills were employed. It was considered that although the type of project and also its size might be material factors it was the conjunction of the particular proposal in a particular environmental setting which led to the need for E.I.A. The Report recommended that a list of types of project which might justify an analysis should be drawn up by the Secretary of State, and that in the private sector the decision in any particular case that there should be an E.I.A. should be the responsibility of the planning authority, or the Secretary of State intervening; in the public sector it was recommended that the decision should be that of the developer after consultation with the planning authority.

The second major issue was the general process of analysis to be recommended. It was considered that the American system had some serious defects and was not appropriate for adoption in this country. The study of environmental impact statements and other written material and the discussions with people with direct knowledge of its application in America showed that there were considerable disadvantages in having specific requirements as to content, whether by statute or regulation, on the lines of the requirements set out on the National Environmental Policy Act. Statutory requirements provide the grounds on which it is possible to take action in the Courts and, as has been found in America, such actions offer an

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opportunity to delay developments irrespective of their merits. Court actions also establish precedents which further restrict flexibility in employing E.I.A. As mentioned earlier, such actions can lead to greater concern with satisfying the requirements than with the quality of the analysis. By attending in detail to every requirement and every impact irrespective of its relevance to a decision in a particular case the environmental impact statements become too long for effective study and discussion; resources are wasted and the inclusion of badly prepared or irrelevant material detracts from the overall quality of the statement. It was concluded that there should be no specific requirements as to content for E.I.A. in this country and that there should be a conscious and informed decision taken in the early stages of an E.I.A. as to what were to be the relevant environmental impacts to be studied.

The third issue for the study was the desirability of commencing the E.I.A. as early as possible in the preparation of development proposals and how this could be accomplished. It was recognised that there might sometimes be difficulties over confidentiality and also inadvertant prejudice to the proposal due to the arousal of public anxiety before details of the proposal has been worked out and could be made known. Nevertheless it was concluded that the potential advantages were so great that the procedure for incorporating E.I.A. into the development control system should be such as to encourage early notification by the developer and an early start to the environmental impact analysis.

Finally, there is the question of responsibility for the analysis, not only the decision to have an E.I.A. in the first place but also the responsibility for carrying out the work and for its oversight and any necessary decisions which have to be made. It was considered that the public interest would best be served by an E.I.A. in which both developer and local authority took part possibly through a joint steering committee to guide the work and make the necessary decisions and possibly through both contributing to the environmental study itself. It would be necessary for this reason if for none other, that the report of the E.I.A. should be a factual and impartial report of the analysis undertaken, and not a decision making document.

Providing that the maximum freedom and flexibility was allowed to those responsible for an E.I.A. to plan and carry it out it was considered desirable to include in Research Report No. 11 suggestions as to the content and process of impact analysis which could be adopted or modified to meet the circumstances of any particular case. These have been set out in detail in Chapter 2 of the report including a classification of the impacts which might arise according to circumstances and the following summary of activities:-

Initiation	Notification to planning authority of project of listed type. Decision that E.I.A. is required. Determination of relevant issues and publication for comment.
Analysis	Impact identification. Review of relevant issues. Consider alternatives. Analysis and evaluation of individual impacts. Review of alternatives and modifications. Report - published for comment.

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Decision	Evaluation of total impacts - planning authority, developer and others. Discussions between planning authority and developer. Decision by developer on proposal(s) for planning approval. Consideration of public comment. Decision by planning authority.
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The Report recommended that the process of impact analysis should be introduced experimentally so that there could be practical experience not only of the analytical process which has been put forward but also to form an opinion on public acceptability, whether there are difficulties in obtaining an early start to the process, how the process affects the lead time in major scheme preparation and what order of costs is involved. The experimental introduction would depend on co-operation by the planning authority and developer and would need no changes in legislation. Minor changes will however be needed to the statutes and administrative regulations if there is a formal adoption of the recommendations of the report. These would be mainly concerned with providing for early commencement, for public consultation and for allocation of costs.

On the first of these powers would be taken for the Secretary of State to prescribe a list of projects and processes which would be subject to environmental impact analysis if the planning authority (or public sector authority) thought it necessary. The developer would be encouraged, but not obliged, to give early notification of his intentions if his project was included in the prescribed list and in most cases it would be in his interests to do so. Power would be needed to require the planning authority to respond to the notification within a specified time (one month was suggested) and to notify the Secretary of State to allow him to intervene if he thought it necessary.

It was considered that much more and much earlier information should be made available to the public than is at present the case. It was felt that one of the weaker features of the present system is that new environmental issues are raised by members of the public or interested parties at a very late stage in the preparation of a project and its consideration by the local planning authority. Often they are brought up by objectors at a public inquiry when, if they are really new issues, there can be little or no factual information or analysis and parties rely on assertion and counter assertion and the very broad opinions of technical witnesses. The Report considered that powers should be taken to require that intended development in the prescribed list of projects and processes should be advertised and to require public notice to be given of the key issues selected for analysis with an opportunity for public comment. This would be the appropriate time for interested parties to make submissions that further environmental issues should be selected for analysis and the report suggested that there should be a further opportunity for the responsible authority to review the relevant and key issues after the process of Impact Identification had been carried through and to take account of the comments which had been received. The Report also recommended that powers should be taken to require the report of the E.I.A. to be made available to the public and comments invited before a final decision was made.

On the third point of costs it was considered that a joint approach to E.I.A. could best be achieved and unreasonable action by either developer or local authority avoided if the external costs (i.e. those not resulting from the work of the directly employed staff) should be shared between the two

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parties. It was felt that the arrangements would have to be flexible and suggested that these external costs should be shared equally unless otherwise agreed between the parties or settled by arbitration. An exception was made in the case of Crown development where it was felt that the whole of the cost should fall on the appropriate Government department.

CONCLUSION

The Report of the study was submitted in March 1976 and published in early 1977. Comments were invited by the Department of the Environment from authorities, professional institutions and other interested bodies and additional time has been allowed for these to be made. It is to be hoped that a statement of the Government's views will be forthcoming at an early date. With the possibility that the E.E.C. will issue a directive to member states it will be unfortunate if a lack of practical experiment is found to be a handicap when discussions are held on the form which the directive should take and what processes of analysis it should require to be carried out.

DISCUSSION

Author's Introduction

MR. C.G. THIRLWALL, in introducing his paper, said that although he had presented a number of papers on this subject since the publication of the report (i.e. Research Report No. 11) on the study which he and Mr. Catlow had carried out for Central Government, the President's invitation to participate in this Symposium was particularly welcome because the Institution embraced both engineers and scientists and also because of the diverse functions of those who worked in the water industry. He believed that this range of interest should ensure an interesting and stimulating discussion.

Those whose work lay mainly in the maintenance or improvement of water quality and the control of waste discharges would be particularly interested in the effectiveness of the consultation which took place on new developments between local planning authorities and water authorities, upon what role they would play in any comprehensive system for appraising the impacts of development proposals or indeed whether, in view of their statutory responsibilities for the control of pollution, impact analysis should take such environmental effects into account at all.

Others, with particular responsibilities on the operational side, would be concerned with the reconciliation of conflicting demands for the use of water and water courses for agriculture and land drainage, for domestic or industrial water supply, and for fishing or other leisure activities. They might be particularly interested in how far the techniques and process of EIA might assist in resolving and evaluating the beneficial and adverse environmental effects of operating decisions.

Those who were directly responsible for the design and construction of major civil engineering works which could have far reaching environmental effects both in space and time, might be interested in the use of EIA in four ways; firstly, as an aid in reaching broad policy decisions on the expansion of water resources where the alternatives under consideration were conceptual and where it was impractical for the purpose of the decision to carry planning and design work to a sufficient degree of detail for more than an approximate review of environmental impacts to be

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undertaken. Secondly, there was the possible use of EIA at the project design stage where alternatives were more limited, and the analysis was directed more towards its possible influence on design and on steps which might be taken to mitigate undesirable environmental effects or to enhance those which were beneficial, bearing in mind the environmental responsibilities placed upon undertakings under the 1973 Water Act. Thirdly, there was the requirement to consult with the local planning authority and the desirability of securing support for major water development proposals. Although the local authority might have a parallel interest in the environment they might have different views on the environmental issues relevant to a decision on a development proposal and on the values to be placed on the various impacts. Fourthly, in the case of development proposals leading to a public inquiry there was the need to provide sufficient and adequate evidence about the environmental effects and considerations at the Inquiry to enable the inspector to reach an informed conclusion on the proposals. Linked with this was the question of the role of EIA in informing the general public sufficiently; in taking account of any views which might be put forward during the project design stage; ensuring so far as possible that objections sustained at the public inquiry were based on an examination of factual and dispassionate analytical material; and that the inquiry was not presented by objectors with new and important environmental considerations of which no, or insufficient account, had been taken during project design.

Although in carrying out the study of EIA for the Department of the Environment he and his colleague were assisted by an Advisory Committee which included representatives from many branches of the Department, their terms of reference meant that the study was primarily concerned with EIA in the context of the town planning statutes or the arrangements for taking planning considerations into account in the case of public sector development. Thus, when they had looked at the need for EIA they had been examining first whether the present development control system (or its equivalent in the public sector) was working satisfactorily and whether present practice provided a sufficient input of technical and scientific information for those responsible for the planning decision. Similarly, when they had decided that for some proposed developments there should be a systematic process of EIA, a good deal of the report was concerned with how this could be assimilated into the development control system.

Apart from their views about the need for EIA he thought that one of their most important conclusions was that EIA should be designed as a process to serve the needs of all the decision makers. That was, in addition to serving the requirements of the planning authority as decision maker, it should include for the requirements of the developer (and his designers) and should provide the vehicle for public information, participation, and consultation so that members of the public could also reach a decision on whether they accepted the proposed development or whether individually or in association with others they would make representations to get the proposal abandoned or modified. They had set out in their report what they deemed to be the decision makers' requirements and these could be summarized as follows:-

- (1) that the decision maker needed to be able reasonably to satisfy himself that the analysis had been carried out adequately, and to understand the degree of precision to be attributed to the different parts of the analysis;

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- (2) he needed a clear and concise exposition of the impacts of the project in respect of each of the issues examined and (in the use of alternatives) an exposition of the comparative performance of each alternative in relation to each impact;
- (3) he needed to know the actions which might be taken and the approximate costs involved in enhancing desirable or mitigating undesirable environmental effects and the measures to be taken to monitor aspects of the environment and control undesirable effects.

Those requirements were common to both developer and planning authority and also a large part were the requirements of the general public as decision maker.

Of course the developer as decision maker had different objectives and values to those of the local planning authority. His primary interest - at least in the private sector - must be economic efficiency and an adequate return on his outlay. Nevertheless, he was also often concerned with the environmental consequences of his actions partly through a desire to be a good neighbour in the area, partly to meet and respond to public criticism, and also because the support of the local planning authority was necessary. But he might also need an EIA to assist in making a subjective evaluation of the environmental benefits of changes or modifications in his proposals, and to relate these to the additional costs which he would need to incur. His final decision on the findings of the EIA were concerned with the specific proposals, changed or modified as he decided, which he wished to be considered for planning consent. In the event of a refusal he needed precision in the reasons given for refusal, so often lacking at the present time, which a comprehensive environmental study should encourage and on which he could make a decision as to his further action.

Although the cost implications might not be foremost in the mind of the planning authority, it could not be indifferent to the approximate order of any additional costs involved in adopting alternatives or modifications in the proposals as originally put forward by the developer but it must in large part rely on the developer for such cost information as well as on accurate details about the proposal, the demands which it would make upon resources, and the outputs whether useful or waste. As the developer was concerned with issues other than environmental impact; cost, technical feasibility, resource availability, etc., so also was the local planning authority concerned with other issues. The planning decision was a policy decision in which, although more local issues might predominate, account must be taken of national and regional considerations and the contribution which the development might make to living standards. The planning authority would also be concerned with the extent to which the developer might contribute to, or frustrate the achievement of, their planning objectives and broader policies for housing, employment, transport, and recreation; and with the extent to which the demands for infrastructure might affect programmes for capital investment and other priorities for development.

It was this realization that EIA had a role to play in the decisions both of the planning authority and the developer, and their parallel though sometimes different requirements, which led to some of the conclusions and recommendations of the report. In the first place this

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was one reason for suggesting that the report of the analysis should be factual and impartial and not a decision making document. Secondly, it led to the conclusion that, wherever possible, the study should be conducted jointly with both developer and planning authority taking part. Both had a great deal to contribute to the study; the developer had the detailed knowledge of his proposals, his arrangements for construction, and the methods of operation after construction works were complete. He would know the labour force which would be required at various stages; the sources of materials required and transport arrangements; the risks involved; and the effects arising from construction or operation which might lead to environmental change. The local authority would be short of the expertise necessary for a full understanding of the project, but should have a great deal to contribute about the existing environment and infrastructure and also about the structure or other planning proposals for the area. It would know something about the existing natural environment and its quality and the opportunities for recreation, and also something about the existing patterns of employment and available skills and surplus in the labour force. It might also have established links with other organizations with specialist knowledge including Government departments, statutory undertakings, university departments, and research institutes. As his paper indicated it was considered that the study could best be managed through a joint steering committee which would determine the brief for the study, the issues to be examined, and generally supervise and co-ordinate the actions of the specialists carrying out the study. The steering committee would decide on the alternatives and the possible modifications to the proposal to be studied, taking account of the order of additional costs which might be involved through their adoption.

Finally, the need to serve the requirements of both developer and planning authority was another important argument for starting the environmental analysis as early as possible in project preparation even if it meant carrying out the analysis in stages. Apart from potential economies in manpower and time brought about by early commencement and collaboration, it should enable the best decisions to be made in the public interest about the project and its design. Effective and timely consideration could then be given to realistic alternatives or to more modest but beneficial alterations in design or in operational processes.

Research Report No.11 pointed in some detail to the limitations in assessment techniques and still more in evaluation and this had been emphasized in the present paper. In the long run, effective decisions would depend upon subjective evaluation by the decision makers after careful consideration of all the qualitative or quantitative assessments in the report of the analysis and the written comments about their importance. It would make a heavy intellectual demand upon the decision makers among many other demands upon their time but it was to be hoped that the need for EIA would not be discounted because it provided no immediate or easy answers, nor that short cuts would be followed by basing decisions on one or two more easily evaluated environmental issues and dispensing with the necessary careful weighing up of all the pertinent factors.

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Verbal and Written Discussion

MR. G. COLE (Ministry of Agriculture, Fisheries, and Food) thanked the author for describing his and Mr. Catlow's seminal contribution to the subject.

He felt that it was right that the author should have included the physical and social environment and policy formation. He noted the reference to enlightened designers and drew attention to the fine contribution made by water supply engineers to the aesthetics of engineering works. It was right that the contribution of reformers such as Edwin Chadwick, referred to in a later paper, should be remembered.

In opening the Symposium Lord Sandford had been somewhat apprehensive of EIA. In so far as this meant inflated procedures he agreed, but he was sure that environmental impact analysis with small initials was needed; in other words, they had to consider carefully the effect of their work on the environment - and, in fact, they were already doing it.

The author had not referred to the recommendation in his and Mr. Catlow's report that the Secretary of State should publish an official list of the types of development that might need EIA. This seemed to be helpful by being both exclusive and discretionary.

He agreed that analysis should not be just a test, but a design tool, and that environment and development needed to be weighed-up from the outset. He sympathized with the emphasis on qualitative techniques, but thought that they should keep an open mind about the quantitative approach. Lord Kelvin had said, in effect, that if one could not express one's knowledge quantitatively it was "of a meagre and unsatisfactory kind". Nevertheless, much would remain subjective for the foreseeable future and it would be as well to face up to the embarrassing question of taste.

The author's references to pressures (pp. 2.2 and 2.4) were much to the point. All the virtue was not on the side of the pressure groups, and the dedicated ecologist, for example, was not necessarily less biased than the dedicated engineer.

Our democracy was not absolute and it had to be decided where to operate along the line between *purs democracy* and *paternalism*. Speaking for himself, and not for the Department employing him, he wondered whether the proper way to deal with engineering and the environment was by a permanent commission which would have the duty of striking a balance in the national interest. It seemed that the only proper answer for all of them as public servants was the patriotic one - where did the balance of public interest lay?

MR. P. SCHOFIELD (Nature Conservancy Council) said that EIA was particularly relevant to two of the Nature Conservancy Council's functions under the 1973 Nature Conservancy Council Act. These were:-

- (1) the provision of advice and dissemination of knowledge about nature conservation (the conservation of flora, fauna, and geological and physiographical features). Part of this process included the notification and subsequent protection

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of Sites of Special Scientific Interest (SSSI); and

- (2) to take account, as appropriate, of actual or possible ecological changes.

Quite clearly, engineering works associated with water authority and internal drainage board functions and activities had had a tremendous impact on flora and fauna and almost invariably led to significant ecological change. The extent of such impacts should be analyzed prior to decisions being taken.

There were two main areas of concern:-

- (a) the alteration of river structure, particularly to bed and banks, and the resultant ecological change; and
- (b) the major ecological changes which frequently took place within a river catchment as a result of large scale land drainage, flood control, or water supply programmes.

The present surveys being undertaken by water authorities under Section 24(5) of the Water Act 1973, could lead to large-scale land drainage proposals. If a number of SSSIs were involved, then clearly early consultation between the water authority and the Ministry of Agriculture, Food and Fisheries (MAFF) and the Nature Conservancy Council (NCC) would be desirable and might reduce the possibility of a costly public inquiry such as that recently held in relation to Amberley Wildbrooks. In such situations a type of EIA, but not on US lines, would be an advantage.

The NCC was not concerned about marginal land of little or no value for nature conservation but was concerned about three main issues:-

- (i) retaining features in the countryside which contributed substantially to maintaining viable populations of flora and fauna;
- (ii) protecting areas of Special Scientific Interest; and
- (iii) ensuring that species of plant and animal which did not adapt readily to changes in land use or of habitat were accorded suitable protection.

Unfortunately, the existing planning process and the plethora of sections of existing Acts relating to environmental protection were not sufficient to ensure the maintenance of the best ecological features which contributed so much to the quality of environment. This was especially so in developments and land use change in the agricultural, forestry, and water industries.

Because of a lack of understanding of the ecology of river systems, very few lengths of river had been designated SSSI. The NCC had been surveying, classifying, and evaluating rivers in this context. Hopefully, existing legislation would ensure better protection of important ecological sites once they were notified.

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The concern was not only one of "environmental activists" but of the Government's advisors on nature conservation. It was of concern in the EEC and also to the Council of Europe's Committee of Ministers who, for example, on 21st February 1977, adopted Resolution (77) 8, "on the protection of lake shores and river banks".

Thus, for major programmes, the NCC agreed with the conclusions of the Catlow and Thirlwall study that there was a need for selective EIA in the UK. In many cases the NCC got involved in studies with other government and planning agencies which might be described as EIA, but the effectiveness of such an approach varied greatly throughout the country.

In order to reduce conflict it was essential that the NCC identified the conservation issues and gave early notification to water authorities - equally important water authorities and water engineers should discuss plans, policies, technological change, and specific proposals with the NCC at the earliest possible date.

MR. P.L. BRAID (Welsh Water Authority) said that what was being discussed was not an import from the USA of the philosophy and procedures adopted by that country. There could not possibly be a proposal to enact equivalent legislation as NEPA 1969, which only covered "major Federal projects", nor was it intended that our courts of law be involved. It had been said that the latter legislation came a century and a half too late. In an issue devoted to "Man-made America" the editors of the Architectural Review described the American landscape as "a universe of uncontrollable chaos inhabited by happy accidents". It appeared that environmentalism was but the conscience and symptom of a comfortable democratic society, and it would not have been appropriate any earlier.

What was now advocated was an inevitable development of the particularly British approach to planning and it revealed shortcomings when it had dealt with North Sea oil development, nuclear power stations and reprocessing plants, the third London airport, new towns, open cast mining, and motorways, etc.

An American correspondent in the early 1960s described the English landscape "as a world of ordered beauty obscured only here and there by sad contrivances". To him the British had a very special relationship with their landscape. The word amenity provided the clue, and it was to be attached to whatever seemed to need protection. He gave examples to his American readers. Naturalists opposed a plan for a sub-station on the Severn near Gloucester on a spot containing an acre of bladderwort "an extremely rare plant with pretty yellow flowers that eat insects. We also had a pair of marshwarblers nesting on the site and would like them left alone if possible" said a letter to the Guardian. This mild plea caused great concern at the CEGB. "We didnt know there was bladderwort on the site when we bought it, but we always try to be helpful and co-operative in cases like this". Yet again, the Friends of the Lake District fought to get an electricity line placed underground, offering to defray part of the additional cost. After a public inquiry, the Minister gave permission for overhead lines along only about 1000 yd of the route. But the North West Electricity Board was so impressed by the extent of the anxiety caused by this threat, that it put the whole line underground.

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So much for the sporting gestures of the 1950s and 1960s. All too often the environment was defended by minor local interest groups and individuals who approached the so-called threat with emotion. All too often public development, and certainly private development, started with a least-cost option in the hope that no one would notice.

The situation now was entirely different. In several countries, eco-political groups threatened, by violent means, the very authority of government. The environment was now a bandwagon carrying all sorts of "eco-nuts", who saw doom and gloom in our way of life and its need for economic growth, and political groups using it as a vehicle for government bashing.

Those genuinely concerned for the environment, now certainly did not give central and local government the benefit of the doubt, and expected a high level of sensitivity to the environment. Perhaps what was now proposed would enable the environment to "speak for itself" in an objective way and on the same terms as economic and sociological factors.

Apparently only between 25 and 50 schemes in the whole economy would be involved in any one year. Engineers seeking fulfilment in dams and sewage works were clearly not going to be held back. On the face of things, they would continue to promote monuments to their skills with the gay abandon of their fathers. Nobody was going to ask water authorities about such little matters as the extent of unaccounted-for water, their ham-fisted projections of water consumption, land drainage works that now benefitted no one, and certainly no one was going to ask whether the resources to be deployed to pollution abatement over the next 20 years would be worthwhile in terms of net environmental benefits. The cost of domestic water metering was evidently too high. It had been worked out that it was cheaper to build more reservoirs and sewage works, and environmental costs were to be measured only in terms of the delay that would be encountered in promoting such works. The environment was cheap at the price.

Essentially, what was intended was to raise the performance of the existing planning process. This might not be enough. The authors of the DoE Report pointed to a difficulty of greater public involvement in the planning process "Few environmental factors can be accurately and completely measured, and still fewer to which a monetary value can be given. They all involve subjective judgements and the question therefrom arises as to whose judgement it should be". The authors were of the view that the local authority "is elected to make such decisions and it was a responsibility which could not be delegated to others nor left to a consensus of current opinion". Clearly, there were to be no referendum here as to whether there should be more or less nuclear power or reprocessing plants - a situation which would not please the Soviet Union! It was naive of people to suggest that politics should be "kept out of the environment".

Ward* in his paper "Educational requirements for impact reviews" argued that "the right people to conduct such reviews should be the public itself, given that the awareness and environmental sophistication of the ordinary citizen is much more important than the educational

* Built Environment 1978, June, 4, 158

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experience of the professional".

In her paper "EIA Some unanswered questions", Sue Clifford* suggested that "if impact analysis is quietly inserted into the planning process as just another technical aid to decision making, then political matters will once again be obscured by professional veils. In impact analysis, as in other fields, public involvement must be fought for as one way of guiding bureaucratic and political action". Such views required an answer. They were not to be associated with the back-to-the-land syndrome which tended to see everything wrong with western society and was curiously very silent about Soviet Bloc and third world societies.

Such comments begged the question as to whether the proposals of Catlow and Thirlwall went far enough in involving the public, in enabling it to be sufficiently informed to make an impact on the climate of professional thinking. Professionals sometimes had too much faith in the idea that given money, time, and application, they could provide for and solve everything.

MR. L.E. TAYLOR (Central Water Planning Unit) wrote concerning EIA in relation to major water resource projects. The water industry had been carrying out a form of EIA for many years, especially since the Water Resources Act 1963, and he had been surprised that this Act had been omitted from the legislation listed in Mr. Reed's paper (p.1.8). The present author had queried the purpose of EIA and on p. 2.5 had asked whether impact analysis should be considered as a design tool forming part of the feasibility investigation. He himself thought that this was appropriate for major water resource schemes, particularly if they were of an innovative nature. In his opinion the feasibility studies of freshwater storage in Morecambe Bay, completed by the Water Resources Board in 1972, and the Wash, initiated by the Water Resources Board and completed by the Central Water Planning Unit, culminated in reports which were good examples of one type of EIA.

Had time allowed at the Symposium he would have illustrated his point with some slides prepared for the PATRAC Seminar referred to on p. 2.5. One slide summarized the Wash studies by "3 Es" as follows:-

Engineering

Surveys
Hydraulic models
Wind, wave and tide recording
Site investigation
Tidal banks
Water quality
Hydrology
Distribution

Ecology

Surveys of:
Waders and wildfowl
Inter-tidal invertebrates
Inter-tidal vegetation
Marine fish and shellfish
Common seals

Economic

Economic aspects
Population
Housing
Employment
Agriculture
Fisheries
Communications
Roads
Railways
Canals
Ports
Access

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Amenity and recreation
The recreation possibilities
Recreation demands and benefits
Potential for recreation
development
Amenity problems during
construction
Visual impact

The Wash study had benefited from the experience gained during the Morecambe Bay study and he felt that it contained many lessons for the water authorities, not least the valuable contribution that could be made by voluntary organizations, the inter-action between working parties, and the need for a strong steering committee. With the present organization of the water industry, a water authority should decide on the need for EIA in consultation with the planning authorities and, if agreed, form a joint steering committee to direct the studies.

On the question of public participation, he drew attention to the success achieved during the Wash study by a series of public meetings to which invitations were issued to all interested parties. The average attendance was about 400. The objectives and progress of the study had been described, and the public had been given an opportunity to ask questions and receive answers from those directly involved in the various studies. Maximum use had been made of visual aids at these meetings, including slides and a film of the various investigations and works.

On p. 27 the author had asked who should pay for EIA. He himself suggested that for a major water resource scheme the bulk of the cost would be a fair charge on the promoting water authority, although it could perhaps be argued that the cost of the economic and social studies should fall on the planning authorities.

With regard to the effect of environmental studies on the lead time for major schemes (p. 2.10) he thought that this need not be extended if the requirement for environmental studies was recognized from the initial concept of the scheme. Environmental studies should start at the same time as the engineering investigations.

The Symposium had demonstrated that environmental studies were already part of the water planning processes, but there was scope for improving the techniques of analysis. To this end it was possible that the water industry could benefit from a case study of the environmental issues considered during the promotion of a major scheme, such as Rutland Water or Kielder Water, and their impact on the completion of the scheme. He would be interested to learn the author's view on this suggestion which he commended to the water industry and offered the help of the Central Water Planning Unit.

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Author's Reply to Discussion

MR. C. G. THIRLWALL, in reply to the discussion, said he was pleased to find that there was substantial support at the Symposium for the adoption of a system of EIA in this country. Mr. Cole had emphasized the need for analysis to be a design tool so that development and the environment could be weighed up at the outset and Mr. Taylor had also said that environmental analysis should start at the same time as the engineering investigation. While this might eventually become standard practice in the case of public sector developments such as those mentioned by Mr. Taylor, it was unlikely to be adopted for development in the private sector unless there were alterations in the procedural arrangements for development control to encourage the developer, in the case of some types of development, to initiate impact analysis at an early date and a requirement for an effective response from the local planning authority.

Mr. Cole had said that EIA was already being carried out for some projects in this country, and Mr. Oldfield gave an example in the resources study in the area of the North West Water Authority (paper No.5, p. 5.1). If so, and bearing in mind that some sort of environmental appraisal was undertaken for most proposals when application was made for planning consent, it might be considered by some that we in this country were well on the way to having an effective system of EIA and that any further improvements could be safely left to evolve over the course of time. There was insufficient justification for taking such an optimistic view. There was a wide disparity in the practices adopted and the care with which appraisals were carried out; there was considerable scope for improvements in techniques; and, without imposing statutory requirements for the preparation of EIAs there was a need to encourage a systematic and logical approach to survey and analysis and the preparation of an impartial and comprehensible report on which decisions about a proposed development could be made. That performance on environmental appraisal was not as effective as it ought to be was brought out in Mr. Oldfield's contribution. He also drew attention to the need for early identification of environmental issues. This would be an essential first step in any systematic approach to environmental impact analysis.

Mr. Cole wondered whether there might be a case for a permanent commission with the duty of striking a balance in the national interest between the engineering and environmental considerations. Inevitably this was a political decision as Mr. Braid had pointed out. He himself felt that such a decision should be made not by the public through a referendum, nor by an appointed commission, but by those who within our system of government were elected, whether at national or local level, to make such decisions in the public interest and were in due course answerable to the public at large for the way in which they carried out their responsibilities.

The decision-making process also concerned Mr. Braid, who wondered whether Research Report 11 went far enough in involving the public and in enabling it to be sufficiently informed to make an impact on the climate of professional thinking. The author was in no doubt that the public were generally insufficiently informed at present and needed access to a full report of the environmental study which had been carried out. Their impact however should be on the decision-making process through representations to the elected body responsible for that decision and for the decision as to which environmental issues

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should be studied. Involvement implied direct participation in the study and except where individual members of the public had special knowledge it was difficult to see how they could contribute to the work of a professional study team charged with producing an impartial report.

Mr. Taylor had referred to the benefits which could arise from case studies comparing anticipated environmental impacts with those actually experienced. There was a great deal of merit in this suggestion and feed back from case studies could improve techniques generally. Research Report 11 identified two areas where it was felt there were considerable deficiencies in the state of knowledge about impacts and suggested a limited programme of post development studies but he agreed that there would be advantage in carrying out such case studies on a wider basis.

3. METHOD AND METHODOLOGY IN SOCIAL IMPACT ANALYSIS

Maurice Broady, B.A.*

The attitude of civil engineers to environmental impact analysis is not entirely sympathetic. Sustained by Tredgold's statement that the purpose of their profession is to direct 'the Great Sources of Power in Nature for the Use and Convenience of Man', they find it hard to understand how anyone can seriously suggest that their works damage rather than promote the public weal; and they bitterly resent being branded as public vandals, as they are so often branded in the course of public inquiries. So I can sympathise with the anxiety expressed by Eric Reed that the benefits which the engineer can give to society may be forfeit if 'articulate pressure groups', which often represent only minorities concerned with conserving the environment, get their way. I can also appreciate his concern that 'a new army of specialists' may be forming who will analyse the environmental implications of major engineering proposals without reference to the social purposes which are their primary justification.

I write, however, as one of the latest recruits to this new army of specialists. Most environmental analysis has so far been concerned with the natural rather than the social environment, and on the social side the economist, with his technique of cost-benefit analysis, has probably been in the van. The sociologist, whose expertise is thought to be about 'people', is usually called upon to defend communities against the depredations that engineering projects are expected to cause. He is usually cast in the role of the defender of the local way of life, as I was myself in the long drawn-out Drumbuie inquiry in 1973-74. Indeed, the work which I did in the Drumbuie case was an 'impact analysis' in the exact sense of the word, since it was arguing that the building of an oil-platform construction-yard would have seriously damaged that community. Concepts may carry with them implications which the practical man often fails to perceive. The term 'impact' suggests that the main effects of a project will be to hit, and thus to damage the environment. This is certainly consistent with the concern that gave birth to impact analysis and the term is unfortunately far too well established for it to be easily changed. But in my own practice, I limit its use to those studies in which one is arguing, as an advocate, against such a project on the grounds that it will have a detrimental environmental effect.

But apart from advocacy, the sociologist has another role which I wish to illustrate in this paper. He also acts as an impartial social analyst. In the Craig Goch reservoir project, which will illustrate my meaning, my terms of reference did not require me to argue either for or against the project but, more dispassionately, 'to advise upon the social implications of the scheme in general, including any long term benefits or disadvantages to the area' (my italics). In my report,

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accordingly, I rejected the concept 'impact study' as inappropriate and, following my brief, described it as being concerned, in a more impartial spirit, with the 'social implications' of the project. For exactly the same reason I also described my analysis of section 21(5) of the 1973 Water Act as an examination of its implications for the proposed Craig Goch development. In both these cases my role was that of an impartial analyst and assessor rather than that of advocate tout court.

The sociologist's role in impact analysis, therefore, is much wider and more impartial than simply representing the interests of communities opposed to major engineering projects. That advocacy role is necessary, important and desirable. But the analysis and evaluation of the social implications of such proposals is no less important. I shall therefore consider in some detail how these different kinds of study were carried out and then go on to discuss some of the methodological questions that are involved in applying sociological expertise to this kind of problem.

THE DRUMBUIE INQUIRY

Drumbuie is a small crofting township on Loch Carron in the north-west of Scotland. Early in 1973, Taylor Woodrow and Mowlems submitted a planning application to establish a site there for building oil-platforms for use in depths of up to 600 feet. Since these platforms had to be submerged to that depth as they were being built, the construction-yard had to be located close to deep and sheltered inshore water. Loch Carron was one of the few suitable places in Great Britain and Drumbuie one of the few sites served by an adequate road and railway. The application was made at a time when the government was anxious for economic reasons to win a share in the market for these platforms, particularly against Norwegian competition.

Opposition to this application was quick to find expression and the Secretary of State for Scotland ordered a public inquiry. In particular, a group of local objectors had organised the South-West Ross Action Group by whom I was retained to argue the case against the project expressly on socio-economic grounds. By the time I was called in most of the relevant evidence had already been collected at the request of the Secretary of State and that evidence, together with discussions with some of the objectors, persuaded me that a good case could be made out. Using the factual material that had been prepared, I was able to start at once on marshalling a coherent argument against the proposal. (1)

It is often supposed that sociology consists in 'doing a social survey': in simply finding out the facts. Sociology, however, is better regarded as a way of explaining things which makes use both of factual evidence and conceptual analysis. In this instance, I was in effect explaining what would probably happen to the township of Drumbuie if the proposed development took place. The explanation was based not only on the facts of this particular case but also on comparative evidence, supported by a number of theoretical considerations. The heart of my argument was as follows. First, there could be little doubt that the incursion of the project into South-West Ross would cause considerable social disturbance. The indigenous society was a small-scale, agrarian, Gaelic community that was characterised by a relatively egalitarian social structure, by the reciprocity of services among its members and by a traditional way of life. Most

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people earned their living in forestry, crofting or fishing or else in small enterprises like the shops, hotels or the boat-building yard. Into this community of at most 3,000 people would come an alien and discordant industrial project, bringing into the area some 400 men (out of the total of 600 probably needed on site) whose life-style would clash with that of the local people and who would strain the capacity of many of the local facilities, such as hotels and public houses.

A sociologist might, of course, be expected to be particularly sensitive to the possibility of social disturbance; but this argument was fully justified by all the evidence available to us. In retrospect, the expectation of serious social disturbance may have been rather exaggerated, but it is fair to point out that that expectation was not seriously disputed at the inquiry. But social disturbance is not the only relevant criterion in such a case and that is why an important qualification was made in the course of my argument.

I made the point - in a normative judgement that went beyond the immediate facts - that it could not be assumed that social disturbance should always be avoided. A community might reasonably be required to accept it if a policy was to be adopted that the Secretary of State was persuaded to be overwhelmingly in the national interest. A community might also be willing to accept it if the disturbance were only temporary and if, in the long-run, it would benefit itself economically by doing so. But the construction work was expected to last at most ten years and probably for much less, and in the short-run it would have damaged the local economy. There was virtually no unemployment in the immediate vicinity of Drumbuie for the economy was thriving and the population had been slowly increasing. Indeed, there was already a labour shortage in some local industries and employment opportunities, which had been fostered by grant-aid from the Highlands and Islands Development Board, were increasing in small-scale enterprises such as fish-farming, ship-repairing and weaving. Such firms were well adapted to the scale and characteristics of the local society. They also used and developed indigenous and often traditional skills on which the long-term well-being of the area depended and, by directly supporting other activities, tended to strengthen the local economy.

To introduce into that economy a large-scale construction project would, in my opinion, have been damaging. The contractors would have been able to offer wages twice as high as those prevailing in the locality and this would have drained labour off some of those activities on which its future depended. Desirable though that increased income would have been in the short-term, it would have been detrimental in the long-run since the duration of the project was limited and it was very unlikely that any longer-term developments would grow out of it. The project therefore would not only have caused social disturbance but economic damage as well and for that reason it was not in the long-term interests of the community that it should go ahead. This argument was not gainsaid during the inquiry and it clearly influenced the inspector in recommending that the contractors' planning application should be rejected.

The Secretary of State accepted the inspector's recommendation. However, he allowed the project to go ahead without a further inquiry at a nearby site on Loch Kishorn where the Howard-Doris consortium had

succeeded in winning the agreement of the local residents. For local opinion was by no means totally opposed to the development. Certainly, Ross and Cromarty County Council and some local meetings were against it but the Skye and Loch Carron District Councils were for it since they valued the increased employment opportunities that it would bring into the area. That was understandable, though the anxieties about the future that are being expressed in the Kishorn area now that the first platform has been built and no further work is in sight suggest that our argument was pretty sound. But supposing that no convenient alternative had been available, should the Secretary of State have rejected the application?

The Secretary of State was well aware that, even if he had accepted the application, the National Trust for Scotland would undoubtedly have appealed against the decision and thereby have delayed its implementation. The land at Drumbuie had been bequeathed inalienably to the Trust which considered that future bequests would be prejudiced if this inalienability clause were set aside. Furthermore, as the rather strained wording of the Scottish Office letter suggested, the Secretary of State was embarrassed by his inspector's recommendation. (2) Understandably so, for if he had accepted the argument against the Drumbuie project as his inspector had recommended, the same kind of case could equally well have been made against any similar development and he could hardly have been expected to accept that the non-disturbance of a small community should always have a higher priority than the national economic interest. That, however, was for the Government to assess and decide. My responsibility was limited to arguing the case against the project from the point of view of some of the local objectors. If justice is not only to be done but seen to be done, then this kind of advocacy is essential and desirable, however inconvenient it may appear to be and however much the engineers may be persuaded about the desirability of the project. But it is no less important to recognise that such arguments on behalf of small communities are not the only relevant arguments and that sometimes the government may be fully justified in overruling them in the wider national interest.

THE SOCIAL IMPLICATIONS OF THE CRAIG GOCH PROJECT

Advocacy does not require one to overlook difficulties or counter-evidence. Indeed, the good advocate is one who can convincingly demonstrate that they do not damage his case. But the sociological consultant may be asked not to act as an advocate but as a consultant, and to analyse dispassionately the social implications of a given project; and this is what the Craig Goch brief required. The project entailed building a new dam to increase the capacity of the existing Craig Goch reservoir so as to meet the anticipated increase in demand for water in the Midlands and South-East Wales by augmenting the dry-weather flows on the Rivers Severn and Wye. Though neither the size nor the kind of dam had been decided by the time I was retained in November 1974, my brief was clear: supposing that a dam was built to 400 m.O.D. what would the social implications of building it be for the 'indigenous population' in what was loosely described as 'the Project Area'.

Neither I nor the engineers with whom I worked had any clear idea what such a report would look like, still less how the analysis would proceed. Since then, the Department of the Environment has published

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two reports on environmental impact analysis, one of which explains an 'impact assessment matrix' in which the interactions between the proposed development and the existing situation can be quickly indicated. (3) Such methods are helpful; but they cannot replace analysis because, as Catlow and Thirlwall note, they do not indicate the patterns of cause and effect or show why a given 'impact' is likely to occur. (4) In my Craig Goch report, the most important single step was to think out the modest causal hypothesis which was to guide and give coherence to my investigation. (5)

Now it was not difficult, given the terms of reference, to list the topics about which information of some kind would be needed: housing, medical services, schools and so on. But the crucial question was how the problem was to be analysed, since only when that was settled could the specific evidence that was needed be decided. We were obviously concerned with both the economic and the social effects which the project would have in mid-Wales. But was it possible to suggest how those effects might vary? After much thought it seemed probable that they would be most directly affected by where the labour would come from. If most of the labour were recruited locally, this would probably affect industry more than if it were brought into the area by the contractor since, unless it drew from among the unemployed, it would have to be drawn from existing industry. On the other hand, locally recruited labour would not disturb existing communities as would imported labour for which temporary accommodation would have to be found, nor would it generate as big a demand for additional social or other services. Accordingly, the provenance of labour could be regarded as the independent, and the economic and social effects as the dependent variables. These would probably vary in the following manner: local labour would produce more damaging economic than social effects while imported labour would cause more social disturbance than economic.

Such a hypothesis guides inquiry by indicating the empirical data that need to be analysed. But adequate and relevant data are sometimes not readily available. For example, it was difficult at first to get precise information about the size and composition of the work-force on comparable projects. We therefore had to estimate the probable labour structure required by the works by devising a method that was based on assumptions about the amount of work likely to be done in a given time by a given number of men. It was eventually possible to check these estimates empirically by analysing the actual labour force that was required for building the Llyn Brianne dam, whose size and structure are broadly similar to those of the revised Craig Goch project.

The first statements about the probable labour-force which were provided by the consulting engineers comprised, year by year, figures giving the total number of workers divided into supervisory staff, tradesmen and skilled workers, and semi-skilled workers and labourers. Such figures were presumably satisfactory for assessing global costs, but they were not adequate for a sociological analysis which had to try to establish how many workers of particular skills might be recruited locally. That needed a much more precise classification of occupations, and particularly of skilled workers, which had to be devised ab initio.

But new methods of analysis as well as new classifications of data may also be needed. As far as I could ascertain, no method had previously been devised for working out how many men might be recruited locally. The procedure adopted demonstrates the logic of sociological

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analysis. The first step was to define from how far away workers would commute to the construction site. The limited documentary evidence together with the experience of contracting firms indicated that they would come about an hour's drive to the site. This area was mapped and the number of people living within it was established by reference to the last population census. Of the population of 60,000, the probable number of 'economically active males' came to 17,000: a figure that constituted the baseline for further analysis.

From which industries, then, would these 17,000 be likely to come? Agricultural census statistics for example, showed that about 5,500 men were employed in agriculture and horticulture. Other information from the Department of Employment permitted us, with some interpretation, to draw up a tabulation indicating how the remaining 11,500 might be distributed among the various 'industrial sectors': 350 in 'public utilities'; 1300 in 'hotels, garages and other services'; 400 in 'mechanical engineering, tools and metals', and so on. Finally percentages were assigned to the number of men in each industrial sector, which indicated the probability that those particular workers would seek employment on the Craig Goch project.

These percentages could not be anything but good guesses since we were dealing with a hypothetical future situation. But they were made after discussions with a number of officials who were directly acquainted with the local labour market and they were supported by more precise reasoning. For example, it seemed likely that relatively few farmers or farm-workers would go to work on the scheme. Farming in mid-Wales was mainly animal husbandry, beef-cattle and sheep. The average farm employed an average of 1.5 persons, usually a tenant-farmer and members of his own family, but very few hired hands. The probability of men being able to move off the farms was therefore likely to be pretty low: possibly 5 per cent, which would give about 200 men. Though the resulting figures were based on hypothetical percentages, these percentages were nevertheless supported by informed judgement and careful reasoning. When added up, it seemed probable that about 1,800 local men might at some time chose to work on the project.

In calculating the contribution which these 1,800 men would make to the demand for about 3,600 man-years of labour over the five year construction period, account had to be taken of the high rate of labour turnover in the construction industry. Once again, accurate information about this was not immediately available, but our own analysis of relevant labour records indicated that the average length of employment would be about 4 months. The 1,800 men would therefore represent only 600 man-years of labour, which suggested that only 17 per cent of the labour force would be locally recruited. The more exact knowledge of construction labour which we now have makes it possible to show a weakness in this argument. For the labour force obviously fluctuates seasonally. This fact, however, had not been taken into account in the previous statistical analysis which failed to allow for the possibility, for instance, that the same man might work on a project for periods of about four months summer after summer. If that were the case, it would obviously increase the average length of employment on the site and thus increase both the number of man-years contributed by local labour and the figure of 17 per cent mentioned above. By analysing records relating to two of Wimpey's motorway contracts in very different parts of the country, we are at present trying to quantify this point in order to make the original estimate more accurate.

SECTION 21(5) OF THE WATER ACT 1973

As far as possible, therefore, a sociologist tries to quantify his findings. But quantification may be nonsense if the assumptions are invalid on which it is based. Indeed, as Catlow and Thirlwall remark, even physical let alone social effects often cannot be quantified, while for many environmental changes 'the state of knowledge and the techniques will often permit only a qualitative assessment although such an assessment may sometimes be accompanied by numerical explanations'. (6) This point will be illustrated by considering how I evaluated section 21(5) of the Water Act. (7)

This section of the Act is a totally new provision in water legislation; and this was the first occasion on which its implications had been considered. Its inclusion in the Act no doubt reflected not only the general sensitivity to environmental disturbance in recent years but also the fact that in Wales water development has become a particularly sensitive issue. (8) The section states: 'It shall be the duty of a water authority who are carrying out works for or in connection with the construction or operation of a reservoir in Wales which permanently affect one or more communities are not primarily intended by the authority to benefit the inhabitants of that or those communities to provide, or assist others to provide, facilities for recreation or other leisure-time occupation for the benefit of those inhabitants'.

Now strictly, my brief was simply to make 'an assessment of the quantitative effects of the Craig Goch project on the local community' (my italics). However, with the Authorities' concurrence, I interpreted the brief as being to consider the more specific and more relevant question: what scale of facilities was it the 'duty' of the Authorities to provide under this section of the Act? Thus my role as a sociologist was less statistical than it was juridical since I was to stand impartially between the Authorities and the communities which might be affected by the works in order to arrive at a fair assessment of the matter.

Two very different suggestions were made about how this adjudication might be quantified. The Water Authorities, evidently with cost-benefit analysis in mind, appeared to consider that their contribution might be assessed by measuring, and presumably costing the disturbance and inconvenience that the relevant communities might suffer. But as it would have been impossible to cost disturbance and inconvenience without invoking so many very arbitrary assumptions, both about future contingencies and their cost, this method was rejected.

The local councils, for their part, proposed that the Authorities should contribute a percentage of the capital cost of the project on the grounds that it would be impossible to specify the exact cost of any recreational projects which they might propose because it was uncertain when the works would be undertaken and because the rate of inflation could not be accurately assessed. They suggested a figure of 3 per cent of the cost of the works which would have placed over a million pounds at the disposal of a community of fewer than 2,000 people. But even if the figure had been only one per cent, giving £400,000, such a method of assessment would have been open to serious objection. Disturbance to a community does not vary directly with either the scale or the cost of a project. It is more likely to be related to

things like the kind of dam that is being built and the size and provenance of the work-force needed to build it. Nor could any particular percentage figure be related to disturbance in any but a quite arbitrary fashion. Crude cost, therefore, could hardly be regarded as a valid index either of the degree of disturbance that would be involved or of the scale of compensation that would be appropriate.

A further point also had to be considered. However appropriate such a percentage levy might be from a commercial, profit-making organisation, such as an oil company, it was not appropriate for a non-profit-making public authority to be so charged. For the cost of any leisure-time facilities would have had to be borne on the water charges which were levied over the whole of the Authorities' bailiwick. Other communities would understandably have felt aggrieved if the scale of provision in the villages affected by section 21(5) was quite beyond what they themselves were able to afford. Equity towards them required that the Authorities' contribution should not result in a scale of provision that was totally out of proportion to that in other similar communities.

Both suggestions for making a quantitative assessment of the matter were therefore unacceptable, not because they could not have been implemented but because the reasoning that underpinned them was not valid. The validity of a quantitative assessment is only as good as the assumptions on which it is founded. This demonstrates that what had first to be decided was not a statistical but a juridical question: what would be fair criteria for deciding whether any money should be allocated at all? The point was the more important since, while my argument could have no legal force, it could well be regarded as a precedent if it were to be accepted.

On what grounds, then, could a contribution under section 21(5) be justified? I argued that there were three grounds which I described as restitution, direct recompense and indirect recompense. If, as a result of the Craig Goch project, an existing amenity would either be totally denied to the present users or would be so affected that its value as an amenity was diminished, the Authorities in my opinion had a duty to provide a similar or equivalent amenity in restitution. 'Direct recompense' would be appropriate if construction workers, for example, made use of a facility, such as a community centre, to the point of strain. And 'indirect recompense', in the form of improvements to existing recreational provisions, would be appropriate to compensate ex gratia for the general inconvenience that the project would cause the local people.

That groundwork of principle having been established, and decisions made about what amenities ought to be provided under these heads, what would be a reasonable sum for the Authorities to allocate? I argued that the figure proposed should bear some relationship to any comparable cases that could be established. The nearest such case was the 'disturbance payments' that the oil companies are making to Shetland and Orkney Islands Councils. In 1976-77, Shetland received £2 million and Orkney £500,000. Both have populations of about 20,000 so the income works out at roughly £100 per head in Shetland and £25 in Orkney.

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These figures offer a starting-point for assessing an appropriate sum in this case. However, the Scottish instances differ from Craig Goch in several important respects. First of all, it is unfair to levy on a non-profit-making public body the charges that might be appropriate for a commercial organization. In any case, the disturbance which the Craig Goch project would cause would be far less than oil-related developments have caused even in Orkney. Moreover, the Scottish disturbance payments are being used to support a wide range of activities, including economic development and social welfare projects whereas the money available under section 21 (5) is expressly limited to providing leisure-time facilities. Therefore the cases are not strictly comparable. However, Orkney's £25 per head could reasonably be regarded an outer limit and the question posed: how much less would it be reasonable to allocate in this case? I do not think that there is any objective way of deciding this, but it seemed to me that the sum of £10 per head per year might be a reasonable and equitable figure, which would give the communities affected the sum of between £15,000 and £20,000 during each year of construction.

METHODOLOGICAL PROBLEMS IN SOCIAL ANALYSIS

These accounts will have indicated the kind of issues a sociologist deals with in impact analysis, how he deals with them and what kind of problems he faces in doing so. A sociologist claims an expertise in examining the way in which engineering projects affect how people live and make their living. On such matters, however, the man-in-the-street may possess relevant and direct experience. He also has opinions. Indeed, in this field everyone is likely to consider himself an expert. It is therefore reasonable to ask whether, and in what degree a sociologist may claim that his judgement is any better than the layman's: whether his claim to a specific competence is justified.

To describe experience is one thing, to analyse it is another. The man-in-the-street may be able to describe his social experience accurately but he is less likely to be able to generalise validly from his experience and to analyse and explain that experience accurately. The sociologist's competence lies in his ability to do just this. To help him, he draws on a body of theory and a literature relating both to the methodology of his profession and to the substantive questions with which he deals. He also commands a set of methods for establishing evidence, relating it to generalisations and for assessing the validity of both the evidence he uses and the generalisations he makes. But to work effectively in an advisory or consultative capacity, the sociologist also needs to be willing to take the risk of applying his competence to practical questions. And since he has to work with people from other professions he has, above all, to be able to express his professional judgements clearly and persuasively.

To analyse or explain experience, even the man-in-the-street has to use concepts and generalisations. However, the layman often finds it difficult to accept that social phenomena can be analysed systematically or subjected to generalisation. How can you possibly generalise about people, he is likely to say. But the point to note is that the generalisations used in the studies that I have described were not about 'people' regarded as separate, individual persons; they referred to social categories, such as 'the unemployed' or 'locally recruited labour'. Such categories are obviously made up of individuals who act in many important respects as the individual persons that they are.

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But they also conduct themselves in ways that are common to members of their category. Sociological statements refer to the probable behaviour of such categories and may be broadly true of those categories without necessarily being valid for every individual within them.

Sociological explanations of the behaviour of these social categories, furthermore, refer to either the structural or the cultural characteristics of social systems. We know, for instance, that there are fewer Irish 'travelling men' in the construction industry nowadays than there were thirty years ago. Even though such men are still to be found, the proposition about that category of labour is nevertheless true. This is not simply because a large number of individual Irishmen each decided, quite independently, not to come over to the British but also because the values and attitudes of a new generation of Irishmen have changed. The sociologist describes values and attitudes as 'cultural' phenomena so as to distinguish them from the structural aspects of a society which also help to explain the matter. For it is also the case that the opportunities for getting work in Ireland have materially improved over the last twenty years and that these structural circumstances have changed in ways that have made it possible for these attitudes to change as well. The sociologist's expertise resides in his ability to conceptualise and to analyse these cultural and structural aspects of a society to which his generalisations refer.

Of course, concepts and generalisations may distort rather than promote understanding. This happens when 'jargon' is used or when concepts are inadequately related to empirical observations. For the practice of sociology, as of any other social science, requires a continuous dialogue between concepts and generalisations on the one hand and empirical evidence on the other. When this dialogue is lacking, conceptualisation tends to become dogmatic and dogmatic judgements are likely to lead to false policy analyses. This can be illustrated by considering the role which the concept of 'a way of life' has played in arguments against the incursion of large-scale engineering projects in rural communities.

Several years ago, I was asked to comment on the sociological studies that had been made as part of the Shetland development plan. In reviewing this work, it seemed to me that the sociologists had, so to speak, scooped up the concept of 'the Shetland way of life' off the streets of Lerwick and included it, without any further analysis or appraisal, into their account. It was being used, though I do not imagine they realised it, in a distinctly Hegelian manner. For 'the Shetland way of life' was presented as if it were a totally unique Volkgeist, which alone gave coherence and meaning to the particular features of that community.' This spirit appeared to be regarded as hovering over Shetland like a balloon, so fragile that it would likely burst at the first gush of oil into Sullom Voe. The Shetland way of life, it was suggested, had been static and unchanging for centuries and it was something which every Shetlander fully and unequivocally participated in and endorsed.

In my judgement, this concept was weak not only because it was not adequately supported by the relevant evidence but also because it was theoretically inadequate. Shetland certainly does have a strong sense of its distinctive identity and Shetlanders were understandably anxious about the effects which the incursion of the oil industry might have on that sense of identity. But their concern was aggravated into a

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possibly excessive anxiety by the way in which the concept itself had been defined. For if a 'way of life' is conceived only in cultural terms as being embodied in a distinctive, indeed a unique set of values and beliefs, sharply differentiated from the 'materialistic spirit' alleged to characterise the British mainland, then it is bound to seem threatened by new developments and more evanescent and fragile than it probably is.

Beliefs, values and a sense of identity are not separate from the other elements in a social system. They are related to economic and social structures such as patterns of agrarian organisation, land tenure and technology, which are no less a part of a community's way of life and which are more substantial, durable and tangible than a focus on values and beliefs alone would lead one to expect. Furthermore, the suggestion that a way of life is virtually static and shared equally by every member of a society exaggerates the degree of social consensus by ignoring structural factors, like differences in economic interests and between generations, which tend to divide rather than to unify a society. The way the concept was defined therefore encouraged both the Shetlanders and the sociologists to emphasise the dangers and underestimate the possible benefits of oil-related developments.

It is sometimes argued that this kind of bias is the mark of a science which is at an immature stage of development. This view implies that the sciences are all essentially alike and that sociology, or the other social sciences for that matter, will become a totally objective science like physics or chemistry as methods, and particularly quantitative methods, are developed that approximate more closely to those of the more advanced natural sciences.

I do not accept that view. Clearly, we share with the natural scientist a concern to discover and explain the regularities that obtain in the social, as much as in the natural world. But I think those regularities are so different from those that the natural scientist studies that, however assiduously we may apply 'the scientific method' in studying them, we shall never be able to emulate the precision of the natural sciences. The reasons for my scepticism can be stated quite briefly.

First of all, a social scientist is himself a part of the phenomena that he is analysing in a way that is not true of a physicist, for example, studying atomic fission. Since we are studying part of what is our own history it is impossible for our concepts to be as neutral as theirs. The same phenomenon is for us the American Revolution, for the Americans the War of Independence; Belsen for the Nazis was part of the 'final solution', for the rest of us it is part of 'the Holocaust'. Though good sociologists make every effort to be dispassionate, in matters affecting our own history, which we are bound to assess in the light of our own value-judgements, it is virtually impossible to achieve the objectivity to which the natural scientist can aspire. This applies with particular force where policy questions are concerned. Even the term 'impact' carries with it, as has been shown, a covert value-judgement.

That is a feature of social analysis which even the most quantitative of methods will never be able to overcome. The quantitative assessments which the cost-benefit analyst makes, for all their sophistication are bound to be based upon some social, rather

than a purely scientific appraisal of the value, say, of a businessman's, as compared with a housewife's time. Nor can the social scientist, even if he believes that he has discovered a regularity or even a law, establish the conditions under which that regularity might be valid with the precision of which an experimental scientist is capable. While sociologists can certainly make comparative analyses, which help to define those conditions more precisely, in the absence of a genuinely experimental method we cannot hope to be able to define them as conclusively as can be done in an experimental science.

A further difference between the natural and the social sciences is that human beings, though they are by no means as free as they sometimes wish to believe, nevertheless do, as physical phenomena do not, to some degree control the environment of which they are part. For men, as political animals, succeed in changing their own circumstances though it is virtually impossible to state the conditions under which those changes will take place. In any case, such changes often produce unanticipated and even unintended consequences. The population predictions on which, for example, estimates of future water demand are partly based have only recently been invalidated, as an unpredicted and unpredictable change in a generation's reproductive behaviour has taken place.

These considerations explain why social phenomena are very different from physical. They justify my view that the social sciences, if sciences they are, are so different from the natural sciences that it is unreasonable to regard them as immature disciplines which some day will reach the sophistication of 'real science'. This sceptical conclusion should chasten the naive expectations that some social scientists entertain about their disciplines being able to emulate and in due course evolve into fully-fledged natural sciences; but it ought not and does not prevent us from seeking to develop more accurate methods of inquiry. It has, however, a number of implications for the application of sociology to impact analysis which can best be expressed as a series of caveats.

First of all, our ability to predict is limited by the fact that societies do not operate like machines, so that the assumption of mechanical regularity in social behaviour on which prediction depends is frequently invalidated. This applies even to statistical projections (for example, of population) which are only as sound as the assumption is valid that factors such as marriage and fertility patterns, death-rates and medical care will remain unchanged. But since public policy is bound to be based upon some assumptions about future circumstances, it is better that those assumptions should be based on evidence and thought than upon hunch. The sounder the evidence and the more careful its interpretation the more likely are predictions to be valid, even though they are likely to be of diminishing validity the broader they are and the more distant the time to which they refer. The forecasts of probable effects that are made in reports such as the one I produced on the Craig Goch project, while they cannot claim to be irrefutable, can claim to be as sound as the best evidence and the most careful and dispassionate thinking about that evidence can make them.

Second, it follows from my earlier argument that neither a sociologist nor any other social scientist can be entirely neutral in an environmental impact analysis. This recognition that value-

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judgements will inevitably affect policy analyses has led some sociologists of a 'radical' persuasion to argue that, since politics are concerned with value-choices and sociology cannot eschew value-judgements, sociological analysis is totally political. I regard that conclusion as a complete non-sequitur. For it ignores the fact that the sociologist is also committed to the dispassionate analysis of the facts of the case and that while he may not be able to avoid value-judgements, he should be prepared to justify those value-judgements rationally and as far as possible to test them against empirical evidence.

In drafting the Craig Goch report, for example, though I was not parti pris as at the Drumbuie inquiry, I was nevertheless either assuming or expressing certain value-judgements. A sociologist, retained as a consultant in the expectation that he will give honest and impartial advice in matters of policy, cannot claim to be entirely value-free. For in agreeing to prepare that report, I was implicitly accepting the ethical judgements that it was desirable to plan to increase water supplies, that the plan itself was not outright immoral and that the Water Authorities were legitimate authorities. The political value-judgements involved are so generally acceptable as hardly to be noticeable, but they might not have been quite so acceptable from the political vantage-point of, say, a militant environmentalist or even some kinds of 'radical'.

The detail of the report also incorporates obvious value-judgements. In arguing, for instance, that 'every encouragement should be given to local recruitment of labour', I invoked not only the practical justification that this would be consistent with 'the obvious desirability of increasing the flow of money into the local economy' but also the argument of equity, that 'the people who have to suffer these snags should have the first option upon such short-term gains as might accrue from the project.' But value-judgements may also be incorporated less obviously in the very words used. By deliberately using the term 'social control' as the heading for the chapter on the implications of the project for the police and social services, I showed that I accepted it as desirable to minimise, if necessary by police action, the social disturbance to the locality which the incursion of immigrant workers might cause. Finally, my concern with how the project would be phased into the existing pattern of economic development in mid-Wales implied quite clearly that I also considered that policy to be desirable. This evidence therefore demonstrates that, even in a report as tightly related to factual evidence and dispassionate analysis as that, value-judgements have inevitably to be invoked. That was still more evident in my analysis of section 21(5), which quite deliberately aimed to spell out the ethical grounds on which the allocation should be made and to offer some indication of how much ought to be made available. But to acknowledge such value-judgements frankly does not, in my opinion, make the reports in which they occur any the less scrupulous in analysis or lacking in objectivity. For as the great French sociologist Raymond Aron has put it, 'the sociologist seeks to be scientific not by being neutral but by being impartial'.(9)

Finally, it is often said that facts speak for themselves. But that is only partly true. For example, it is a fact that in Powys in 1974, the average gross earnings for men aged 21 and over who were in full-time employment was £37.4 a week. It is another fact that in May 1975 a large engineering contractor was paying basic labourers a

total of £86.1 for a 57-hour week. But how many workers in mid-Wales would have been induced by those high wages to go to work on Craig Goch is a matter of judgement, even though we sought to express it as a percentage probability, in making which many other factors have to be taken into account. Again, when asked what anxieties they felt about such a project coming to their district, 48 per cent of our informants considered that the increased traffic-flows on the roads were likely to be very or extremely serious. But quite apart from the minor statistical error to which answers derived from a population sample are subject, we also know that people's fears are not always justified in the event. So the question is therefore raised as to how much weight we should give to that statistic; and that is a matter of judgement. Thus, however carefully the evidence is collected, since that evidence is often partial, incomplete, circumstantial and occasionally conflicting, the sociologist is obliged not just to assemble it but to evaluate and assess its significance as well.

Sociology, therefore, to say the least of it, is hardly an exact science. Indeed I do not think that it is or ever will be in any precise sense 'a science'. Claims that it, or any other social science, is so are merely rhetorical. Such a conclusion will dismay only those who suppose that only 'science' can produce valid knowledge and understanding. But to recognise that our methodology approximates more closely to that of the historian or the lawyer than to that of the chemist or physicist does not mean that sociology need be either invalid or slipshod in its methods. We seek to quantify so far as we can do so without distorting what we are quantifying; and we seek to argue with a discipline and care that is no less scrupulous for being mostly in words rather than equations. But for reasons which I have been at pains to explain, we are inevitably involved in making judgements both about the values that we invoke and the factual evidence of which we make use that necessarily go beyond the specific data that we collect. This is especially so in applied studies such as impact analyses. The sociologist's credibility is not helped by his making excessive claims for the validity of his discipline. It resides rather in the value of the contribution which he actually makes to specific problems and the honesty and scruple which he exerts in making that contribution. The President of the Institution of Civil Engineers has only recently been arguing that 'the civil engineer works for a great deal of his time on the boundary between the calculable and the incalculable' and that he must necessarily rely to some degree upon 'engineering judgement'. (10) That being so, I hope that I can expect from the members of this cognate Institution some particular understanding as one who, in quite another but relevant profession, is also facing exactly the same problems.

1. For a fuller discussion see: Broady, Maurice, 1975, "The Drumbuie inquiry: David and Goliath in rural development", Community Development Journal, 10, 79.
2. ibid., 85-6.
3. Clark, B.D., et al, 1976, "Assessment of Major Industrial Applications", Department of Environment, London, England, 17.

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4. Catlow, J. and Thirlwall, C.G., 1976, "Environmental Impact Analysis", Department of the Environment, London, England, 44.
5. Professor Maurice Broady and Associates, 1975, "Craig Goch Project: the social implications", Craig Goch Joint Committee.
6. Catlow, J. and Thirlwall, C.G., 1976, 41.
7. Professor Maurice Broady and Associates, 1977, "Craig Goch Project: the implications of section 21(5) of the Water Act 1973", Craig Goch Joint Committee.
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9. Aron, Raymond, 1960, "Science et Conscience de la Societe", European Journal of Sociology, 1, 19.
10. Wood, A.M. Muir, 1977, "Presidential Address 1977", The Institution of Civil Engineers, London, England, 18-21.

DISCUSSION

Author's Introduction

PROFESSOR M. BROADY introduced his paper by commenting on the ambiguous and contradictory attitudes that the general public sometimes had toward engineering projects, and the effect this had on engineers, making them sceptical about the public's reactions. The question for the sociologist was whether one could really be objective where people were concerned.

He had some sympathy with the animus that had been expressed against those who chose to oppose planning projects by militancy or by disrupting public inquiries. To be fair, however, this disruption was often intended to contest the fact - which in other contexts engineers themselves had sometimes been known to do - that the terms of reference of public inquiries often excluded from consideration relevant, if more general issues, such as whether a proposed motorway was needed at all. On the other hand, this militancy might also express a totally cynical attitude towards liberal democracy. It might be based on the view that the law merely served the interest of some exploitative power elite, at the expense of the interests of "the people" - or those whom the agitators chose to regard as "the people". It might well express a root and branch opposition both to political authority and to professional judgement which it cynically proposed to replace by some form of populism or "power to the people".

In rejecting this cynical approach, however, one must not reject scepticism also. Scepticism was the wise man's main defence against the pretensions of a frequently evil world. Impact analysis was one kind of scepticism. For while it did not assume that the engineer and his political masters were crooks, it did recognize the fact that engineering projects had sometimes had undesirable consequences which could have been foreseen, but which their promoters, having an axe to grind, either failed to notice or even wilfully neglected to consider. At one time, questions about the social consequences of engineering works could have been ignored. As one old Scots engineer said, speaking of the possible social effects of hydro-electric schemes in the Highlands, "Well, there might have been a wee bit genetic effect, but that's all". The concerns of the environmentalists, which Professor Edwards had helpfully classified

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in his paper, were legitimate concerns which could no longer be brushed aside.

Both science and politics injected scepticism into our public affairs: science through critical discussions in the journals and conferences, politics through the processes of debate and public argument. Good policy, like good science, derived from the tension between the conviction of its promoters and the scepticism of its critics. Both conviction and scepticism were needed. The sociologist - or any other expert, for that matter - might act in relation to an engineering or planning project either as a convinced advocate who entered the debate parti pris, arguing either for or against the proposal, or as a more impartial analyst who was trying to assess dispassionately both its benefits and its snags. Since the concept "impact" implied damage, he preferred to use the term "impact analysis" only for those cases where, as an advocate, one was mainly trying to demonstrate the disadvantages of a project and to speak of analysing the "social implications" where a more impartial appraisal was being made.

People tended to define things they do not really understand by their most obvious characteristics. Seeing the sociologist with his questionnaire interviewing on the front door-step, people were prone to regard sociology as equivalent to doing a social survey: to finding out the facts. This was consistent with a characteristic English empiricism which assumed that knowledge was a compendium of factual statements. But sociology, like any other discipline, was a way of explaining things: in this context, a way of explaining the kind of socio-economic effects a particular project was likely to have. One or two examples of such explanations were given in the paper. At this point, he wished to make the methodological point that, as well as finding out the facts, indeed before searching for the facts - and as a condition of defining what particular facts (in Mr. Oldfield's terms what "level of detail", were relevant, theories, or at least hypotheses were developed and new methods of analysing those data might have to be developed as well. Facts did not, as was sometimes supposed, speak for themselves!

A further misconception that engineers sometimes laboured under was that unless knowledge was scientific it was useless. A science was concerned with establishing, in its particular domain, regularities, preferably in the form of laws, from which predictions could be made. There clearly were regularities to be observed in the structure of social activity; but they differed somewhat from those that operated in the physical world. This was because it was difficult to specify exactly, and it was certainly not possible to specify experimentally, the conditions under which those regularities were found; because those conditions changed over time; and because we acted consciously, that was to say politically, to change both the conditions and the regularities which they were believed to govern. Nor could sociology quantify its findings, except in a modest degree, without either ignoring certain important and unquantifiable social phenomena or seriously distorting them by trying to do so. Thus sociology, like any other social science, could not predict with the assurance of an experimental science and for that reason it perhaps was inappropriate to describe it as a "science" at all.

What possible use could sociology be, then, in analysing the likely consequences of a major engineering project? That it could not produce

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a fully scientific answer was no real cause for concern, unless one adopted the view that only scientific knowledge was objective and every other kind of knowledge was entirely subjective. To describe something as subjective implied that it was based purely upon personal hunch or intuition or judgement. Of course, judgement was involved in making sociological generalizations, especially when it related to a practical project and to practical decision-making. As Mr. Oldfield remarked, decision-makers accepted that they had to take "the risk of inevitably inexact generalizations", which specialists were apt to dislike making. Judgements were obviously made by individuals and in that sense they could not avoid being personal. But that did not mean that they were merely subjective fancies. For the personal judgements that the sociologist, like the engineer, made came only as the final step in a long process of rational, if not scientific analysis: i.e., analysis of which, as in a court of law, the value of the evidence could be tested, the cogency of the inferences drawn from that evidence could be assessed, and the logical connections that constituted the argument could be appraised dispassionately. Even though our analyses and explanations were couched mostly in words rather than in figures, their quality could be judged impersonally and the good analysis could be clearly separated from the worse. In analysing either the impact or the implications of large-scale engineering projects, therefore, the sociologist could contribute a rational assessment of its likely consequences and thus of the policies that might be adopted in order either to avoid or at least to alleviate those consequences that might be regarded as undesirable.

Verbal and Written Discussion

DR. H.H. CRANN (Welsh Water Authority) commented on the author's contrasting of his different roles as advocate at Drumbuie and as analyst at Craig Goch, and on his remarking that social science involved subjective value-judgements to an extent almost wholly absent from experimental science. It was this significant content of subjectively-influenced value-judgements in sociology that made possible a situation which, in the experimental sciences, would be almost unthinkable - the accommodation within the one discipline of both advocacy and objective analysis.

One of the difficulties in the sociologist's work must be in making valid value-judgements. The author had instanced as a value-judgement, a propos Craig Goch, "that every encouragement should be given to local recruitment". The validity of this proposition seemed questionable on the ground that local recruitment to short-term construction projects could well draw local people from permanent jobs and then to unemployment (as had occurred elsewhere), and so lead to disruption of, rather than benefit to, the local economy. He asked the author to indicate the sort of considerations that led to this particular value-judgement.

The author had touched on the point that environmental impacts, and their sociological aspects, were not confined to the area of a particular development. Just as the Drumbuie development would have social effects locally there would be other social effects, via economic factors, over the larger population of the country as a whole if, as a result of not proceeding at Drumbuie, the platforms were built in Norway. He invited the author to comment on the feasibility and manner of taking this into account.

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He noted that the author had indicated that the expectation of serious social disturbance at Drumbuie might have been exaggerated, and he wondered how feedback of this conclusion, and the consequent improved precision of future analyses, could be achieved in the author's non-quantitative field. Having regard to the similarity between Drumbuie and many of the projects which water authorities carried out, he invited the author's suggestions as to how the adverse social and economic effects owing to the temporary incursion of a large industry at Drumbuie might have been overcome or mitigated if the Secretary of State had decided to approve the development.

On the author's reference to the concept of "the Shetland way of life" and its supposed vulnerability to incursions and influences from outside, he endorsed, from his own experience as one of these "incursionists" in rural Caithness and rural Merioneth, the author's view that this vulnerability and changelessness were frequently overstated. He felt, too, that the interactions between residents and incursionists (and their families) working on such projects had beneficial social effects both on the incomers and the community - effects which he hoped the author took account of in his analyses.

On the part of the paper on S.21(5) of the 1973 Act, he remarked that while this provision undoubtedly had its genesis in the context of reservoir developments in Wales, it was matched by a similar, though less far-reaching, provision in respect of reservoirs in England in S.20 of that Act; and, while not disagreeing with the author's instancing, as an effect calling for compensatory provision, overloading of local recreational facilities by construction workers, he did not think that transient effects of this sort in themselves invoked the provisions of S.21(5), which explicitly referred to communities being permanently affected.

He agreed the author's discounting of the concept that the scale of provision should be percentage-related to the cost of the scheme. Compliance with S.21(5) involved replacement of the lost community facility where this was possible, and otherwise the provision of some alternative facility similar in nature and value to that lost, account also being taken of any less tangible losses to the community. Recognizing that there would be cases where it would be difficult to evaluate a loss, he would nevertheless prefer wherever possible to determine the level of provision on an evaluation, however qualified and approximate this might have to be, rather than by the subjective determination, as the author suggested, of what was "reasonable".

He was glad to admit, however, that one element of the S.21(5) provision for Llyn Brenig which the Welsh Water Authority was at present discussing and which was not based on evaluation, quite fortuitously amounted to the same order of per capita cost as the author judges reasonable - a tribute to his value-judgement in a difficult field!

MRS. KRISTINE BURNETT (Sussex University) emphasized the point made by the author that "common-sense was not enough" when considering social aspects of engineering projects. She gave a few examples of research which showed how attitudes to "environmental impact" could vary from one group to another, and not always in the way predicted.

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The examples were taken from the West Yorkshire Transportation Study (conducted by Wytconsult, a company formed jointly by Martin and Voorhees Associates and Halcrow Fox and Associates). The first concerned attitudes amongst people who lived in parts of Rotherham and who were exposed to very high levels of environmental intrusion from HGVs - as measured by objective standards. However, contrary to expectations, the HGVs did not represent an intrusion to the residents because they were aware of living in an area of heavy industrial activity; and thus the HGVs were quite consenant with their expectation. Indeed, the presence of the HGVs provided reassurance that the area was industrially active and their large numbers meant that there were no immediate threats of unemployment: they provided reinforcement of the concept that the area was a "good" place in which to live.

This example was contrasted with another survey conducted amongst car-owning residents of Todwick; by objective standards Todwick is a suburban dormitory for commuters to Sheffield. This was, however, vehemently rejected by the residents, who claimed that Todwick was a "village" in its own right, even while they admitted that most of its residents, like themselves, commuted to Sheffield or Rotherham and depended on these towns as work centres. Thus, road improvements within Todwick had negative connotations, in that they were perceived as being provided, not for the "villagers" (local residents) but rather as "rat-runs" for people from further afield. This concept reduced the perception of Todwick as an entity and was forcefully resisted. They did not want the proposed road improvements: rather they preferred to maintain the status quo (a rather bad access road), which reinforced their sense of a village community.

These two examples showed how social research could add new dimensions to the understanding of ways in which different groups related to the environment, and judged different aspects of its as more or less valuable.

She expressed concern that the views of the less organized and articulate groups in society were likely to be ignored amidst the clamour of the growing number of middle class pressure groups. Some people argued that the views of those who welcomed the plan to build the Third London airport at Cudlington on the grounds that it would bring jobs to the area, were swamped by the clamour of the better-off property owners. Earlier Lord Sandford had mentioned that rather surprisingly there had been no public inquiry in the case of St. Katherine's Dock development. She did not find this surprising - residents of Lower Hamlets did not operate or express their views through such formal organizations but that did not mean that such views should be ignored. Sociological theory and method could make a valuable contribution to the understanding of these issues, which were increasingly relevant in view of concern about environmental impact.

MR. D.M. GILES (Southern Water Authority) mentioned recent work done by the Resource Planning Directorate of his Authority, which included the investigation of two different ways of providing raw water storage to meet the future demand of the South Hampshire growth area. These were: traditional pumped storage reservoirs, or a less conventional scheme for regulating river flows by seasonal groundwater abstractions which were becoming an increasingly popular means of managing water resources.

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The two alternatives had quite different environmental impacts. In the case of surface reservoirs, the visual impact was significant for a large number of people as they passed the site on a motorway, for example. Groundwater schemes, on the other hand, had a negligible visual impact but by changing river flows they might be seen as affecting the sport of a relatively small number of highly influential people who owned much prized game fishing on the Hampshire rivers.

Arguably, the environmental effects of these schemes were beneficial but that did not absolve the Authority from the responsibility of taking environmental impact into account at the pre-public inquiry stage. He thought that as a sociologist the author might be in the best position to answer two questions arising from this work. Firstly, was a water authority right in assuming that consultation with public bodies such as the County and District Council, the Ministry of Agriculture, Fisheries, and Food, and The Nature Conservancy Council reflected adequately the views of the public in the early stages of an investigation, or should more direct contact with the public be made? If more direct contact was recommended, how should this be undertaken? Secondly, how did one balance objections from a relatively small number of very influential people against those from a large number of the general public? Should comments on a scheme from a Peer of the Realm be allowed to carry more weight than those from a Commoner?

MR. J.G. HYSLOP (EM Management Ltd.) referred to the emotional and subjective approach of sociological assessment of construction works: if the case presented was weak, the emotional content was greatest. He compared the different approaches adopted by the author for the Craig Goch Inquiry, and the case presented against Drumbois and suggested that there was an ambivalence which called the neutrality of the sociologist into question. The expense of engineering works meant that they were promoted only after searching and detailed engineering and financial analysis and examination.

He suggested that as commercial organizations would also pass on the costs of any compensatory levies to their customers, there was no equity in exempting public authorities. If no benefit accrued to an authority from the proposed works there was no justification for them.

MR. H. SPEIGHT (Southern Water Authority) suggested that, with all that was being said about environmental impact assessments, there was a danger that the public might be led to overlook the fact that the 1973 legislation had done more than simply create very large water supply undertakings and very large sewage disposal authorities. He appreciated that Institution members north of the border and across the Irish Sea had not been included in what, he recollected, had been described earlier that morning as very advanced and effective legislation in the technical sense. Nevertheless, England and Wales had, in the Regional Water Authorities (RWAs), bodies which were environmental custodians; regulatory bodies active in water quality control and which had oversight of the manner in which water abstractions were authorized; bodies which were charged to have regard to the preservation of flora and fauna and objects of architectural and historic interest; but bodies which also had responsibilities for more direct and day-to-day activities such as fisheries and recreation.

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There was available within the RWAs a fund of expertise which now permitted internal evaluations of environmental impact to be made, and it was important to stress that such evaluations were regularly being made. To a degree they had been made for many years by the predecessor bodies, what had changed was the breadth which they could now encompass. There was no shortage of sensitivity or of ability within the RWAs, but the environmentally sensitive public clearly felt that not enough was being done in this direction. He suspected also that the academic world might, at times, come to the same conclusion insofar as not all the relevant expertise was available within the RWAs nor, possibly, was it being employed from outside sources frequently enough. It was of interest in this connection to recall that it was only in the years immediately preceding reorganization that biologists employed by the then river authorities began to contribute their particular expertise as a matter of course on water quality matters. Hitherto the expertise of the chemist had been regarded as sufficient to reveal all and the time might yet come when the RWAs would find themselves employing resident sociologists to provide an in-house contribution to the overall assessments provided by engineering, science, ecology, and sociology.

He believed that the problem to be faced was that of securing a greater public perception that the RWAs were both capable of taking, and indeed were taking, an objective view in assessing the effects of new developments which impinged on the water cycle. The Institution's symbol of Aquarius summed-up the situation in the sense that the sensitivity to the potential consequences of his actions was reflected by the fact that he was obviously pondering very deeply indeed about what they would be. No-one had ever doubted, at least not in his hearing, the ability of mind and science which the pondering pose represented, but perhaps the time had now come for the Institution to animate the emblem. If, for instance, Aquarius were to turn clockwise through 110 degrees we would see him face to face and it was more than possible that he might be seen to display surprise at finding an audience observing him attentively. His ponderings were deep and had been going on for many years and, hitherto, the logical outcome of each pondering session had been to get on with the job of building something which added to the quality of life in an effective and economical way. Having got over his surprise Aquarius would doubtless put his bowl to one side and would then be seen engaging in discussion and consultation with those whom he had so recently ascertained were expecting him to explain what it was all about.

He saw the immediate goal as that of securing a better public perception not only of what was being proposed in any particular engineering project but why ... and how it would (or would not) affect the contemporary environmental situation.

It might be that this better perception and understanding could arise directly from more and more participation. He hoped, however, that the industry would not go overboard in advocating any wholesale adoption of environmental impact assessment without first attempting to achieve the desired goal by less time-consuming methods. He sought from the author in fact what Mr. Giles had sought earlier, an indication of how better public perception might be secured without making the environmental assessment, rather than the engineering works, the end-product of the whole activity.

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BRIGADIER C.C. PARKMAN (Ward, Aschcroft and Parkman) wrote that he did not agree that the civil engineer was not sympathetic to EIA, but the civil engineer was normally a practical man and felt that any EIA study must include the economy of the proposal.

He was surprised that the author had not mentioned the environmental impact study commissioned by the Scottish office for the Drumbuie Inquiry and carried out by Sphere. This study dealt with all the aspects - cultural, social, physical, and economic - of the platform site proposal and provided the factual base for the debate in which the author, along with several other eminent specialists of various disciplines independently commissioned by the National Trust for Scotland, played a part.

He did not believe that an impact analysis should be an advocate; he thought his objection to the advocacy approach was best illustrated by a quotation from the paper, in which the author said "there was virtually no unemployment in the immediate vicinity of Drumbuie for the economy was thriving and the population slowly increasing." The author did not say, although it was true, that there was practically no male or female between the ages of 16 and 40 in Drumbuie because they all emigrated to work in the Strathclyde area, or that the infrastructure including rail and road was in rapid decline, or that the increase in population was caused by an influx of retired business people from Edinburgh.

Author's Reply to the Discussion

PROFESSOR M. BROADY said he thought that most of the major points raised in the discussion concerned the balance between objectivity and subjectivity in sociological analysis. Mr. Hyslop, for example, had referred to "the emotional and subjective approach" of the sociologist while Dr. Crann was anxious about "the content of subjectively influenced value judgements in sociology".

People's "subjective" perceptions and attitudes were among the data with which sociologists had to deal. In his view, the analysis of these "subjective" phenomena could be objective. The social scientist could describe them accurately and then analyse and explain them objectively. At present, the scientific evidence about people's reactions to engineering projects was fairly sparse; but the more evidence was collected the more likely it was that the reason why some engineering projects caused social disturbance and others did not would be understood. The more careful were the inferences that were drawn from that evidence and the more discriminating the assumptions and the concepts that were used in analysing it, the greater the objectivity achieved. He was pleased that Dr. Crann's direct experience had confirmed his own more analytical criticism of the concept of "a way of life".

Replying to Mr. Giles' point, he considered that the views of official bodies were not always identical with those of the general public. That possibility had been recognized in the obligation which recent planning legislation had imposed upon local authorities to give citizens the opportunity to participate in the planning process. Public meetings could certainly help to elicit public opinion but, as Mrs. Burnatt had indicated, the views of the less articulate members of the public might even then not be sounded. In any case, the opinions of

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influential or particularly vociferous people might carry greater weight than those of the general public. The public's views, however, could be established systematically and reliably, as was done in the Craig Goch inquiry, by the careful use of random opinion surveys. But even then, technical or political considerations might justify a water authority, for example, in adopting policies that some sections of the public might object to initially.

In reply to Mr. Speight's question about how "better public perception" of engineering projects could be affected, that was a problem for a public relations expert rather than a sociologist. The sociologist's prime obligation was to establish facts validly and to analyse them impartially. In the Craig Goch inquiry, for example, a sample survey was used to assess public reaction to the proposed works. The fact that about 80 per cent of the sample were in favour of the project was obviously more helpful to the promoters' case than if only 10 per cent had been for it. But whether he was acting as an analyst or as an advocate for or against a project, the sociologist had to establish such data objectively and his first obligation was to strive for such objectivity.

He emphasized, however, that in using such data to make inferences about the probable future effects of a new project, judgements were inevitably involved that could not be quite so objective. He hoped that he would not be condemned for candidly drawing attention to this fact which was true of any applied science, including engineering. This was because, in practice, circumstances were always much more complex and idiosyncratic than were the laboratory conditions under which pure scientific propositions were established. Scientific propositions were general statements; but projects were specific and particular, so it was always necessary to adapt general principles to the specific circumstances of the particular case. This was even more necessary in projects where people were involved than it was in the case of engineering. Thus, if the sociologist had better evidence and more accurate concepts, he would certainly be better able to anticipate the consequences, both good and bad, of a given project, and so to recommend policies that might mitigate any adverse effects. But even so, he could not have the same confidence in his predictions as even an engineer could in his since they depended upon many more uncontrolled, and uncontrollable variables than the engineer had to contend with, such as the calibre of the gangers in particular construction companies. But better a reasoned expectation, backed by good evidence and sound thinking, than mere hunch.

The scope of a sociologist's inquiry was obviously governed by the brief that he was given, which defined many of the value judgements that must inevitably be made in any investigation. What ought to be included in the study was so defined. It was perfectly reasonable of Dr. Crann to ask whether a sociologist would consider the wider social effects of engineering projects. But public bodies only retained sociologists to consider what they regarded as relevant to their needs. In the case of Craig Goch, the Water Authorities' brief limited the investigation to the effects in "the project area", while in the Drumblie inquiry it was a government department interested in promoting that project which argued the wider economic benefits of the scheme, since it presumably regarded such considerations as favourable to its case.

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In accepting a brief, a consultant at the very least went along with the assumption that the project was worthwhile. Certainly, he would *hardly be retained if he were likely to argue otherwise*. To that extent, he was already committed to the project; and in his opinion it was more honest to recognize that than to dissimulate. But the degree to which he was parti pris varied according to whether his role was primarily that of an analyst or an advocate. For to be, in one sense or another, parti pris did not mean that the sociologist could not be relied upon to deal with evidence and inference carefully and impartially. [This was especially the case if his role was that of analyst. In short, though no consultant could be neutral, that did not prevent his being impartial in collecting and analysing the evidence. The distinction between neutrality and impartiality needed to be much better understood.

Finally, much concern had been expressed about value judgements. In his view, they could not be avoided in decision making. The anxiety which had been expressed derived in large measure from a false polarization of subjectivity and objectivity. Dr. Crann, for example, had contrasted what he described as "subjective value judgements" with the allegedly total objectivity of "experimental science". He claimed to prefer even an approximate quantitative evaluation of the effects of a project to what he called "the subjective determination ... of what was "reasonable"". But this totally ignored the fact that quantitative estimates of such effects themselves rested upon assumptions that were no less subjective. Indeed, engineers often complained that the single-minded application of economists' or accountants' quantitative yardsticks produced misleading evaluations of the relative merits of alternative ways of dealing with engineering problems. Moreover, the "subjective" assessment which he advanced was not just hunch, as the pejorative term "subjective" suggested, but was based on reasoned argument and the analysis of such relevant quantitative evidence as was available at reasonable cost.

Dr. Crann asked for an explanation of the value judgement "that every encouragement should be given to local recruitment" of construction workers. This rested upon the proposition which could be justified by good reasoning, that the first option on any benefits should go to those who had to suffer inconvenience from the project. But it also depended upon the quantitative estimate that to employ about 200 men out of the regional labour-force of 17,000 was likely to cause only marginal inconvenience to existing industry. Both factual evidence and reasoning were involved in any soundly-based value judgement.

To describe a proposition as "subjective", however, implied, as Mr. Hyslop's statement indicated, that it was merely emotional and therefore untrustworthy. It also implied the opposite, that if a proposition was "objective" it was totally valid. Validity in that case was often equated with quantification. But quantification was not always the touchstone of validity; indeed, it could sometimes produce quite misleading results, as had been demonstrated of some forms of cost-benefit analysis, which itself was by no means free from "subjective" judgement. But we frequently used the term "subjective" when all we meant was "personal", and personal judgement or discretion was always used in making decisions, the more so the higher up the level of responsibility one was. Nor were such judgements

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always capable of being expressed quantitatively. They were no less good for that: for a "personal" judgement was not invariably a mere emotional hunch. For even in such discretionary judgements we were entitled to look for good reasoning and sound evidence - and quantification as far as possible. In the difficult task of social analysis it was in that sphere of rational, if not always quantifiable, and still less scientific, analysis that the sociologist, like all other social scientists, operated.

4. THE ENGINEER IN ENVIRONMENTAL DESIGN AND MANAGEMENT

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Groups from within the broad 'environmental movement', which has developed in the last two decades, are classified with respect to goals and examples are given of issues involving conflict over current engineering philosophy and practice.

Comment is made on the changing role of the engineer with the structural re-organization of the water-industry, improvements in the scientific data-base and the greater emphasis on conservation and environmental protection.

To an outsider, the 19th and early 20th centuries seemed to provide the most favourable and conducive climate for dramatic, individual engineering enterprise in Britain. This period of accomplishment drew heavily on pioneering contributions made earlier: the first pound locks in river navigation were introduced by John Drew in the 16th century; the transfer of water from Hertfordshire to London by a 38 ml artificial water-course, and its subsequent reservoir storage, was completed by the beginning of the 17th century; the extensive drainage of the Fens had been accomplished by Vermuyden about fifty years later; our intricate canal system, started by Brindley and Smeaton, was well advanced by the end of the 18th century. Nevertheless, it was the pressing social and public health problems associated with the growth of populations in the developing cities of the 19th century, generated by the Industrial Revolution, which created the demand and challenge needed for the development of municipal and water engineering. Chadwick in his Report on the Sanitary Condition of the Labouring Population (1842) saw the chief remedies emanating from applications of the science of engineering; amongst these was an insistence that sanitation should be hydraulic, arterial and water-carried with pipe-drains to every house. Such increased water demands and the cholera epidemics of the period reinforced the need for ample and protected water supplies. The provision of upland direct-supply reservoirs kept civil engineers busy for many decades and it is said that Bateman alone designed schemes for 30 major towns and cities. This rapid growth of engineering in the 19th century gave rise to formal educational recognition of the subject and

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the institutional establishment of the profession. By 1818 the Institution of Civil Engineers had become established, to be followed in 1873 and 1896 by those of the Municipal and Water Engineers respectively. (Armytage (1))

Much seems to have changed since those 19th century days when single-minded engineers seemed to achieve far more than might be expected of mortals. This apparent change may be a distortion of perspective which time will correct but there seem quite explicable reasons, both intrinsic and extrinsic, for the re-mortualization of the engineer. The intuitive elements of engineering have been eroded by science and teams with complementary skills have replaced the individual designer. The growth of population, with its rapid concentration in cities, providing much of the social thrust for municipal engineering, is spent and industrialization might now be regarded as in a substitutive phase of an overall 'steady-state'. But in addition to these special factors, and possibly the stifling of enterprise in mature societies, there are changing environmental attitudes and utilization patterns which impinge on the traditional freedom and role of the engineer. It is these contemporary environmental attitudes and uses which I shall attempt to analyse from the viewpoint of the applied ecologist, seeking also to identify engineering responses associated with these recent changes.

The environmental movement, which has grown appreciably in the past two decades, is composed of an agglomeration of groups which, although frequently overlapping in their sentiments and objectives, sometimes have quite separate and even conflicting aspirations. The following represent some of the more important groups and typical issues which concern them.

1. There are those who are anxious about the profligacy in the utilization of non-renewable resources, and even renewable resources the wasteful use of which diverts attention from worthwhile human endeavour. This group, which might be described as the resource conservationists, is essentially concerned about man's future welfare, extending the time-scale of responsibility for contemporary actions. (Meadows (16))

In the field of waste-treatment technology, for example, it has expressed anxiety about the waste of resources in the 50% of sewage sludge which is produced and not returned to productive farmland or used for energy generation, its particular focus being on the inorganic plant nutrients (N and P) which such sludge contains. Analysis shows however that the full utilization of these elements from sewage sludge on the land would make a comparatively small impact on our fertilizer requirements, constituting less than 5 and 10% respectively of the N and P currently used, but a more fundamental challenge of the basis of waste-treatment, which aims, in breaking down organic matter to small molecules, to reverse the primary objective of our agricultural system of organic synthesis, seems far more worthwhile. The sewage-treatment system is actually not very efficient at breaking down organic matter, most being left as sludge, nevertheless it is the waste of organic matter in sewage sludge, representing the plant production of more than 150,000 ha

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or 1.5% of good agricultural land (Grades 1, 2 and 3) in Britain, which should perhaps be of more concern both to the resource conservationist and waste-treatment technologist.

2. Many land-owners and farmers, their anxiety often emanating from the sacrifice of good agricultural land for water-storage (a problem highlighted particularly by the lowland pumped storage schemes of the last 20 years), and many fishery owners and anglers (their annoyance stemming from damage to exploitable fish stocks by inadequate pollution control measures and unnecessary, ill-conceived or poorly executed land-drainage schemes) are also resource conservationists but their basis is more practical than the first group, their time-scale more immediate, and the focus of their attention more location-orientated.

The field of land drainage is one which creates much conflict. In the hillier and wetter areas of Britain where salmonid river fisheries are important field-drainage frequently improves crop and stock yield (Cole (8)) but inevitably the field-drainage of large areas of catchment causes accelerated run-off and low dry-weather flows. The loss of aquatic habitat, caused by field drainage, is often exacerbated by arterial drainage which removes the riffle-pool sequences so essential to salmonid stocks (Moyle (17)). The resolution of the requirements of these two apparently conflicting resources, farming and fisheries, is left principally to the drainage engineer who occasionally reveals not only an insensitivity to the needs of fisheries but also an ignorance of hydrological principles (MacDonald (15); Liddell (14); Elson and Tuomi (12)). The preparation of Conservation and Drainage (Water Space Amenity Commission, in press) should improve mutual understanding of problems if not the technical competence of design solutions.

3. There are those who believe that the moral responsibility of man should extend more firmly to the rest of nature (a biocentric morality or metaphysic rather than an anthropocentric one) and are critical of the tradition of Western civilization, developing from the Greek philosophies and Christian theology, that man is free to deal with and transform nature as he pleases, regarding it as a system of resources, since it exists only for his sake (Passmore (19)). Both Descartes and Bacon, who has been called the philosopher of industrial science (Armytage (1)), had this anthropocentric vision of nature and its exploitation, which finds expression in the application for Charter of the Institution of Civil Engineers that civil engineering 'is the art of directing the great sources of power in Nature for the use and convenience of man'. The basis of Nature Conservation, particularly that of the protection of rare species and communities seems to rest in part on a broader biocentric viewpoint.

The most publicized example of conflict between the development of water resources in Britain and the protection of rare species and communities of plants has undoubtedly been the creation of Cow Green Reservoir, Teesdale, within an area containing a unique assemblage of arctic and alpine plants left since the end of the last ice-age, and required principally for

industrial water supply. Parliament approved reservoir construction with certain safeguards of the flora and fauna. Subsequent detailed investigations of the area, supported largely from industrial sources (Clapham (7)), have demonstrated that reservoir impact is not as extensive as was first suspected.

In the U.S.A., following protective legislation with respect to endangered species in 1973, there have been some substantial delays to water resource programmes, none more dramatic than that to the £65 mill Tellico Dam project on the Little Tennessee River. Below the dam is the only recorded site of the snail darter, a fish discovered only a few years ago. It has been suggested that river regulation might cause its extinction. Whilst the colonization of reaches of the neighbouring Hiwassee River is being attempted to provide another site and to allow the scheme to proceed, this particular example has focused attention on the need to re-examine the absolute conservation priority conferred on endangered species.

4. The fourth environmental group might be regarded as the preservationists, resisting change and seeking the maintenance of traditional land-use and management patterns. This psychological comfort of stability, whilst understandable, sometimes prevents real improvements in human welfare and constrains man's natural adaptability. Much resistance to the construction of upland reservoirs, in areas of low land productivity and value and of visual monotony, emanates from this source. Mr. E. Hutton in 'A Book of the Wye' published in 1911, only about a decade after the construction of the Elan valley reservoirs, reveals this adaptability when writing about the beauty of the upper Wye valley

"But after all, I suppose the chief sight to be seen from Rhyader is the Birmingham Water Works and Dams. They sound prosaic enough, but on inspection prove really none so bad. Here is our modern form of Romance and it is tremendous enough to astonish and impress even the most convinced rebel against modernity".

In the field of land-drainage, resistance to changing management techniques has been expressed in opposition to dredgers, whose access to channels is made easier by the removal of hedges, and more widely to herbicides used for aquatic weed control. Such resistance is not always soundly based and in the Gwent Levels of Wales for example, an area of 8250 ha of predominantly pasture drained by 1400 km of permanent channels, historical study suggests that there has been little change in hedgerow length since the introduction of mechanical dredgers in the 1930s and despite the annual application of the herbicides dalapon and 2-4D to all main channels for the control of emergent plants since 1966, most plant species which were recorded in the early 19th century remain similarly distributed today, often within the same localities. Of those species which have changed their distributions far more have increased their distribution or been recent additions than have decreased in distribution or disappeared (Wade (24)).

5. The last well-defined group of environmentalists, the recreationists, seeks to utilize water-space more extensively. In most recent reservoir schemes there has been not only substantial recognition of the importance of recreational provision but also a sensitivity and understanding of conflicts between certain recreational pursuits and the incompatibility of some with nature conservation (Saxton (20)).

There are, however, even in the engineering profession, preservationists who grossly overestimate the adverse effects of some recreational activities on water quality in reservoirs and still prevent access to direct-supply catchments. In many direct-supply reservoirs, with simple treatment facilities, the angler is still prevented from using ground-bait, a practice widely regarded as crucial for productive coarse-fishing. The restriction should be factually substantiated or withdrawn for calculations suggest that, in a budgetary sense, the input of organic matter or plant nutrients from ground-baiting is unlikely to be of any significance when compared with other sources of these materials from catchments and, in the case of organic matter, by algal synthesis in the reservoirs themselves.

In practice, the divergence of philosophy and aspiration between environmental groups produces conflict of objectives in apparent allies as to what is environmentally best and there can be no coherent view. The engineer as the designer of major schemes has traditionally been arbiter seeking the optimal environmental compromise compatible with the primary objective of the scheme, whether it be economical water-supply, land-drainage or waste treatment. In recent years there have been some outstandingly good evaluations of the environmental impact of estuarine barrage projects leading to alternative designs mitigating damage and maximizing benefit (Corlett (9); C.W.P.U. (6); N.E.R.C. (18)) sponsored by the Water Resources Board and latterly commissioned by Central Water Planning Unit. Such impact studies are generally site or location orientated however and one of the major current needs is to extend these rigorous environmental analyses to evaluate current practices and proposed methods of operational management. The restriction on ground-baiting in direct-supply reservoirs has already been cited; other examples include the impact of channel modification on fisheries and methods of weed control for flood prevention (Dawson (10)). Some progress has been made through studies, commissioned by the Central Water Planning Unit, on such subjects as the impact of ground-water abstraction and storage on chalk-stream ecology and the effects of flow regulation and inter-catchment transfer, but the identification of subjects remains capricious. Whilst in the field of safety-evaluation of biocides released to the environment the Pesticides Safety Precautions Scheme formalizes safety testing, evaluation is solely of direct toxic effects and not of the environmental consequences of their biocidal success on the target organism (Brooker and Edwards (5)). For example, it seems that the effectiveness of dalapon and 2-4D in killing bank-side vegetation of channels is causing bank erosion in some areas. How widespread is this problem and what application strategy would

minimize the damage?

It is only in comparatively recent years that water engineers, with their practical, numerate and objective-orientation have had much sensible dialogue with aquatic ecologists, whose subject has been transformed in the past decade by techniques introduced from other fields to analyse complex systems and model their behaviour. This change in ecological orientation now makes the involvement of ecologists in design and operation evaluation worthwhile. With respect to reservoirs, Steel (21)(22) has demonstrated the influence of algal growth and zooplankton grazing on water quality and its implications in system design. Thomas and Compston (in press) have designed an amenity lake in Ghana to reduce weed problems by considerations of basin shape, depth regulation, shore management, introduction of fish predators and use of de-stratification techniques. George and Edwards (13) have demonstrated the effect of wind-induced currents on spatial patterns of phyto- and zoo-plankton and have modelled these effects to optimize outfall siting. With respect to channel design and maintenance Brooker et al (4) and Dawson (11) have calculated Manning friction coefficients, evaluating the effects of weedgrowth-flow inter-relations. Brooker (3) has also produced a nomograph to help drainage engineers predict the effects of any herbicide induced weed-kill on the oxygen resources of a channel and on its fish populations. These examples demonstrate the change in hydrobiological territory and the erosion of the disciplinary no-mans land between the water engineer and the aquatic ecologist - a change to which the water engineer, system designer and operational manager might respond more readily.

To what extent has the training of engineers reflected these environmental developments in aspiration, use and evaluation procedure? With respect to formal education, comparatively few University Engineering Courses explicitly indicate in prospectuses that there is any broad consideration of the impact of engineering on the natural environment or of the changing constraints to which the engineer is exposed. The compulsory paper on 'The Engineer in Society' required by the Council of Engineering Institutions for entry to the engineering professions seems, from the student reading list, particularly deficient in books on natural resources and conservation. A few University engineering courses, such as those at U.M.I.S.T. and Imperial College, London (Baldwin and Wyatt (2)) are making serious attempts to introduce courses giving students an awareness of environmental issues and problems. Other Universities, such as Aston, have introduced general educational programmes, involving lectures and discussion groups on important contemporary themes, for a wide spectrum of disciplines: the opportunity which this approach affords to structure inter-disciplinary discussion is commendable.

The shifting, and seemingly retracting, ground of the engineer in environmental design, with the growth of environmental legislation and the planning profession and with the increasing diversity of data inputs, is matched by the changing role of the engineer in environmental management. With the fragmentation of the water and sewage industries before 1973 and their heavy

dependence on technical understanding, the dual engineer-manager seemed a reasonably efficient and economic solution. Confusion over roles sometimes presented problems however. With the establishment of the Regional Water Authorities, of considerable size and expanded function, corporate management, freed from the dominance of one technical discipline, has been both possible and desirable. However given the disciplinary spectrum of management in parent organizations it is understandable that at this early stage in the evolution of Water Authorities, engineers abound in the higher echelons of management: disciplinary balance may take many years to achieve. It seems therefore that in the future, in both environmental design and operational activities the engineer will less automatically play the role of manager, his talents being focused technically and in parallel with those from other professions and disciplines. The extent to which the engineer emerges, from those of contributing disciplines and professions, as the natural coordinator and leader in corporate management will increasingly depend not on historical privilege but on personal skills and attributes, including those providing an awareness and responsiveness to changing environmental aspirations, problems and conflicts. However the technical demands of his subject give the engineer experience in translating briefs of cost constraints and seemingly conflicting requirements into practical solutions, often incisively and occasionally elegantly. This translation is what management is about. No doubt the challenge to the engineer of retaining his eminence in environmental management will be the keener with a competitive meritocracy displacing historical privilege.

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DISCUSSION

Verbal and Written Discussion

MR. H.J.M. SPEED (Newcastle and Gateshead Water Company), in opening the discussion, said that no one now denied the need to take a broader view of an engineering project: perhaps it would be more accurate to say few people, rather than no one, since clients in the private sector were still naturally disinclined to spend more than the bare requirement.

The author talked of the traditional narrow view of the engineer and, at least in the paper, described this as the anthropocentric view. The quotation from the definition of civil engineering by Threadgold, was taken a little out of context of the original definition which ran to some 750 words; indeed, the phrase was becoming quite threadbare! It was only fair to Threadgold to look at the conditions persisting at the time when he wrote his definition. It was a time of rapidly accelerating industrial revolution; a burgeoning population was overwhelming towns which were already overcrowded. There were frequent epidemics and there was widespread disease. What in these circumstances was the crying need? The answer was the survival of man himself. Socially, the country was near the bottom of Maslow's "Pyramid of need" and it was only natural that engineers' energies should be diverted to ensuring the survival of their own species; the anthropocentric approach was the right one then. The natural environment probably did suffer, although it had the capacity to absorb and adjust at least to some of the shocks of the industrial revolution. However, when the balance of nature was disturbed it tended to fight to restore the position and he suggested that the pressures from the various environmental lobbies today were, to a large measure, nature's reaction to the liberties taken during the country's industrialization.

The author referred to the narrow view taken by engineers but he himself did not think it was entirely fair to blame engineers alone. They were employed by clients and if there was no client then there was no money and no project. The client had in the past required, and still required, a scheme to be as economical as possible and essentially the engineer had to produce a pragmatic compromise optimizing nearly always in terms of first cost and running costs rather than some ideal "best" solution. But what was "best"? He thought that it depended very much upon the culture one was talking about. In an impoverished country, the cheapest solution was almost certainly still the best, indeed the only one available. It was only where a degree of affluence existed that it was possible to leave the purely anthropocentric, or perhaps even sociocentric, solution, afford the extra cost or delay, and generally put in the extra effort needed to find a more naturally sympathetic compromise. This compromise had to be made, of course, not just in terms of the biosphere but of the overall balance of sociological economic, aesthetic, and all the other impinging forces, interests and disciplines.

Traditionally, the engineer had found his pragmatic compromise on his client's behalf by doing just enough to satisfy objectors and in many cases, as the author allowed, a good, even excellent, solution was achieved. Today the inclusion of the views of experts in biological

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MR. J.A. TINKLER (Wessex Water Authority) referred to land drainage and agreed that it could not be gainsaid that there had been a swelling protest about some of the side-effects of land drainage especially upon wildlife conservation, landscape, and fisheries.

This was not to say that land drainage had reached the depths of environmental disfavour of, say, DDT, nuclear waste disposal, or white bread, but it was certainly bad enough to be dismaying to water engineers involved in land drainage who found that the environmental changes their schemes had been seeking to achieve for the benefit of agriculture or urban flood alleviation had, fairly suddenly, been overtaken by a change of emphasis - a change which resulted in a much greater value being placed upon some of the side-effect disbenefits and which called therefore for either a cessation of some schemes or operations, or for changed practices to minimize the environmental disbenefits. Wessex Water met this situation very early in the days of the new Authority and he described the ways by which they had sought, since 1974, to reduce the conflict between land drainage and the environment and even to achieve some degree of harmony.

In 1975 a multi-disciplinary group within the Authority prepared a set of guidelines for the guidance of staff, both design and operations. The first part specified all the consultations to be made, both within the authority and with outside bodies, before work was undertaken.

In addition to consultation on specific projects, commencing as early as possible in the scheme's gestation period, they were also twice-yearly liaison meetings with staff of nature conservation bodies when the works programmes for all the Authority's functions were discussed and likely areas of sensitivity were identified. These meetings were at divisional level and among the matters raised at the last meeting were, for instance, the re-routing of a new water main through an arable field instead of, as originally intended, through a piece of what turned out to be floristically interesting downland and the existence on a river bank of the Large Odder, a parasitic plant on nettles, which was fairly rare, and how the plant's existence on that reach could be safeguarded.

Consultation was only one part of the guidelines. The other part was a manual of good practice to enable river works to be executed with as little environmental disturbance as possible.

MR. M.W. KNILL (Southern Water Authority) mentioned four reservoir schemes which had been undertaken in the last two decades and demonstrated the changing climate of public opinion on environmental issues during this period.

The number of witnesses now to be called at a Public Inquiry into a reservoir scheme was becoming frightening. It was unlikely, however, that even the widest cover of relevant disciplines would convince many emotional opponents of schemes that they were not right to pursue their objection for as long as possible, even well beyond the point where any scheme might have statutory authority.

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Reference had been made to the need to increase the environmental awareness of the young engineer during his education. To endeavour to inject fairly narrowly based courses to meet this need seemed less preferable than the broader approach referred to at Aston and, indeed, practised at Imperial College over the last quarter century. The problem seemed to be the very limited number of centres of higher education which were endeavouring to broaden the outlook of the traditionally narrow-minded average engineer.

MR. J.R. FAIRBANK (Southern Water Authority) thought it might be useful to consider, as an object lesson, his Authority's recent experience with regard to Amberley Wildbrooks, already mentioned during the day.

The Amberley Wildbrooks Scheme was, it was believed, the first land drainage proposal to be the subject of a Public Inquiry, and although it met all the Ministry of Agriculture, Fisheries, and Food economic criteria, the Minister was unable to approve it for grant aid because the site was of considerable importance to conservation interests. The Wildbrooks in their undrained state attracted considerable numbers of wintering wildfowl and waders, and were important for other fauna, flora, and natural history features unique to the site.

The Southern Authority was attempting to follow practices similar to those of the Wessex Authority, already mentioned by Mr. Tinkler, in taking some trouble to consult with conservation interests in advance of its schemes. How then, did it come to pass that one of its schemes was rejected in this way?

Mr. Fairbank's formula for success with regard to arterial land drainage schemes was:-

$$C + K + f's = H$$

that is:-

**Consultation (between the promoters and conservation interests
+ Knowledge (of the environmental situation) + Money (for
compensation) = HARMONY**

Unfortunately, with regard to Amberley, all of the terms on the left hand side of the equation were deficient. Although the Authority was now carrying out consultation in a way thought by all concerned to be satisfactory, early attempts at liaison (dating back to before water reorganization and including the designation of a conservation zone) were insufficient to prevent conflict. Similarly, in the early stages of the scheme, the Nature Conservancy Council lacked knowledge, being unaware of the considerable value of the site to their interests. Finally, there was no source of funds to compensate the farmers for their lost farming potential if the scheme they had requested were not carried out. So, while the Authority were carrying out consultations in a way that the conservation interests considered satisfactory, and whilst the Nature Conservancy Council were increasing their knowledge of sensitive areas as fast as their resources would allow, there was still apparently no immediate possibility of there being money made available to complete the equation.

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The money problem was rather by-passed in the WSAC "Conservation and Land Drainage Guidelines, Draft for Consultation", which suggested that works of environmental protection were "often low cost". This would probably be the case for most works required to mitigate any harmful effects, and such works would hopefully be grant aided. However, this would not be so in "no-go" situations such as that at Amberley. For these, the Porchester report on Exmoor made the realistic suggestion that farmers denied the opportunity to realize their full agricultural potential should be compensated from national funds.

Until the money problem was solved at governmental level so that the equation could be completed, there would continue to be conflict rather than harmony.

MR. E.J. PIPE (Central Electricity Generating Board) referred to the lack of a consistent attitude to industrial developments among environmentalists.

In the mid-1920s the electricity supply industry constructed a hydro-electric reservoir at Maentwrog in North Wales and this attracted opposition. However, a lapse of 30 years seemed to change the outlook. In 1958, by which time the reservoir had metamorphosed into Llyn Trawsfynydd, the Central Electricity Generating Board proposed to use it for cooling the projected Trawsfynydd thermal power station. An environmentalist organization responded by issuing a pamphlet which included a photograph of the reservoir on the same page as a sketch of the proposed power station. Against the sketch was printed "We do not want to exchange that for this". Their opinion of the reservoir was further indicated by the fact that the pamphlet consistently referred to it as a lake and described the region as "unspoilt". The implication seemed to be that reservoirs were nice but that steam raising plants were nasty.

Another 12 years or so elapsed and back across the border, the Trent River Authority was considering the need for a new reservoir. An environmentalist organization prepared a publication which indicated their dislike of reservoirs and pointed out all the alternative means which, they thought, were available for supplying water. Among them was a distillation plant which, of course, required extensive steam raising plant. The implication seemed to be that reservoirs were nasty but steam raising plants were nice!

MR. J.E. THACKRAY (Severn-Trent Water Authority) wrote that the author, in presenting his paper, regretted that there was not some organization at the centre to take the place of the former Water Resources Board in undertaking "dispersed" analyses, e.g. of desalination, etc. This comment was worrying in that it seemed to show a lack of understanding of the mechanisms presently available within the water industry.

In practice, the National Water Council with the aid of the Water Research Centre (both National bodies) was able to produce a review of desalination published in December 1977*.

* Desalination 1977, 1977, National Water Council

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His concern was that there seemed to be a yearning for some "authoritative" national body who could be persuaded of a particular section's point of view, and once having been so persuaded, who would have the authority to impose it on Regional Water Authorities. This prerogative could only reasonably be exercised by Government, and it should be noted that the Minister and the Secretary of State already had substantial powers of direction under the Water Act 1973, Section 5.

Author's Reply to Discussion

PROFESSOR R.W. EDWARDS, in reply to the discussion, supported Mr. Speed in his concern that Threadgold's application made in support of the Charter of the Institution of Civil Engineers in the early 19th century, part of which was quoted in the paper, should be judged in historical and literary context. He had merely tried to imply that social priorities and attitudes, embodied in frequently quoted passages from that application, had changed in the last 160 years and the strongly anthropocentric posture of the 19th century was being replaced by one giving more consideration to the conservation of nature and environmental protection.

Mr. Speed, Mr. Skinner, and Mr. Knill took rather different attitudes to the need for putting engineering, at first degree level, in a wider perspective. It was the author's unashamed view that many areas of vocational education needed a broader base to give the student awareness of the contribution of his subject to the welfare of man and the biosphere. In engineering this broader base should include considerations of the impact of the engineer on the natural environment and changing attitudes towards this impact. He also believed that in some institutions of higher education, concentration on vocational training had gone too far and that restitution of more liberalizing educational elements was needed to prepare young people to appreciate life more fully and not merely to work more competently.

Contributors took similarly divergent views over the degree to which spatially dispersed environmental damage might result from changing operational methods. Mr. Skinner seemed to support his own anxiety that EIA had generally focused on specific schemes at the expense of potentially more pernicious changes of a general nature. As a general example, hedge removal had proceeded for many years, with a profound effect on both the appearance of the countryside and the abundance of many wildlife species before a proper evaluation of its effects was undertaken. Of perhaps more relevance, current studies suggested that the removal of bank-side trees in recent years had contributed to the diminishing status of the otter. That value judgements must be made was inescapable, but that they should continue to be made in ignorance of environmental consequences was inexcusable. As Mr. Thackray had indicated, organizational mechanisms for identifying and analysing such problems were available. He could assure Mr. Thackray that he was well aware of such mechanisms, although he remained ignorant of evidence of their widespread imaginative use other than the initiatives taken by the Central Water Planning Unit to examine the environmental impact of such procedures as artificial recharge, inter-catchment transfer, and river regulation.

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The author, having expressed concern about the considerable variation in the quality of land drainage schemes he had seen, particularly with respect to their effect on the aquatic and riparian environment, he was reassured by the contributions from Mr. Tinkier and Mr. Fairbank that in some regions, such as the Wessex and Southern Water Authorities, very detailed consultative procedures were laid down and great care taken over environmental protection. He reaffirmed, however, that, in his view, land drainage remained one of the environmentally critical functions of water authorities requiring very sensitive management and that the adequacy of training, for land drainage staff and operatives, in fisheries and environmental protection, should be examined critically.

5. ENVIRONMENTAL IMPACT ANALYSIS - PRACTICAL EXPERIENCE*

J.B. Oldfield, B.A., LL.B**

INTRODUCTION

"The other day I came down from a round of the High Street fells to find much of the once-idyllic hamlet of Mardale Green, drowned by the water engineers 40 years ago, almost indecently exposed to public view. I sat, at the entrance to Riggindale, on the tumbled ruins of Mardale Hall and tried to bring this lovely corner, dimly remembered, back to life - the little, yew-shaded church on the side of The Rigg, the old Dun Bull on the farther shore, the farms, the winding lanes and, always, the air of peace and quietude. All gone, now so long ago - just the old walls showing above the mud, the sheep grazing on the former intake fields, and the ugly white shore line reaching round the contours. It could never happen today, this rape of a lovely valley and the destruction of an ancient community."

(A. Harry Griffin, The Guardian,
31st July, 1978)

Mr. Griffin, a much respected Northern writer, was of course referring to Haweswater. One hesitates to interrupt his reverie to ask why he says "It could never happen today". Does he mean that major engineering structures will never again be required in beautiful places, or that objectors are so well organised that those structures would never be permitted? If so, then a symposium on Engineering and the Environment would just be looking at what had happened in the past. In fact, of course, the symposium is concerned with the future, to contribute to an understanding of how major works can be devised and designed with a proper regard for the environment. What constitutes "a proper regard for the environment" is a matter of endless dispute, and one of the most useful functions of environmental impact analysis may well be to set up procedures and techniques to establish what "a proper regard" should encompass in any particular case.

This paper however is not concerned with the philosophy or techniques of how this might be achieved. It is predominantly concerned with practical experience gained in the North West Water Authority of a major comparative environmental impact study on water resource development, and with offering some reflections prompted by the experience. It is written from the point of view of a senior manager within an authority which would eventually undertake the promotion of a particular scheme, so it is concerned with the relevance of such studies to the promoting authority's interests, and with practical considerations involved in conducting them.

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** Director of Resource Planning, North West Water Authority.

It should be emphasised however that this paper's preoccupation with a water resources study should not be allowed to obscure the fact that the "dirty" end of the business also gives rise to very significant engineering/ environmental problems, or the fact that people who live in badly run down industrial areas are just as anxious to preserve (or better, improve) their environment as are the custodians of the avowedly "beautiful" areas.

DESCRIPTION OF STUDY

A brief outline of North West's water resources study may be helpful - explanations will come later.

Engineering and environmental studies were put in hand at the beginning of 1977 into a short list of four schemes for possible water resource developments at:-

- Borrow Beck - an upland tributary of the River Lune, with the relevant part of the valley lying between the M6 at Tebay and the A6.
- Haweswater - lying in the north eastern fells of the Lake District, where there is already a major reservoir built by Manchester and completed in the early 1940's.
- Hellifield - an agricultural area on the upper reaches of the River Ribble, near Skipton.
- Morecambe Bay - where banded storage was of interest (not estuarial barrages).

The engineering studies have been carried out by the following:

- Inland sites - Messrs. Babbie, Shaw and Morton, assisted by Messrs. Rofe, Kennard and Lapworth in respect of Haweswater.
- Morecambe Bay and river intakes on Lune and Ribble - Messrs. Binnie and Partners.
- Aqueducts and Treatment Works - North West Water.

The Authority's own staff have also been responsible for work on hydrology, river ecology, water quality and river management.

The Environmental Impact Study has been carried out jointly with all the structure planning authorities affected, with the overall management and professional conduct being handled on behalf of North West Water by Messrs. Land Use Consultants.

These engineering and environmental studies soon became known as the Four Site Saga, because of the scale and complexity of the plot.

Reason for Study

The first question that needs to be answered before embarking on an environmental impact study is the question that should be answered before embarking on any enterprise or project: Why do it at all?

One answer arises out of a water authority's statutory duty under Section 22, Water Act 1973:

"In formulating or considering any proposals relating to the discharge of any of the functions of water authorities, those authorities.... shall have regard to the desirability of preserving natural beauty,..... and shall take into account any effect which the proposals would have on the beauty of, or amenity in, any rural or urban area.....".

(One should observe in passing that the last words quoted refer to "urban areas", reminding us that this duty applies in areas that are, so to speak, the backyards of our industrial towns, just as much as in National Parks and the like).

It would however be taking a narrow view of an authority's responsibilities to say such studies were necessary because of this duty. After all, the Act does not require such studies - it is up to the individual authority to decide how it discharges the general duty.

A more satisfactory answer is that a major public authority cannot responsibly embark on a project without trying to ensure that it has informed itself of the implications of that project and of alternatives to it. The depth of study required, and the means adopted for it would vary according to the requirements of the case. In the case of North West's regional water resource studies, several possible solutions were envisaged, all of which would be very different in their impact. It was thus difficult to avoid the conclusion that a fairly wide ranging study was required if the Authority was to be properly informed.

Another reason for such a study in this particular case was obvious when one moved one's thoughts ahead from the Authority's decision to the promotion stage. As a purely practical consideration, environmental analysis is probably essential on such a major issue if a future promotion is to be carefully structured. It would be absurd to suggest that the presence of such analysis would ensure success in the promotion, but on a major water resource development the time may be not far off when its absence would be damaging to one's case.

It was a combination of the above reasons that led to North West's study. The general rationale was spelled out in the terms of reference given to its environmental consultants, where it was explicitly stated that the Authority wished to respond to the spirit of its duty under Section 22 of the 1973 Act, and said:-

"The aim of this appointment is to provide the Authority with sufficient information on environmental and amenity matters of both fact and judgement to enable it to reach a comprehensive understanding of the environmental and amenity issues involved, as a step towards its formulation of a sound and generally acceptable strategy for the development of regional water supplies."

Scope of North West's Study

The need to make judicious use of public money means that the options selected for study have to be narrowed down to those that seem reasonable possibilities.

What happened in North West Water was that work was carried on from where its predecessor authorities and the Water Resources Board had left off. North West looked at the possible sources already identified, ranging from Craig Goch (in mid-Wales) to Irthing (near the Scottish border), and narrowed them down to the short list of four set out above. The choice of short list was based predominantly on engineering and economic considerations, with little more than a layman's appreciation of the differences in environmental character of the various sites.

From North West's point of view it was a useful short list because of the variety of developments and potential that it covered:-

- (a) the possible developments ranged from small to large - in the event, from about 200 Ml/d to 800 Ml/d. This meant that a wide range of possible future demands was covered.
- (b) the inclusion of estuarial banded storage meant that the totally different engineering and environmental characteristics of this concept could be evaluated against the inland schemes.
- (c) environmentally there was a difference in character between Haweswater and Borrow Beck on the one hand, and Hellifield on the other. The two former are upland sites, while Hellifield has more of the characteristics of a lowland site, with many farms and villages, a trunk road and a main-line railway.

The value of this or any other short list may, however, not be apparent to objectors at an inquiry. They may well pursue other possibilities, including some that never even appeared on the long list. This would not be too serious a problem with suggestions such as desalination, or recycling the River Mersey, which could be dealt with on overwhelming cost and technical (and probably environmental) grounds. The bigger problem would be with the "also rans". There is an unavoidable discontinuity of information available about schemes on the short list and schemes that are not, and a further discontinuity develops between the chosen solution and other possibilities discarded along the way.

This discontinuity of information has to be accepted because it results from the logic followed in coming to a chosen solution. Water authorities have the responsibility of spending public money, and the choice of short list - as a step to a chosen solution - implies a decision that the extra cost of the rejected schemes cannot be justified. If a water authority takes such a decision in what it sees as the public interest, it is naturally not interested in spending further public money on detailed study of those rejected schemes.

Content of Study

While the short list is constrained by the promoting authority's views on technical and economic feasibility, the content of the environmental study carried out once the list has been established needs to be reasonably

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comprehensive. There are two dimensions to comprehensiveness in this context; the range of topics covered by the study, and the level of detail that needs to be established on each topic.

The range of topics covered in North West's Study was chosen to try to ensure that there would be little risk that any significant issue had not been identified. The relevant part of the environmental consultants' terms of reference illustrate this point. They were instructed:

"To organise and conduct a comprehensive environmental impact study and comparative environmental assessment of the impacts of the alternative water resource developments. "Environmental impacts" are to be interpreted as including not only repercussions on land-form, hydrology, ecology, landscape and environmental quality, but also interactions with socio-economic patterns including human settlement and employment, transport, recreation and other land uses. The significance of the impacts of each proposal must be considered in relation to both the construction and operation stage",

and amongst other things,

"To review and assemble published and readily available past work relevant to the environmental aspects of the proposed alternative developments,

and

To review all statutory planning and existing other policies relating to land use, economic, environmental and other relevant matters affecting the schemes."

In the other aspect of comprehensiveness, namely the level of detail that needs to be established on each topic, a distinction can be drawn between unavoidable impacts at one end of the scale, and optional variations at the other.

The former have to be explored in enough detail to enable one to assess their significance, and thus their relevance to the eventual decision. A clear example in this category is the impact on agricultural land. There is no way a reservoir could be built at Hellifield, for example, without extensive impact on the agricultural economy of the area, so an adequate appraisal is obviously highly relevant to the decision, and considerable detail is required on such matters as numbers of farms, effect on their viability, and the value of lost production.

At the other end of the scale, (the optional variations), would come the possible extent of recreational development at a particular reservoir. Again, Hellifield provides an interesting example, although there are many others. The site characteristics of Hellifield, and its location close to the industrial areas east and west of the Pennines, have led many to see it as a "recreation honey-pot", but there are very strong local interests who are appalled at any such suggestion. But despite the strong conflict of interests, the eventual scale of recreational activity that might be permitted if a reservoir were built there is not in fact relevant to the decision as to whether that site should be chosen or not. North West is of course interested in the difference in recreational potential between this site and others, and indeed in the views of different parties as to

whether any recreational development at all is desirable, and if so what extent of development would be desirable, but in no more detail than is necessary to establish these matters in general terms. It would be pointless to go into greater detail because issues of recreation policy and management would not need to be decided until long after the policy decision has been made on choice of site, and would themselves need to be the subject of very careful discussion with the planning authorities and other interested parties.

Although agriculture and recreation have been chosen to illustrate unavoidable and variable impacts, there is in fact a link between them in the extent to which the loss of jobs in or related to agriculture might be mitigated by employment arising out of recreation. Some indication of the possible extent of recreation-related employment, and of the cost of providing it, could be relevant to the decision.

The section below headed "Level of Detail" comments further on the topic.

Conduct of North West's Study

Decisions on how North West should conduct its Study were based on considerations of practical administration and of public acceptability. It cannot be emphasised too strongly that the following paragraphs do no more than describe the arrangements made for this particular Study. They are not to be taken as implying a prescription for other studies either in North West or elsewhere. The aims, magnitude of topic, significance of environmental aspects, and time and resources available would all differ from case to case.

From the brief outline already given it is obvious that the overall study was a complex one, because of the diversity of its components and their location. The environmental side of the work was especially complex because of the need for communication with three different engineering groups and sundry working teams and the six structure planning authorities affected by one or more of the river intakes, reservoir sites, aqueducts and treatment works.

There was no question of North West's being able to conduct the environmental investigations on its own: it simply had not enough staff with the required expertise, and the handful that it had could not be diverted from their normal work. If the Authority was to have a role in the work, it would clearly have to be exercised through environmental consultants retained by the Authority.

As there appeared to be no precedents, in this country at least, for such a comparative appraisal, the general concept was discussed with each of the County Planning Officers in the structure planning authorities. Quite apart from the encouragement received from their uniformly favourable response, this series of conversations was of great value in enabling thoughts to clarify on how best to conduct the Study. Suggestions made by them ranged from having the Water Authority conduct the Study on its own, to having the structure planning authorities conduct it. In the event, the solution chosen was a joint Study, with the Authority and the structure planning authorities working together.

The aim has been to try to ensure widespread acceptance of the results of the Study by putting great emphasis on its being conducted with complete

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objectivity, and to secure the commitment of the structure planning authorities to the professional content of the work, without binding them to any conclusions that might be drawn from it. This has resulted in a structure that appears complicated, but in practice seems to have worked well.

The arrangement chosen was that the overall direction of the study has been in the hands of a body styled the Environmental Impact Panel, which consists of the County Planning Officers, representatives from Messrs. Land Use Consultants, and Authority representatives for liaison with consulting engineers and other working teams. The Panel has met under the chairmanship of the Authority's Director of Resource Planning. Subject to this overall direction, Messrs. Land Use Consultants have been responsible for the management of the study: this has entailed responsibility for its professional standards and methodology, for establishing time tables and work flows, and for the myriad of working links in the field. The working links include many District Councils as well as Government bodies, research institutes and so on; in the interests of objectivity, response has been sought in every case at professional level, without politically oriented comment from members.

To support the aim of professional objectivity, arrangements were made to ensure that members of the structure planning authorities were able to review the progress of the Study as it went along. In parallel with the officers' Panel, an Environmental Impact Review Committee was set up, chaired by a member of the North West Water Authority, and composed of two members from each of the structure planning authorities. On completion of the Study, it will be sent to all the structure authorities, to all District and Parish Councils affected, and to a wide range of other organisations. These bodies will all be invited to submit their comments to the Authority, so that the Authority's decision will include consideration of these comments as well as of the Study itself.

In view of the many brick-bats that are thrown at planning authorities, it must be recorded that North West Water has derived great benefit from the very thorough, constructive and diligent response given by the planning authorities in the course of this Study, and indeed on many other topics. It appreciates this response very highly. Acknowledgment must also be made of the careful co-operation given to Messrs. Land Use Consultants by the many Government agencies and other organisations consulted by them.

In an earlier paper in this symposium, Mr. Thirlwall raised the question of "who should pay for the analysis", and implied that public sector developments might call for different arrangements from those applying to private developers. In North West's Study, costs have lain where they have fallen, with North West paying for the consultants, and the planning authorities bearing their own costs, as indeed did the organisations consulted in the course of the work. One County Planning Officer raised the question of having North West pay for staff time, but the point was not pursued, let alone pursued with vigour. The attitude has been, explicitly in some cases, implicitly in others, that work of this kind is of the very essence of the function of a planning authority, and that accordingly they should bear the staff costs associated with the work. As a passing comment, it would seem that this approach to costs is probably right for public sector developments, not the least of the reasons being that it would be too frightening to contemplate the prospect of having to agree apportionments of cost in each individual case.

In these comments on the conduct of the Study, attention has been drawn

to the attempts to achieve professional objectivity. While it is essential to strive for objectivity in an environmental or any other appraisal, it would be naive to suppose that objectivity would carry much weight in localities potentially affected. Two limitations should be noted, both of a political nature. Firstly, decisions at local level are of course made by councillors, and not by planners. This was vividly illustrated at an information meeting with parish councils in one of the areas affected: a representative from one of the Authority's consultants unwisely said that the planning officers favoured a particular course of action, only to bring the rebuff from the county councillor in the chair: "To hell with the bloody planners - we make the decisions". The second limitation to note is that people living in a locality potentially affected often dissociate themselves from their district and county councillors just as much as any of the latter may dissociate themselves from their planners. Indeed, an emerging trend in North West's area at least is for parish councils to seek to assert themselves as the true custodians of local interests.

Timetable

One of the recurrent problems throughout the Study has been that of the timetable to be adhered to, because there was an unavoidable difference of emphasis between the interests of the Water Authority and those of the County Planning Officers. As a matter of good management, the Authority wanted to see the Study conducted in a reasonably brisk fashion, and has insisted on timetables being established for control purposes. This was done because experience usually shows that it is all too easy to lose impetus unless control is pretty firm; furthermore, the longer the Study lasted the more it would cost in consultants' and staff time.

While North West itself had enough problems with the special workloads and deadlines that had to be imposed on its own staff, who of course had other duties to perform, this kind of problem was much more acute with the structure planning authorities, who had to fit the Study work in with their normal workload, which meant that they could be faced with conflicting deadlines. The County Planning Officers have consistently pointed to what they regard as an unrealistically short timetable; indeed one of them is reported as saying, "There is nothing wrong with the Study that six months on the end won't put right".

There has been some extension of the original programme, but the principal effect of the Authority's desire to complete the Study as close to the timetable as possible has been an ever more emphatic insistence that attention should be confined to significant issues, and uninformative detail should be avoided.

REFLECTIONS PROMPTED BY NORTH WEST'S STUDY

The second part of this paper offers a number of reflections prompted in particular by the major Study described above, but also by North West's more general experience. It is hoped that these comments may be relevant to other environmental studies that may be undertaken.

Effectiveness of Organisation

Before proceeding to offer reflections on some of the problems encountered in the Study, due balance demands the comment that from the management point of view the form of organisation adopted appears from all accounts to have worked successfully, and that the main objectives have been

achieved. The success of the Study as an environmental appraisal will be open for all to judge when the report is published early in 1979.

A number of elements have contributed to this success. Firstly the recognition within North West itself that the study was going to be a complex one, and that it would need firm and carefully directed management attention if it was to be held together and completed on time; secondly, use of environmental consultants whose awareness of the sheer managerial complexity of the work was evident from the start; thirdly, the response from the planning authorities, to which tribute has already been paid; and fourthly (and this is good luck) the personal contributions made by the consultant's project manager and the co-ordinators nominated by the County Planning Officers, who have borne the brunt of the day to day work.

Level of Detail

The level of detail required in the study is a matter where persistent difficulties have arisen because of differences of attitude between those with strategic interests and those with particular interests.

Those in the Authority responsible for the management of the overall engineering and environmental studies are predominantly interested at this stage in issues relevant to the strategic decision, and are interested in detail only in so far as it is relevant to establish these matters (e.g. cost, yield, environmental consequences) within reasonable confidence limits.

Those working on the study have, of course, to get into a certain amount of detail before they can generalise on the aspect they are concerned with. What has been interesting, however, is that there have been instances where each participant has wanted more specific detail from others as an input to his own work than he has regarded as necessary for him to provide as an input to theirs. It has been suggested by one environmental consultant that part of the explanation for this is that environmental studies are at a very early stage of their development, and consequently more detail rather than less is required. One suspects however that the problem on detail has arisen from the understandable desire of any specialist to prefer the security of detail to the risk of inevitably inexact generalisations, which none the less are what is required by the decision makers.

A related topic raises the fundamental issue of the relationship between engineering definition and environmental considerations - which should come first? An example relates to Haweswater, but is not unique. The engineers, when considering possible development at Haweswater, ask whether there are any environmental thresholds, beyond which there would be a different order of impact; if there were, they could take account of them. The planners for their part ask whether there are any design thresholds, beyond which a different order of cost would be involved. But neither side wishes to commit itself, and declines to specify thresholds. Now if it is really true, in this example at least, that there are no significant thresholds, it would seem to follow that there is a great deal of sense in following the customary practice of not bringing in environmental considerations in other than a rudimentary way until the main options have been defined, and some degree of engineering definition attempted.

If that happened it would mean that planners would tend merely to be responding to ideas dictated chiefly by economics and by constructional and operational considerations, which is at best a responsive role, and may emerge as a negative one. Is it reasonable to contend that if planners

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cannot provide guidelines and indicate threshold points, they are thereby consigning themselves to such a responsive role, and cannot expect to make a creative contribution to decisions?

Obsolescence of Material

At the time North West's Study was being set up, it appeared to be on a realistic activity path leading to promotion in the discernible future. On this original timescale, obsolescence of material was almost certainly not a problem. However, the view now being taken of growth in demand for water is that the rate of increase will be very much slower than in the past; if the forecasts based on this view are anywhere near correct, North West is likely to be nearer a twenty year time scale for promotion than a ten year time scale. Will the material become obsolete, and nullify the value of the study?

It could well be that even on the extended time scale, obsolescence of the material may not be too much of a problem because of the strategic emphasis of the Study - the guideline throughout has been to concentrate on those matters that are likely to establish significant differences between one scheme and another, and one would expect changes in these factors to be likely to occur only very slowly. There will obviously be changes in population, roads, agricultural activities and so on, but it is perhaps unlikely that these would be sufficient to necessitate a complete re-working of the study. Nevertheless, it is possible to foresee the need to make some kind of validity check of the material if it were to be used after the lapse of a number of years.

If the study had been more detailed than strategic it would very rapidly have lost value, because the more detail it had contained the more it could have been challenged as being out of date.

It is a matter for consideration as to whether there is not a greater danger from obsolescence of attitudes rather than of material. One cannot predict what the economic circumstances of the country will be more than a few years ahead, still less what will be the attitude to (for example) recreational opportunities, or what will be the future environmental fashions and so on. Only time will show whether the emphasis on objectivity will have provided a durable core of material that needs only to be re-interpreted, rather than re-evaluated.

Degree of Commitment

Another interesting topic on which to reflect is the degree of commitment that can and should be obtained in an environmental impact study.

It has been explained how the structure planning authorities at member and officer level have accepted the separation of the objective study from comment on the results of it, and that North West has enjoyed a high degree of co-operation in professional analysis and commitment to that analysis. Nevertheless, North West Water and the County Planning Officers have had a common interest in avoiding an implied commitment to any particular development which may have been defined for purposes of the study: the County Planning Officers have rightly reserved their freedom to comment on whatever specific proposal may later be made, just as North West has reserved the freedom to formulate whatever seems the best development at time of promotion, without being committed an uncertain number of years in advance to any particular location or design details.

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It is interesting to speculate as to how much objective commitment it would have been possible to obtain if implementation had been more imminent. Would members of planning authorities have been as willing to let their officers participate, and if they had, how constrained would the professional contribution of those officers have been by thoughts of what their members' attitudes might be? It was an instructive experience recently when, on a planning application by North West Water for a major development (not for water resources), the planning officers made no recommendation to their authority one way or the other; this was not because the application did not raise serious planning issues - for it did - but because the proposal was exciting strong local opposition. Their action says much for their sense of survival, but it raises interesting and important questions about the relationship between planning and politics. Does this mean that professional planning comment becomes irrelevant (as well as imprudent) when local feeling is strong; if so, what are the implications of this in terms of narrowing the limits of effectiveness of an environmental study?

Conclusion

It is impossible for one concerned with practical planning to agree with those proponents of environmental impact analysis who seem to wish to extend its realm to wide ranging limits, embracing alternative technologies and the rest. Obviously a water authority needs to be aware of relevant developments and if necessary to be working on them, but that is a very different matter from setting up one's planning on the assumption that alternative technologies will yield solutions that are feasible or credible in cost terms.

The relevance of environmental analysis to a water authority is the contribution it can make to its decisions, by establishing what "a proper regard for the environment" should encompass in any particular case. But the particular cases chosen would usually arise out of the authority's own perception of known or foreseen problems. This point is stressed because of the plain fact that responsibility for water services and responsibility for planning matters are vested in different bodies, although it plainly is in the public interest that they should seek as much common ground as possible.

What North West's Study has done is to bring these two "sides" together in a relationship of shared endeavour that has certainly been of benefit to North West in improving its understanding of planning attitudes, and one hopes it has been of benefit to the planners in improving their understanding of North West's problems. This shared endeavour has not been, as some people have wrongly thought, an attempt at consensus decision making. Indeed, it has been emphasised throughout that the aim has been to obtain information as an input to North West's decision, not a recommendation on a preferred solution.

Mr. Thirlwall makes the comment that "the planning system is... inadequate in that it offers insufficient scope for the consideration of alternatives", but he is less clear cut on the question of whether environmental impact analysis is essential for the consideration of alternatives. Experience in North West suggests that environmental impact analysis, in the sense in which the term is usually used, is much more relevant in cases where there is a realistic choice between alternatives, than it is for a single project. Where there are alternatives, environmental measurements can be taken to find out which are of sufficient importance to contribute to the decision. But even there, it must be remembered that from a water authority's point of view environmental

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considerations are just one element in the assembly of costs and risks and consequences that need to be analysed in the making of a major decision.

There are, however, many circumstances where a water authority has little choice of site. In these circumstances, it is suggested that the role of environmental analysis is different and more limited. There is little point in assessing and evaluating general impacts if nothing can be done about them either by going elsewhere, or by mitigating them by careful design. In other words, there is no point in taking measurements that are not going to be used. This line of thought leads to the same position as that reached by one eminent landscape consultant, who has put forward in conversation the view that "environmental impact is a question of design" - that is to say, effort should be concentrated on accommodating the proposed works to their local environment, rather than on a merely academic study of impacts.

In addition to forming a component in the promoting authority's decision, the moment of greatest relevance for an environmental study would be at a public inquiry. In so far as one is addressing an impartial Inspector, who is conducting an impartial examination of a particular proposal, a body of objective data must be relevant and helpful, especially when it bears on what are likely to be some of the most hotly contested issues. The strongest justification for environmental analysis is that, having contributed to the promoter's decision, it constitutes a bona fide attempt to assist the inquiry. This justification stands, it is suggested, notwithstanding the fact that the same material may be distorted and selectively mis-quoted by objectors.

Environmental appraisals cannot quantify many of the topics they cover, but the fact remains - and it is unpalatable to some conservationists - that these unquantifiable factors have in some cases to be balanced against additional expenditure, so that at the decision stage a price is in fact put on them. It does not seem to be obvious to some that a water authority, like a nation or an individual, has limited resources, so that additional expenditure in one direction means deferred or abandoned expenditure in another. This is a point of especial interest in the region covered by North West Water, where in addition to the high amenity areas of the Lake District, the Forest of Bowland and the Pennines, there is the widespread environmental affront of grossly polluted rivers in the industrial areas, caused in part by the Authority's own elderly and overloaded sewage works, defective sewers and unsatisfactory storm sewage overflows. Mr. Griffin appears to imply, in the quotation at the head of this paper, that some high amenity areas are priceless; if this is true, it might mean that they could be preserved inviolate only at the expense of the prolongation of squalor elsewhere. Since choices have to be made, can environmental analysis assist in decisions on how much of the public's money should be spent on particular increments of environmental protection in high amenity areas, when one of the alternative uses for the money is in making environmental improvements in disadvantaged areas?

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DISCUSSION

Author's Introduction

MR. J.B. OLDFIELD, in introducing his paper, said that he had described an environmental study from a managerial point of view. His job in the North West Water Authority was to plan for the future, and he was interested in environmental analysis insofar as it was relevant and necessary to defining projects to help in the future. He emphasized that the study described in the paper was in no way put forward as a prescription for other studies. Indeed, his Authority were handling other major problems in a completely different manner.

It was clear from the paper that a major public authority had to take environmental issues seriously. It was irresponsible to seek to dismiss them as tiresome window-dressing problems. Indeed, if a public inquiry was likely, it was in the promoting authority's interests to understand the environmental arguments likely to arise, and, better still, to be able to show that it had weighed these matters in making a decision. Having said that, he expressed a number of reservations which tied in with some points made in the discussions on earlier papers.

Firstly, he emphasized the point that however objectively one sought to appraise environmental issues, what one was really up against was resistance to change - any change. In North West for example, there were protests when they wanted to demolish old water towers - not because they were picturesque, but because they were there! This seemed to mean that there was an element of unreality in the process of public objection and inquiry, as the inquiry itself purported to consider the merits of a particular proposal for change, whereas the objections were often rooted in fundamental resistance to change itself. If North West should promote one of the schemes covered by the study, he doubted whether the issues raised at an inquiry would be any different because of the study. He also doubted whether the attack on the Authority would be any less violent. That was to say, no amount of sophisticated analysis would be likely to seem relevant to one who was expressing or rationalizing a fundamentalist objection. (He was, however, confident that the defence would be very much better).

Secondly, he wished to express reservations about the comfortable assumption that one could establish "the public interest". He wished he knew who the public was, and what it really wanted:

- Was it the local residents affected by a scheme?
- Was it the elected representatives in the area?
- Was it the self-appointed bodies of environmentalists and other pressure groups?

If it was just these, then it was fairly easy to find out what they thought. But what of President Nixon's invention, the silent majority?

He suggested that on the issues they tended to be concerned with, most of the silent majority were (quite properly) concerned just with living their own daily lives. In a wholly neutral sense, they neither knew nor cared.

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Dr. Collingwood had remarked that "in environmental matters the public were the judge". He himself suggested that they were not, at least not the vast majority of them. These matters were judged by a small minority. What they have to weigh up in their decisions was how far views expressed by a small number of people were representative of the climate of opinion, for it was this that influenced how far they went beyond the least-cost solution.

When they went beyond the least-cost solution they were of course quantifying environmental issues. He supported fully what was said about not seeking quantification at the analysis stage in areas where quantification was not realistic. In this context, he wished to repeat the question he had posed at the end of his paper: "Can environmental analysis assist in decisions on how much of the public's money should be spent on particular increments of environmental protection in high amenity areas, when one of the alternative uses for the money is in making environmental improvements in disadvantaged areas?". He said that he would like to be convinced that the answer was "Yes, it could", but he feared it was "No, it can't".

The question of public consultation had also been mentioned. This was a topic that had had to be considered carefully in respect of North West's study. Quite apart from the practical problems involved in trying to consult the public at large, he had formed the view that consultation should be principally with the planning authorities, who in theory at least represented the views of the people in their areas. How the planning authority formed its views was something it had to resolve for itself, and indeed, on a major issue it might choose to engage in some form of direct public consultation. He did not think, however, that the fact that the theory of democratic representation could often work out pretty shakily in practice was a good argument for a water authority to try to canvas public opinion direct on major issues such as those under discussion.

Next, he emphasized the point that environmental impact analysis was only a part of the information needed for a decision. He thought that it was quite wrong (as someone had suggested earlier at the Symposium) to see it as a means of arriving at a consensus decision. In the context in which he was talking, the decision on which scheme to promote had to be taken by the water authority, and "environmental considerations were just one element in the assembly of costs and risks and consequences that needed to be analysed in making a major decision".

Lastly, he wanted to draw attention to the point he had made in the paper about the particular relevance of environmental impact analysis at the stage where alternative solutions were being analyzed. He thought that this was where it had its most useful role to perform, as part of the information on which the decision was based. The dilemma created by the way the planning system operated at present was that in theory a public inquiry was just concerned with the specific proposal before it, whereas in practice it was common for alternative solutions to be brought into the discussion either as part of the justification or as part of the objection. On major and controversial issues in the public sector at least, he wondered whether there was not a case for having a system where the inquiry itself was structured to hear a full discussion of the alternative solutions so that the issue might be settled by a single decision.

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Verbal and Written Discussion

THE RT.HON. BARDNESS WHITE (Royal Commission on Environmental Pollution) said that she had expected the author to say rather more than he did on the given programme topic of public inquiries, and whether they were a curse or a blessing.

The way forward should lay, as the author had said, in joint studies. The water authority and the planning authority should work together from the start with voluntary conservation organizations brought in as the scheme began to take shape. This should help to minimize founded rumours.

Turning from the author's internal EIA to the more controversial topic of the EIA imposed by external authority, Lady White said that the House of Lords' Scrutiny Committee was embarking on an examination of the EEC draft proposal for a direction on EIAs which derived only in part from concern for the environment. The Treaty of Rome was less concerned with the environment than with distortion of competition within the Community. A variety of EIA procedures might create "irregular conditions for investment and thus irregularities in competition" between one area and another. "The same industrial sector might thus be compelled to observe restrictions which varied from state to state".

This aspect of environmental protection was not familiar to us and there might be considerable difficulties in reconciling our planning system with those of our partners. We had heard of a possible Secretary of State's list of installations for which EIAs might be obligatory. The EEC was already discussing its own list.

No one wanted the American type of obligatory assessment. But we were not as yet clear what we really did want. Our planning system did not provide adequately for the consideration of alternatives nor for situations where major issues of national policy had to be determined. The defects of Windscale as a mode of inquiry, lay in the confusion between two issues - first, should we reprocess nuclear waste and, secondly, should we do it at Windscale? The second was a planning issue. The first was not. We could have the same confusion in the Vale of Belvoir.

Mr. Peter Shore, (the then Secretary of State for the Environment), had pronounced on 13th September 1978 on the expected Belvoir Inquiry. He had turned down a Roskill-type planning commission and seemed to think that "a preliminary meeting" held by the inspector would be sufficient to sort things out, plus, of course, the studies already carried out by NCB and the planning authority. Lady White was not convinced that this still essentially localized approach was right for such a major proposition.

She said the water industry ought to hold occasional examinations in public into areas of controversial activity to assess "the background and the need" against which particular local propositions could be judged. As President of CPRW she had been attacked by what Lord Rothschild would call "eco-nuts" because she had refused to bandwagon against the Welsh Water Authority's proposal for a long sea-outfall into Cardigan Bay.

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It would have been easier if she had been able to refer to a report on the justification for long sea-outfalls in general, following a hearing at which those who felt passionately against could have had their case publicly examined. Putting virtually untreated sewage sludge on land was another possible topic.

MR. T.A. JOHNSTON (Babtie Shaw & Morton) said that having been involved in the North West Water Authority's engineering study of the inland reservoir sites at Hellifield, Barrow Back, and Haweswater, his comments would deal with the relationship between engineering and environmental studies.

The study came under two headings, a traditional engineering study and participation in the environmental impact study. Quoting the terms of reference, their principal tasks in relation to the environmental work were:

- (1) to provide engineering information to Land Use Consultants at dates to be mutually agreed; and
- (2) to work in close co-operation with Land Use Consultants and the other study teams so that there was a well-informed and creative interplay between those responsible for engineering and for environmental and landscape matters.

Since this was the first environmental study of its kind in the UK it was expected that all the participants would learn some useful lessons. This was in fact the case.

Mr. Herbert had referred to Land Use Consultants' position as "technical translator" and he himself wanted to pay tribute to their skill in this role. At the start of a project, there was often a regrettable lack of understanding between planners and civil engineers. In the study, it was essential for the engineers' proposals to be presented in a form which was familiar to the planning authorities. Given time to work together, groups of engineers and planners usually built up a mutual respect but time was short on the study and it simplified their task to describe their work to only one set of planners (i.e. Land Use Consultants) rather than to each planning authority.

The time allowed for the engineering study was 15 months with the engineering report being submitted about six months ahead of the environmental report. The time proved adequate for the production of the engineering report. However, there were timetable problems related to the exchange of information between the participants in the studies. The engineering and environmental studies had started about the same time and the early months must have been particularly frustrating for Mr. Herbert and his colleagues, who were anxious to receive scheme drawings for discussion with the planning authorities at the earliest possible date. However, drawings were one of the end-products of an engineering study. The early months were occupied by site investigations, hydrological analyses (which were undertaken by one of the Authority's working teams), and preliminary design calculations, and some months passed before they were able to issue preliminary scheme drawings.

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He suggested that in future exercises of this type it would be worthwhile to allow the engineering study a lead time over the environmental work, and to arrange for the engineering and environmental reports to be submitted simultaneously.

One of the reasons for starting the studies at the same time was to encourage discussion between the participants, and this raised the question "How could one ensure that the interplay between engineers and others, i.e. between the initiators and the commentators, was genuinely creative?". The Authority convened regular tripartite meetings of staff from the Authority, the environmental consultants, and the consulting engineers. The meetings were conceived as partly progress meetings and partly "brain-storming" sessions. The latter aspect was sometimes less fruitful than anticipated. With hindsight, one could see reasons for this, associated with the dual role of Land Use Consultants and with the large number of study participants. On other projects, they had employed or worked with landscape architects who were retained solely as landscape advisers. In these cases, designs were discussed "on the drawing board" and this situation would probably arise if one of the North West schemes was promoted. However, in this particular study, the environmental consultants had to use not only their own expertise as planners and landscape architects but they had also to present the views of the planning authorities. Thus, any matters of substance had to be referred to the planning authorities. Inevitably, the consultation process took time, and because of the tight programme, there were instances when they received preliminary rather than considered views from the planning authorities.

The environmental investigations did not reveal the need for any fundamental reappraisal of the engineering work but they did influence the engineering report in a number of important ways.

The progress of the engineering study on the three inland reservoir sites was to some extent a process of elimination. Over 50 schemes were considered in the course of producing a final list of 14. Without the planners, the final list would have been shorter. All 14 were feasible but some which had significant engineering or cost disadvantages had been retained in the final list for environmental reasons.

Some topics had to be considered in greater detail than would have been the case in a traditional engineering study at the strategic level, e.g. the consequences of reservoir draw-down in all the schemes and the consequences of the transfer of water from the river Eden to the river Lune in some of the schemes based on the river Lune. At the start of the study they had assumed that topics such as this would not be significant in the choice of reservoir. However, the planners had placed considerable emphasis on these topics and this was reflected in the final engineering report and also in reports which the engineers prepared on specific topics in response to questions from the planners.

One striking example of the environmental influence on the engineering work was the selection of an aqueduct route from Staingillis pumping station at the confluence of the river Eden and river Eamont, near Penrith, to Haweswater reservoir. The aqueduct was to be about 20 km long and there were a number of feasible routes, similar in length and in cost. It seemed unlikely that any one route would have

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an over-riding engineering advantage. It was decided that, for the purposes of studies, the route preferred on environmental grounds would be adopted. Using the preliminary engineering drawings as a basis, Land Use Consultants discussed the alternatives with planners from Cumbria County Council and the Lake District Planning Board and obtained agreement on a route.

The environmental study generated more engineering work than was expected when the first manpower budgets were prepared. Originally it was assumed that 10 per cent of the time would be employed on "environmental" tasks. In practice about one-quarter of the time was used in this way.

The role of EIA in this country was still being determined and, in doing so, the distinction between a formal environmental impact study and environmental impact analysis was important. An environmental impact study might or might not become just another hurdle on the path to promotion of major projects. Nevertheless, the effect of projects on the environment was already being considered in many design engineering offices. If, despite the quotation at the start of the author's paper, a new dam was built at Haweswater or one of the other sites, the engineers would take advantage of design methods and construction techniques which were not available 40 years ago. EIA would be one of these techniques as it took its place as another tool of the trade.

MR. N. BUCHANAN (Northumbrian Water Authority) said that a document, "Design and Export" had been issued a few weeks before the Symposium by the Economic Development Committee for Civil Engineering, and had made the following recommendation about the pre-construction period of schemes:

"Government should make a determined effort to reduce the pre-construction period for major civil engineering schemes, without sacrificing good design or the advantages of public involvement. Ways in which such a reduction should be sought in the roads sector include a closer examination at each engineering, administrative and statutory stage of preparation to ensure that all proposed information requirements are relevant, that evidence is not repeated across inquiries, and that inspectors' reports are processed more quickly. Another way is for public clients to improve their presentation of information and evidence so as to ensure a better understanding of the advantages and disadvantages of each scheme. More generous compensation and speedier payment to those affected by a scheme should also be considered".

The uncertainties, costs, and duration of the preconstruction period affected the efficiency of the designers and, although there was no doubt that the study described in the author's paper would ensure a better understanding of the advantages and disadvantages of each scheme, would it help to reduce the preconstruction period?

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On the face of it, the water industry ought to be able to process their schemes quite quickly. After all, they buried their water transmission systems in the ground, their service reservoirs were covered with earth, and their impounding reservoirs, if dealt with sympathetically, could be claimed, with some justification, to enhance rather than detract from the environment. However, the duration of the main preparation period for water schemes had increased in the last decade and was, in some cases, as much as 15 years. On the other hand, industrialists appeared to be able to obtain permission for their developments with the minimum of fuss and this might be because their schemes usually offered substantial employment prospects which the capital-intensive water industry could not.

When the former Northumbrian Water Authority looked into meeting the water needs of their area, they found that the most economic combination of works involved the construction of six reservoirs and the building of three links between reservoirs and rivers. However, after consideration of all the alternatives, the scheme adopted was one based on a reservoir in the North Tyne Valley and tunnel transfer links from the river Tyne to the rivers Wear and Tees.

The author expressed the view that the time was probably not far away when the absence of a formal environmental study could be damaging to a promoter's case. Although no such study was carried out for Kielder, there was no doubt that the effects of the scheme on the social structure, ecology, and environment were more than fully discussed at the six-week public inquiry and again when the inquiry was reopened for four weeks a year later. He wondered whether if a formal study had been carried out, this would have reduced the 188 objections or merely given the objectors more information with which to criticize the chosen scheme and show that the rejected alternatives were preferable.

In many ways, the North West study was analogous to the site investigations carried out by engineers to ascertain the geological conditions of sites. Such site investigations traditionally cost about 1 per cent of the scheme tender figure, and the author was requested to publish the costs of the study to both the regional water authority and the various structure-planning bodies. If environmental studies became accepted practice, he himself pleaded for planners and sociologists to appreciate that designers and contractors worked in real time, and to ensure that environmental studies were not allowed to be conducted in geological time!

DR. D.E. WRIGHT (Sir William Halcrow and Partners) said that the thorough analysis of environmental effects was a new and wide-ranging discipline, and they had only a limited practical experience in the UK of the application of environmental analysis. This had to some extent been reflected in the papers presented at the Symposium which had naturally tended to concentrate on the general principles of the subject.

There had already been some discussion about quantifying environmental factors. It seemed that some of the qualities of the environment could be quantified (for example, fish populations) and some could not (for example, aesthetic judgements). Thus, the real nub of the problem was that the host of different factors which input to an environmental analysis neither fitted readily into one overall framework nor had a common measure:

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this meant it was very difficult to demonstrate inter-relationships and come to an accepted judgement. The problem was exacerbated because of the subjective methods sometimes employed and the emotions aroused.

It would be very helpful to know the way in which the author and his colleagues intended to present the various items of environmental information, how they planned to weigh the different factors in the process of arriving at a judgement of their relative merits, and how the results of this environmental study influenced the final decision on resource development. He believed the work was now reaching the stage at which some of these central questions should be addressed, and at the proper time it would be fascinating to have a second paper from the author describing how these conceptual problems had been overcome.

He felt that the following points were worth emphasizing:

- (1) EIA was only relevant where there were realistic alternatives to be considered. They did of course require honesty when asking the questions which might identify alternatives so as not to simply pander to engineering prejudices. Technical imagination was needed.
- (2) EIA was only one input to the jigsaw of information to be brought together in the decision-making process. It did not (or should not) make the decision by itself.
- (3) The main engineering options should be defined (on the usual criteria of design, operation, construction, and cost) before considering EIA. In the past engineers had not always been very good at defining alternatives and as noted under (1) this was not a part of the process which could be avoided.
- (4) There was no point taking environmental measurements that were not going to be used - they must not be seduced by the ease with which certain "environmental" parameters could now be measured.

There were two points which the author made which he himself wanted to discuss at slightly greater length:

- (a) Preservation of environmental features had to be balanced against additional expenditure. Instead of trying to ascribe values to particular environmental factors, it was simpler to lay before the final decision-making body (whatever form that might take) the best alternatives (say no more than 3 or 4) in terms of economic and environmental advantages. Each would possess a matrix of cost inputs and environmental qualities: one would be cheapest, while the more expensive alternatives would each have a certain combination of environmental features. In this way assumptions about relative values were not buried in the analysis, and the real issues were highlighted.

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- (b) *The preservation of one person's "environmental" feature might mean that improvement to the environment of a disadvantaged area had to be delayed. During an earlier discussion at the Symposium it had been said that frequently objections to a proposed development were made by the small, articulate, organized, and relatively better off groups, while the larger, less articulate, poorer and not so well-organized sector of society remained unheard - and they might support the development. Thus, particular attention had to be paid to communications with those affected, to ensure that as far as possible a balanced response was obtained. This could be a very difficult task.*

The final decision reached would reflect the physical, social, economic, and technological position and well-being of the community - in this area there were no absolute priorities. In the UK they were in the fortunate position of being able to afford at least some of the extra resources needed to preserve environmental amenity, but if they were desperately poor, hungry, with uncertainty hovering over next week, never mind next year, would they (could they) have equal concern about what appeared to them to be strictly irrelevant? Could they wonder if the poor and underprivileged sometimes felt that environmental analysis was a rich man's hobby? It was not, of course, but care needed to be taken in presenting these concerns in their pure light as the outcome of a responsible care for the natural world in which they acted as stewards, not exploiters.

MR. J. PATJN (Babbie, Shaw & Morton) said that it had often been suggested that a period of about 10 years was required between the promotion and commissioning of a water scheme in the UK. In his experience this was now regrettably a serious under-estimate. He had been involved with two large water resource projects in England in recent years - one in the North East and the other in the South West. In both cases it appeared that the actual period between the initial promotion and commissioning would be almost 15 years, made up of 10 years for clearing the hurdles to obtain powers and 4 to 5 years for construction of the physical water supply works.

It followed that water authorities were rightly planning their resource developments for a period of about 25 to 30 years ahead but, he had noted that when information on the estimated consumption over that period of time was submitted at an inquiry the objectors strenuously questioned the figures as unrealistic arguing that estimates for such a lengthy period ahead could not be reliable - and a long expensive argument thereupon ensued at the inquiry as to the need for the scheme promoted.

Work started on Kielder in 1968. This led to extensive feasibility studies and a 6-week long inquiry in February/March 1972 - indeed a most searching and extensive inquiry. Four months later the reporter recommended approval of the scheme and it was thought that construction work could have started in 1973 to relieve shortages estimated to arise in part of the authority's area by 1977, but in January 1973, a letter was received which became known as the Ministry's letter of "indecision".

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This indicated that although the DoE inspector appointed had reported in favour of the scheme, the Secretary of State was not satisfied that all possible alternatives had been fully examined. In April 1973, instructions were issued to prepare more detailed studies for no less than 15 reservoir sites, which had been considered previously and rejected. These further studies required geological reports for each site within a period of 8 weeks before the reopening of the inquiry in June 1973. Outline proposals and estimates for these schemes were prepared at the eleventh hour in time for the reopening of the inquiry which lasted for another four weeks. A different reporter was appointed for the second inquiry and in September 1973, he submitted his report recommending the original scheme. This was passed to the Secretary of State and in May 1974, formal approval was given but with the exclusion of powers normally granted under a water order which had entailed much delay in starting the construction contracts as approval had to be obtained from the planning authorities for temporary works such as construction plant, contractors' sheds, offices, and the like.

Civil works contracts were put out to tender with all possible speed and it was now anticipated that water from Kielder would flow southwards to the Tees by mid 1981 - a matter of 14 years from the date when active steps were taken towards the promotion of the scheme.

The project to which he referred in the South West was the Colliford scheme involving a new reservoir on a bleak area of Bodmin Moor, in Cornwall. The source was favoured in 1967 by the then Cornwall River Authority following a feasibility study of several possibilities for augmenting the water resources of their area. A lengthy period of negotiation led to the South West Water Authority, after reorganization, adopting the Colliford scheme. A public inquiry was held in January 1976, and the reporter recommended approval of the scheme in the autumn. It was thought that construction could have been put in hand on the essential strengthening of access roads during 1977. However, there were minor complications owing to the need to flood a small area of common land. To meet that situation the Authority acquired land outside the flooded area to be made available in exchange for common grazings. This all appeared to be a relatively straightforward operation. Not so, however, as approval had still not been granted to proceed with the works.

This was one of the areas most severely hit by the 1976 drought and the same area was presently undergoing another serious drought. During the drought of 1976 the Minister appointed with emergency powers would have liked to sign the water order but could not do so although he had an unqualified recommendation from the inspector who conducted the inquiry. Now, after a lapse of more than two years, with another drought, the order was still not signed. Accordingly, from start to finish, although the reservoir works were not on a very large scale it appeared that the time between promotion and commissioning would be of the order of 14 years.

It was not unreasonable that proposals for water resource developments should be outlined at a public inquiry, particularly where there were agricultural or other like interests involved. In the present climate, with conservation pressure groups highly organized to object to anything that constituted a change, opposition could certainly be expected. These pressure groups represented a small, but noisy, minority of the populace who, if they were so disposed, could certainly delay the approval of works which were in the wider regional or national interest.

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Unfortunately those who appreciated the opportunity to visit completed water schemes were silent and were not represented at the inquiries. He had learned with interest that the North of Scotland Hydro-Electric Board had in 1978 provided facilities for no less than 115,000 visitors to inspect the dam and fish pass at Pitlochry in respect of which there were noisy protests and a public inquiry in 1948.

He would like to suggest one change in the inquiry procedure. He had noted that in England the reporter appointed was normally a planning inspector of the department whereas in Scotland it was usual to appoint a QC or other suitably qualified person who had no connection with the central department involved. He felt it would be better to make a change in England and appoint some person whose impartiality could not be questioned.

It seemed to him that, in the present climate, they were likely to be faced with an inquiry on most water schemes of sizeable proportions; particularly if the reservoir headworks were located in an attractive upland area or on a site where there were conflicting interests. However, he had the impression that the procedural process could be speeded up if there was a more realistic approach to the situation on the part of the ministers and department involved. He had never been able to understand why the Secretary of State for the Environment found it necessary to reopen the Kielder inquiry and thereby set back the timetable a matter of two or three years. In the case of Colliford, he would have thought that a more realistic approach to the urgency of the situation would have revealed some procedural steps which could have avoided such a lengthy delay. He suggested that ministers should accept a greater degree of responsibility and be more willing to take decisions which, in most cases, were so essential in the national interest and thereby reducing the period between promotion and commissioning to a sensible degree.

He welcomed Land Sandford's frank comment in opening the Symposium on the subject of EIA and hoped that engineers would not become so bogged down contributing material required for excessive EIA studies that their creative skills and energies were dissipated and diverted from concentration on the real designing activity of the engineer for which they had spent many years in training. If they did have time and energy left over, they should engage on refuting much of the nonsense (as distinct from sensible comment) published by noisy conservation groups by preparing material for the media, with a view to restoring a balanced view on such matters.

MR. R.G. SHARP (Severn-Trent Water Authority) said that he had much sympathy with the dilemma expressed in the paper as to how far one went with environmental and economic studies of alternatives for major resource developments, where the options were numerous and environmental aspects loomed large. That sympathy stemmed from the experience of a recent heavily contested but successful public inquiry at which numerous alternatives to the promoted scheme were raised, and from the prospect of at least two other controversial inquiries in the foreseeable future.

There was clearly a need to limit the extent of the examination of alternatives in order to avoid the process getting out of hand in terms

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of cost, time, and manpower. However, the very process of short-listing and finally making the selection of one chosen scheme for promotion was an open invitation to the opponents of that scheme to argue all the advantages of the rejected ones - and even of ones that were not on the promoter's or objectors' lists in the first place. A major problem was that each alternative scheme affected an entirely different set of opponents, and the promoter had to justify disturbing one group rather than the others.

The author had said (p.5.3) "on a major water resource development the time may be not far off when it's environmental analysis / absence would be damaging to one's case." He himself took the view that the time had already arrived when that was so, but he thought it should be an EIA standing for Environmental Implications Assessment (rather than Environmental Impact Analysis). "Implications" was a more neutral and general word than the rather emotive "Impact", which suggested an inevitable collision, and "Assessment" embraces a qualitative judgement rather than the more precise and quantified answer implied by "Analysis". A qualitative judgement was surely more appropriate to disparate environmental issues and was less likely to give "phony" answers.

In promoting a major resource scheme with environmental implications (hence likely to be controversial), they were governed by the public inquiry procedure. This evolved before it became necessary, fashionable, or even practicable to consider numerous different ways of attaining the same ends, and might not be best suited to appraising multiple choices. It required that the promoter from a complex combination of technical, economic, environmental, and political considerations, necessitating difficult and controversial value judgements. Some of the options were likely to be ruled out on technical or economic grounds but others would involve environmental assessment.

The next stage was to move to an advocacy situation in promoting the selected scheme against all comers. This put a heavy responsibility on the promoters to get it right in the scheme selection before going to promotion at an inquiry. This in turn meant work in depth on several schemes, some or all of which might be rendered abortive.

With these thoughts in mind he was gratified by the author's remarks in his introduction on the advantages of a public inquiry being able to consider more than one proposal for promotion. This supported views he himself had put forward in the conclusions in his own paper*. The advantages were that it would make an inquiry more objective, more positive, and would hopefully limit consideration to the specified alternatives.

* Sharp, R.G. 1978 Journ. I.W.E.S., 32, 405.
Planning and management of river basin resource systems.

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MRS. D.M. RAIKES (Welsh Water Authority) said that the references made by several speakers to public inquiries had given the impression that managers and decision-makers were not part of the general public, and that this led to a "them and us" situation not conducive to harmony. The general public could be divided into four categories:

- (1) Those who lived in the immediate vicinity of the works proposed, some of whom earned their living in the area, and others who might have spent their life's savings on a house in that location for its peace and quiet.
- (2) The statutory and voluntary bodies, who were both knowledgeable and responsible.
- (3) The "don't knows" (a large body).
- (4) The lunatic fringe.

Whatever one's views were about the time and money wasted by some of these people, one fact had to be borne in mind. That was that they all needed information, and often highly technical information, and that time spent on this both before a public inquiry and during construction was not wasted.

MR. A. BLENKHARN (Water Space Amenity Commission) wrote that the Symposium was timely, especially for those in the water industry who were concerned with environmental management, public access, recreation and amenity. The scope for both harmony and conflict was enormous. The extent of public land ownership was as follows:-

<u>England and Wales</u>	<u>ha.</u>
Forestry Commission	466,700
Ministry of Defence	210,500
Conservation Bodies (National Trust, RSPB, County Trusts)	168,500
Crown	158,000
Water industry	152,000
National Coal Board	79,200

Much of what was owned by water authorities and water companies lay in upland gathering grounds but as the author had indicated so clearly there were very many installations in the heart or on the fringe of our great cities. Environmentally and socially these were just as important as the national parks, the lowland landscapes, or the green belts. Hence, compared with others in the big league of public landowners, the water industry's responsibilities were much broader based. The rest were mostly concerned with the uplands or the depths of the countryside, but they also had their roles to play.

How could the engineers and managers in the water industry best achieve harmony with the environment in going about their everyday work? By far the greater part of their time was spent dealing with a host of smaller works, none of which would ever need an environmental impact study nor a public inquiry, but even routine maintenance on a river, at a reservoir, a pumping station, or a small sewage works could be important

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in the sense that it could adversely affect those things which were needed to maintain or improve the environment.

Training, therefore, had a place and that suggested by Professor Edwards was perhaps the most urgent - post-graduate, in-house and multi-disciplinary. To extend university courses and extra studies should, nevertheless, be the long-term objective.

In the meantime some work was going on with the Department and the major public landowners to prepare guidelines for "environmental management". Some comments from the author on the following points would be welcome:-

- (1) To secure improved long-term management of publicly owned land so as to encourage, in addition to the primary use of the land, and with proper regard for economy, the protection and enhancement of landscapes and townscapes, wildlife habitats, geological and physiographical features, features of archaeological or historic importance. Public access and recreation also had a place here.
- (2) To achieve such objectives would involve surveys, assessments, statements, implementation, and monitoring. This also meant consultation with many appropriate bodies for advice and guidance.
- (3) An environmental management plan would provide a broad basis for long-term management, attempt to reconcile conflicts, and provide a framework for the assessment of costs and benefits. But the type of land and size of holdings owned by public bodies varied greatly, and probably more so in the water industry than anywhere else. Details for the industry would need to be worked out in relation to its special constraints and opportunities.
- (4) A variety of methods were available to implement an environmental management plan. These might include work by direct labour, by contractors, by volunteers, or by labour provided under programmes administered by the Manpower Service Commission. Where land and building were of outstanding importance for conservation it should be the long-term intention to manage these specifically for conservation purposes. Alternatively, a conservation organization might manage the site under a lease or management agreement.
(N.B. there were already some outstanding examples of both within the industry)
- (5) Following the guidelines set out above would often, though not always, involve some expenditure from public funds. The amount would depend upon individual circumstances but it was not envisaged that their adoption would involve major expenditure. Indeed, in some cases there could be savings, for example by reducing the frequency of cutting certain grass areas or allowing

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the regeneration of woodland to take place on others. Certain historic buildings could be maintained and run by voluntary organizations at little or no cost.

- (6) Establishing the principle that capital works or an annual management budget of a public body could also include a built-in commitment to undertake some work in the interests of landscape, townscape, and wildlife conservation. This commitment could also include a statement in the annual reports of public bodies. This would be of valuable public benefit in relation to local goodwill, in encouraging voluntary labour, and in stimulating worthwhile consultation.

There was some comment by several authors and from the floor about the adverse effects of land drainage and river improvements. Nowadays the argument seemed to have settled on the theme "to drain or not to drain" as opposed to the amelioration of approved schemes to satisfy landscape, wildlife and fisheries needs. This shift in emphasis brought with it a whole range of financial and economic problems in such areas as agricultural grant-aid and compensation or the greater risk of flooding in urban and industrial areas. Public inquiries clearly had a place here but they would not solve the basic underlying problems. However, harmonies and/or conflicts of this kind were not limited to national parks and there was still a long way to go to a "planning" or "political" solution for the country as a whole.

MISS M. LINDLEY (Rofe, Kennard, and Lapworth) wrote that both Mr. Thirlwall's and Mr. Oldfield's papers directed discussion to the analysis of the impact (or effects) of formulated proposals and gave little attention to the many opportunities which might occur from the initiation of a project for securing harmony or reducing possible conflict. The scope of such opportunities varied widely with the type of project and the type of environment, and might be most significant in medium and small schemes. They should not, however, be overlooked or lost to sight among the massive exercises thought appropriate to major schemes.

There was a danger in formulating set plans for environmental impact assessments at an advanced stage, either informally and "in house", or a full public assessment somewhat later. The need for continuous awareness by the engineers involved at all stages and the gains which could result from this might be overlooked, or even suppressed. The call for greater environmental content in university engineering courses was inconsistent with a tendency in some quarters to exclude or reduce the engineers' contact with environmental interests and sources of information. Much information was now available in this country on the location of areas of ecological interest, archaeological sites, and other features. These, if mapped for the overall project area, could be used to minimize conflict in many aspects from the earliest stages of the siting of works, either to avoid impact altogether or to initiate discussion to find an optimum solution.

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MR. R.B. ARMSTRONG (Southern Water Authority) wrote that a limited impact assessment had been used in conjunction with a series of site investigations to reduce a list of 20 potential reservoir sites in South Hampshire to 3 or 4 main options. This had not been a public exercise but the co-operation of the County Council, the District Councils, the Ministry of Agriculture, Fisheries, and Food, the Nature Conservancy Council, and the Civil Aviation Authority (because of an airport adjacent to some of the sites) had been sought. A points assessment system had been devised to weigh the relative importance of the comments received. This exercise had been particularly helpful, as many of the sites were found to be similar in respect of availability of storage and cost of construction.

The assistance of these bodies had been readily given, but when an officer of the County Council had been asked if they would be prepared to take part in an EIA under a joint steering committee as suggested in Research Report 11, the reply was that it would be unlikely as staff resources could not be made available. Although this was not important at the time, it did raise the question that a regional water authority might be left without power in such a situation to seek co-operation for a joint exercise if an EIA did become a necessity for a successful reservoir promotion.

On p.5.4 the author referred to the "also rans". There were other problems where a large number of alternative reservoir sites were being considered as an early disclosure of information before the technical details were worked out led to excessive and often unnecessary blighting. How great was a regional water authority's moral responsibility here for if all potential sites were announced "prematurely" a large number of existing property owners might experience difficulties when wishing to sell or develop their properties; this was clearly undesirable from the public relations viewpoint. On the other hand, if an authority was seriously considering a small number of alternatives which had not been publicly announced and did not disclose this information in the event of a direct inquiry by a prospective purchaser or developer, there was an equally undesirable situation. The right time to announce reservoir proposals was often difficult to decide.

It was possible to put a cost on the unquantifiable factors referred to on p.5.12, but only implicitly by evaluating the cost of alternative developments, if such be available, to avoid the environmental objection to a preferred scheme. However, he did wonder whether the regional water authorities devoted sufficient attention to evaluating and informing the general public of these costs in terms they could readily understand, i.e. the extra they would have to pay individually to enable the environmental objections to be met. It did seem that the "social responsibility" of environmental objectors was often publicized in a most unbalanced manner.

BRIGADIER C.C. PARKMAN (Ward, Aschcroft, and Parkman) wrote that in his opinion a public inquiry was much better than an inquiry behind closed doors, and at least allowed the various protagonists to ventilate their points of view. Mitigation was undoubtedly an important component but ruled out the alternative, which sometimes was the right answer - to do nothing.

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There must always be a trade off of benefits and penalties in an impact analysis, and the study should look at both. The fact that benefits might be regional, and penalties local, made the work more difficult but not impossible.

Author's Reply to Discussion

MR. J.B. OLDFIELD, in reply to the discussion, said that he felt honoured that the discussion had been led by such a distinguished figure as Baroness White, and that he shared her distaste for imposed procedures on the American model. From experience of EEC directives affecting the water industry, he was also apprehensive of what EEC involvement might mean.

Mr. Johnston and Mr. Herbert had been diligent and valued consultants during North West's study and with hindsight he shared Mr. Johnston's view that the engineering studies should have been allowed lead time over the environmental work.

The comments by Mr. Paton and Mr. Buchanan tended to see environmental considerations as yet another factor that prolonged the pre-construction period. No one could tell whether this would be the effect of formal studies, but the aim in North West had been to achieve a fully informed decision, by appraising in advance the environmental issues that could be expected to emerge in a public inquiry. The answer to Mr. Buchanan's question about cost was that the cost of North West's study was way under half of 1 per cent of the cost of any of the schemes envisaged.

Dr. Wright, in his thoughtful contribution, wondered how the author and his colleagues would present the environmental information. Certainly there would be no attempt at numerical weighting, such as was referred to by Mr. Armstrong. Indeed, Dr. Wright accurately described North West's thinking on this topic when he argued against ascribing values to particular environmental factors, and referred to the matrix of cost inputs and environmental qualities that would need to be considered in deciding whether "it was worth spending extra financial resources to preserve a particular group of environmental features".

Mr. Blenkarn and Miss Lindley both referred to the need for training and for the engineer's involvement in environmental matters as part of his customary approach to his work. Miss Lindley wisely deplored the opposite tendency, to isolate engineers from environmental interests and sources of information, although it was just possible that this was a gentle rebuke for the way he organized North West's study.

Mr. Sharp's views were close to his own in many respects, and in particular, he endorsed his preference for the term Environmental Implications Assessment as being a more accurate and less emotive description of the process.

6. ENVIRONMENTAL FACTORS IN OVERSEAS SITUATIONS

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INTRODUCTION

Throughout the ages man has been striving to raise his living standards whilst responding to constraints imposed by limited knowledge, technology, skills and materials and by economic restrictions. His efforts have inevitably been subject to compromise and frequently to plain failure.

The rudimentary technology of the Stone Age afforded a limited return to efforts at gaining subsistence and provided a meagre if not precarious protection against environmental hazards. Transition to Neolithic agriculture in effect increased the growing capacity of the land with the result that larger populations could be supported. Later, metallurgy, irrigation and other technological achievements of the Bronze and Iron Ages prepared the way for the settlement of man and ultimately for urban living.

As learning increased various aspects of man's development became subjects for philosophical study, for instance the relationship of population size to the structure and stability of political institutions and the contrasts between urban and rural modes of existence, but systematic work in human ecology had to await the accumulation of scientific, geographic, ethnographic and demographic data collected by nineteenth century investigators. Eminent 19th and early 20th Century psychologists studied the importance of the environment on behaviour and identified the interaction between the individual and the environment. Today, a well established and stable community can be viewed as an expression of the harmonious integration of man within the surrounding physical environment.

It is therefore essential that this environment be understood as completely as possible as a prerequisite to the implementation of new developments. This is no less true in other, poorer parts of the World where compelling social and economic circumstances require a rapid increase in local food production, the exploitation of raw materials or industrial development. Neglect of the effect upon the environment of such developments may result in the emergence of conditions that seriously detract from the value of the development.

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ENVIRONMENTAL IMPACT

The expression "Environmental Impact", which appears to have originated in America, has been readily taken up in the U.K. Impact implies collision and damage so that acceptance of the expression suggests that development however beneficial its primary objective, is expected to carry with it adverse secondary effects. This is doubtless due in part to the forceful expression of views by those who have deep concern for particular aspects of the environment. But perhaps it is also indicative of the measure in which this country has been endowed with natural characteristics favourable to man, a gentle topography, fertile land and temperate climate so that as a generalisation change may be deemed undesirable. Certainly there are few areas remaining unaffected by man's intervention with the natural state of affairs, but over the greater period of history of this country, changes have been instituted slowly and in harmony with nature. Serious "Impact" has been limited mainly to the later period of development in areas of concentration of a growing population, with the emergence of urban communities and particularly since the industrial revolution. In recent times, it seems that there has been an exponential rise in man's ability to interfere with the natural course of life and with the environment, to his advantage but in some respects to his detriment.

Fortunately these processes have been accompanied by a growing awareness of the less acceptable aspects of change. Some of these have been all too clearly apparent, choking smogs telling of atmospheric pollution, odourous rivers devoid of any fish life, overcrowded tenements and slums. Others are far more insidious, the lurking hazard of catastrophic release of poisonous gas from chemical process plants, unknown long-term harmful effects of apparently beneficial drugs, the increase in ultra-violet penetration of the atmosphere, the encroachment of concrete civilisation on a diminishing area of open country-side.

Much has now been accomplished in countering the most direct and obvious of these menaces to man's well being and the Water Engineer has made a substantial contribution to such achievement. The very nature of his work has brought him into a close working relationship with specialists in a wide range of subjects, with doctors and health officials, chemists, biologists, agriculturalists and so on. His approach has always tended to be multi-disciplinary accepting the need to seek the knowledge and advice of others, to meet and, sometimes, to reconcile or find a compromise between the conflicting requirements presented to him. With this background the U.K. Water Engineer is enabled to provide a useful service overseas in developing countries that have yet to gain their own expertise. The needs and conditions are different from those in the U.K. The technology established in this country has to be used as a base but it is essential to maintain perhaps an even greater vigilance for potential problems not previously encountered.

The needs of the developing countries are brought to our notice dramatically and horrifyingly in newspaper reports of floods, droughts, famine and disease. Behind these reports lies the pitiable fact that a major part of the World's population exists at the subsistence level, their only certainty that of future hunger, unrelieved labour, illness and premature death. Changes are required in a desperately short time scale and against a background of a hopelessly imbalanced economy. In these circumstances, the concept of the "impact" of development upon the environment takes on a different significance. Principles remain the same but there is a radical change of emphasis. The development of all those facets of the environment

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that can be directly utilised or modified to relieve the more pressing human problems is paramount, subject only to the avoidance of consequences which might detract from that purpose. The identification of secondary effects is of importance; to enhance and take credit for those that are beneficial, to eliminate or make allowance for those that are detrimental.

Sometimes development is required in an environment that is particularly hostile to mankind or that has become so as a result of man's activities. Here conservation for its own sake is a far less pressing consideration than in a developed country. However, the absence of an educated and informed public or influential minority to probe and question proposed developments, or of a political system which permits of such questioning, throws even greater responsibility upon those required to make technical decisions.

The compelling urgency of many developments requires resort to the whole background of modern technology in their accomplishment. But in the use of that technology it has to be recognised that complex solutions may not be appropriate. It is of little avail to provide the technically ideal processes or equipment if these cannot be understood, operated and maintained by those who will ultimately take them over; or where consumables and replacement parts cannot be obtained due to lack of management ability or, as is frequently the case, lack of foreign exchange to purchase them. Construction techniques have to be matched to the available resources in labour and materials.

Technology has to be used to make a thorough analysis of the problem to be answered, to provide, evaluate and compare alternative solutions and, not least, to identify and assess possible secondary effects.

As in the U.K. the contribution of the Water Engineer overseas is widespread, encompassing the investigation and exploitation of available water resources, the provision of water supplies for domestic, industrial and agricultural purposes, drainage and waste disposal, public health, irrigation, land drainage, flood control, coastal protection and hydro electric power. Some examples with brief mention of their environmental implications are now described.

MUDA IRRIGATION PROJECT - WEST MALAYSIA

The Muda Irrigation Project is situated in the northern states of Kedah and Perlis in West Malaysia. The project area lies in the wet equatorial climatic belt about 5°N of the Equator, where the climate is dominated during most of the year by deep moist equatorial air masses and heavy convectional rainfall is frequent. The Malay Peninsula is sheltered from the full force of the south-west monsoon by the mountains of Sumatra and receives some shelter from the eastern monsoon by its central mountain ranges. The driest months in the year in Kedah and Perlis are late December to March and the wettest are October and November. Rainfall is, however, also greatly reduced from June to August. Near the Kedah coast the average annual rainfall is about 2,300mm and this is somewhat reduced further inland. Prior to the construction of the irrigation project, rainfall and run of river irrigation schemes made possible the cultivation of one rice crop per year during the wet period between August and December; however, during dry years crops occasionally suffered from water shortage. The construction of this project enabled surplus water to be stored during the wet season for subsequent distribution during the dry season so as to make possible the cultivation of a second crop of rice over an area of about 1,000km² of coastal plain.

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The works comprise a main reservoir in the inland hills made up of two basins formed by three dams and linked by a tunnel; in the plain two barrages and 98km of main canals serve a reticulation system to distribute the water to the padi fields. Immediately prior to the implementation of the scheme Malaysia imported on average about 300,000 tonnes of rice each year. The increase in rice yield from the area irrigated by water from the new reservoir increased from about 200,000 tonnes to 600,000 tonnes per annum, and with consumption rising annually, the execution of the project was clearly a vital factor in boosting the nation's economy.

The two reservoir basins have a combined water surface area of 90km² and are situated in dense jungle near the border with Thailand. Due to terrorist activities over a considerable period prior to construction, there was no resident population within the reservoir area and consequently no resettlement problems were encountered. Timber of commercial value had been largely extracted from the reservoir area; new roads provided for the construction and maintenance of the dams, spillway and tunnel were routed through previously inaccessible jungle which provided new sources of timber. Communications were also substantially improved between these areas and the commercial centres near to the coast and, although a dusk to dawn curfew was in force in the jungle area, daytime timber extraction work was subsequently possible, largely uninterrupted by terrorist activities.

No provision is made for the discharge of compensation water from the dams to the two principal rivers affected by the impoundments. Although both rivers are a source of water supply to scattered villages on the fringe of the jungle and the coastal plain, there is normally enough run-off from the natural catchment area downstream of the dams to keep supplies at an acceptable level. During the dry season, water is released from the dams for irrigation purposes and this assures supplies which prior to the scheme could not have been guaranteed.

Draw-off from the reservoir is from two screened intakes placed at the base of each of the dams. Water is drawn at all times from the hypolimnion of the thermally stratified reservoir and discharged to the rivers through hollow jet air discharge valves. This mode of discharge ensures rapid re-oxygenation and the cold water warms soon after release due to the constantly high ambient temperatures prevailing. Undoubtedly the river fisheries immediately downstream of the dams have been severely affected by the reduced water levels and low water temperatures, but on the other hand, fisheries which provide a source of food in the populous areas further downstream benefited from maintained flows during the dry season. Water released from the dams is high in soluble iron and manganese and considerable staining of the river channels for 2 or 3km downstream has been observed. No ecological surveys have been carried out in the areas affected by staining, mainly due to the relative inaccessibility of the rivers concerned.

The construction of an almost entirely new canal and drainage system to serve the irrigated area has brought about many changes to the way of life of the largely agricultural community. New canal banks, used as roads, and new bridges spanning the waterways have improved communications to areas hitherto served by a sparse network of tracks, often inaccessible during inclement weather. Farming methods based on a single annual rice crop were no longer adequate for the double cropping cycle; buffaloes providing traction for ploughing and burned stubble ash with animal manure to revitalise the soil gave way to modern tractors and bagged fertilisers. The farmers themselves had to be persuaded to change their long-accustomed traditional methods, with inevitable resistance from the older generation. Due mainly to the

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persuasive nature and organising ability of the local Drainage and Irrigation Department Engineer, change from single to double rice cropping in the project area was achieved over a carefully planned five year period. Special facilities have been provided for efficient drying of the rice following harvesting and new rice mills have been built to process the increased quantity of grain produced.

Fish culture in the padi fields is usually undertaken in conjunction with the production of rice. When the water in fields is drained off to ripen the crop, the air-breathing fish move to troughs or tanks in the corners of the fields, and are then harvested. Complementary to the double rice cropping cycle it is therefore possible to increase the fish harvest.

Although farming systems that are largely dependent upon wet rice cultivation are in general effective in maintaining soil fertility and crop yields at a satisfactory level, the financial return usually procures only a low standard of living for the farmers. The environmental changes brought about by the Muda Irrigation Project can be considered as a whole to be beneficial in that the return for effort has been rewarding. In general, the two main reasons for the rice farmers' low standard of living are firstly from population density and land tenure in the rice growing areas and secondly from the low returns per man obtainable from the traditional rice growing methods. By providing water in sufficient quantities and in the right season, planting high yield varieties of rice and mechanising farming methods, the way is paved for the improvement of the farmers' lot; however, only radical social change by overcoming the land tenure problem will bring about more efficient overall management.

Extensive mechanisation and the application of fertilisers and herbicides increase the capital and operating costs which then have to be offset against the increased yield from double cropping. It is likely that only in well organised and financed situations will a fully mechanised and efficient double cropping rotation produce favourable returns on capital invested. This form of rice cultivation is unlikely to be introduced extensively in the rice growing areas of the world for some time to come.

Black Bush Polder and Tapakuma Schemes - Guyana

These are schemes undertaken between 1960 and the present time for the reclamation, drainage and irrigation of coastal areas in Guyana.

Practically all the land which is being developed lies below high tide level and perhaps the most important feature on which agriculture depends is the requirement to provide adequate drainage. Traditionally, this was effected by evacuation of water during periods of low tide to the sea or river by simple undershot gates. In addition, with the prevailing high rainfall (averaging 2000 - 2250 mm per annum), protection is necessary from flooding caused by over-spilling of swollen water courses and the large number of swamps in this "land of waters".

The very flat nature of the land requires drainage channels of large capacity and of very small slope. Consequently developments are typified by a series of long, straight channels both for drainage and for irrigation. Because of the very high water table and the extremely soft ground conditions, access roads have to be elevated above the general ground level and the channels are often over-sized hydraulically in order to obtain sufficient embankment material on which the roads are built. Many schemes, where drainage has to be discharged into the seas, require pumping stations because

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accretion of the sea littoral tends to block both natural and artificial outfalls. (In fact, a cyclical pattern of accretion and erosion takes place in a westerly direction).

The need for adequate sea defences, particularly during the erosion cycles, is becoming more acute following the gradual increase of development, which is concentrated and becoming relatively stabilised along the coastal margin. In the early (19th century) days of plantation development it was simpler and cheaper to retire further and further inland behind sea defences consisting of an earth embankment, but this process cannot any longer continue. Moreover there is a conflict between sea defence and drainage requirements.

Given high rainfall and a high water table, it is not immediately obvious why irrigation should be so important, but the traditionally irrigated crops of sugar and rice are demanding enough to require irrigation during the two seasonal, though not very well defined, dry periods. The obvious sources of water are the swamps of the hinterland which have been improved and regulated by the construction of very long embankments across the natural drainage channels leading the waters onto the frontlands. The reservoirs and "conservancies" so formed are very shallow and have an operating range of only a few feet. The dams themselves provide the necessary flood protection for agriculture and the surface area of the reservoirs invariably exceeds that of the land that they irrigate. Obviously this situation would pose serious environmental consequences in other countries, where land is less plentiful and where topography would allow a much smaller ratio of reservoir surface to irrigated development.

In considering the environmental aspects of these reservoirs, it should be borne in mind that the land sterilised by the creation of conservancies is generally of little or no agricultural value and in any case is prone to flooding during the wet season. The fertile soils adjacent to the coast are very well defined and the line of demarcation between swamp land and the higher white sand series which contain them is very clear. The environmental aspect of the reservoirs is therefore perhaps mainly concerned with ecology of fish and animal life and a little forestry. Very few human beings have been disturbed by the creation of the conservancies. The relatively few settlements of the indigenous peoples have continued to survive on the higher ground on which they were originally established above flood level. The slightly higher retention levels of these reservoirs are but a few feet at most above those which prevailed naturally before the construction of the reservoirs. Agricultural activity has therefore generally taken place on land free from flooding and such fishing activity, on which they also depend, has in all probability been improved rather than interfered with. There are a number of interesting scientific studies completed and in hand, concerning the fish population of the inland rivers, lakes and swamps.

For example, at Tapakuma, in addition to enlarging existing lakes and conservancies, a new lake was also located in a river valley which was heavily forested. Apart from limited tree clearance to define a navigation channel, no general clearance was made and there was a minor problem on filling the reservoir when for a year or more the products of dying vegetation created some considerable change in the water quality, which in any event has a very low pH. An apparent decline in the number of edible lake fish (lucanani) in recent years, has followed the very considerable increase in the fish population which followed the creation of the reservoir (about 1964). One theory is that this species found a more advantageous means of escape from

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the predators, the electric eels, by finding shelter amongst the mass of tree trunks and drowned forest material of the new reservoir floor. This refuge has, with the passage of time, become less dense and the theory is postulated that it thus gives the electric eels greater opportunity to seek their prey. However it appears more likely that this is a typical development experienced on the formation of a new reservoir. In the first few years the rich supply of organic matter causes a surge in aquatic bio-productivity. This is followed by an increase in population of fish which eat small food and subsequently of predators. But the delay while the populations increase to the limit of their food supply causes imbalance. Thus about now, some 14 years after impoundment at Tapakuma, a surplus of electric eels relative to lucanani might be expected.

The impact of other irrigation works (channels, control structures and roads) on the agricultural coast land areas is perhaps more readily understood by sociologists than engineers. Settlement of these coast lands goes back for well nigh two hundred years. Despite the gradual trend of development to move inland from the coast, the population still clings tenaciously to a narrow band which rarely extends more than a mile back from the shore-line and it is within this narrow ribbon that village settlements have gradually merged one with another in a long, continuous strand. All activities connected with agricultural development have traditionally taken place therein and there is no obvious change in the physical environment resulting from the superimposition of a network of irrigation and drainage canals on the plain between the coast and the swamps of the "back lands".

There has been considerable reluctance by the local population to move away from the coast and to establish new communities inland. The farmers, with few exceptions, seem to be content to travel daily on foot or by tractor to and from the fields remote from the coast. Not surprisingly, the provision of good roads, water supplies, housing and schools has been the primary factor where success has been achieved in establishing a few inland villages. Future irrigation projects will have to provide more and better roads for purely agricultural purposes, but it will need a far greater impact than this to change radically the way of life of the farming community.

Fortunately and perhaps unexpectedly in those surroundings, there is a remarkable absence of those debilitating diseases that are endemic elsewhere in similar circumstances. Perhaps the most important factor towards the improvement of health of the Guyanese population has been the eradication of malaria (by the classic use of DDT) commencing some 40 years ago. Continuing precautions are necessary to prevent a resurgence of the disease. Irrigation and drainage channels were formerly the principal source of water supplies, but these are now generally being obtained from deep wells, tapping underground reservoirs all along the coast. Drains tend to remain the natural repository for rubbish and sewage.

To have witnessed the transformation from a subsistence survival in squalid housing to the standard of life now enjoyed in neat and tended homes of the same villages - all as a result of irrigation development - leads one to conclude that the general welfare of the population has been improved without serious detriment to the environment.

Augmentation of Water Supplies - Antigua

Following a water conservation study in Antigua in 1963/63, 19 impounding reservoirs were constructed with capacities ranging up to about 4800ML.

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They were intended to conserve the intermittent runoff from the very erratic rains so as to increase the supply of water for agricultural irrigation. In the years 1964-68 Antigua suffered a severe drought, rainfall in the final three year period being the lowest since records were instituted in 1874. Consequent upon this drought it was decided to augment the public water supplies by utilising the largest of the then recently constructed reservoirs, known as the Potworks Reservoir. The investigation at the time showed that the water in this reservoir was of a satisfactory quality and that a contribution of 4 ml/d could be obtained from the reservoir towards the overall demand on the island of 9 ml/d. Because of the high evaporation from the relatively shallow reservoir with large surface area, it was found that the greatest benefit could be obtained by operating it in conjunction with other sources of supply namely groundwater and a distillation plant. The optimum yield was given by heavy drawoff from the reservoir whenever surplus water was available and by conserving groundwater at such time.

The area below the reservoir is low-lying and subject to flooding and hence a treatment plant was planned at higher land over a kilometre distant from the intake.

There are a number of scattered houses with primitive sanitation in the reservoir catchment which consists mainly of scrub and pasture land with some limited areas of cultivation for maize and sorghum. Even the reservoir margins are grazed by livestock since vegetation grows rapidly as the water line recedes. Storm rainfall carries a great deal of suspended matter into the reservoir which tends to be turbid. For these reasons full water treatment is provided, consisting of aeration, pre-chlorination, coagulation and clarification, rapid gravity filtration and post-chlorination. Provision is included for sulphur dioxide de-chlorination, but this has proved unnecessary in practice and residual chlorine is deemed to be necessary as a safeguard against contamination in the distribution system.

No problems have been reported from algae blooms or plant growth in the reservoir. Aerial spraying of crops in the vicinity of the reservoir with DDT pesticides was observed and a recommendation was issued that this practice should be discontinued. However, there is no legislation for enforcement of any form of control within the catchments. The extent of bacteriological and chemical contamination is not really known as testing facilities on the island are almost non-existent.

The reservoir has been stocked with a variety of fish, believed to include Tilapia, Catfish and American Black Bass. These are said to thrive, but fishing remains very much a pleasure pastime. Elsewhere on the island fish farming has been instituted in water supply reservoirs but not on an intensive scale. As a matter of interest, in the early days of the operation the pumps delivering water from the reservoir to the treatment works were found to cut out on overload. On being dismantled the cause was found to be an accumulation of large fishbones and this trouble has now been obviated by the introduction of cleanable screens into the suction pipes to the pumps. Another unexpected feature of the scheme was experienced during the clearance of the reservoir area. This was previously partly covered by Manchineel trees which have a poisonous sap. The sap causes serious acid burns when it comes into contact with the skin and a number of workmen involved in the tree clearance had to receive medical treatment as a result of such burns.

Since commissioning, the treatment plant has operated reasonably well. The problems that have arisen stem primarily from the

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absence of skilled labour and because of the need to anticipate all requirements in the way of consumable materials and spare parts, delivery of which is usually protracted. The local supervisors were selected because they had some previous experience on chemical process plants, but they had no relevant background in the water industry. The operators were intelligent and quick to grasp routine procedures, but it was incredibly difficult for them to gain any understanding of these procedures. They had virtually no previous contact with any form of mechanical or electrical plant. Even a simple piece of equipment such as a gate valve was a mystery to them and they had to be trained in such elementary matters as the reading of a gauge. Training was given both in UK and by direct expatriate supervision in the first few months of operation, but it is of little surprise that accidents occurred. For instance an incorrect connection to a chlorine cylinder allowed liquid chlorine into the dosing equipment which was rapidly eroded beyond repair. Fortunately, there was no direct escape of gas on that occasion, but the potential for dangerous accidents is obvious.

The waste elements from the treatment plant have created no difficulties to the present time. Wash water from the filters is returned to the reservoir. The sludge from the clarifiers is drained to settlement and drying ponds.

Consideration has been given to the development of artificial catchments for the efficient collection of rainfall, but this would occupy far too large an area of all too precious land. However, one artificial catchment already exists in the runway and paved areas of an airport base and it has proved possible to utilise this as a source of potable supplies for an adjacent district.

Main Drainage Project - Sharjah, UAE

The provision of adequate sanitation generally follows after the needs for food and water supplies are satisfied. Alternatives to water-borne sewerage are being developed for the intermediate technology situation, but conventional disposal systems are provided for urban communities in those countries where the economy permits. The main drainage scheme for the City of Sharjah in the United Arab Emirates will ultimately serve a population of 150,000.

A significant feature of the new sewerage system is the extensive recourse to pumping due to the very flat terrain; in fact the entire flow of sewage will need to be pumped to the treatment works. In the anaerobic conditions of the pumping mains the tendency for the sewage to become septic, already high as a result of the hot climate, is increased. The problems that arise in Middle East countries under such circumstances have been widely reported.

To minimise the development of septic conditions in the pumping mains, oxygen will be injected into the sewage in the mains. A reliable supply of liquid oxygen in the quantities required is not available in Sharjah at the present time and the oxygen will therefore be generated 'on site' using the pressure swing absorption (PSA) process. At the ultimate development of the scheme, a number of PSA plants will discharge several tons of oxygen per day into a ring-main system from which oxygen will be drawn for injection at key points of the major pumping mains.

There will also be a tendency for septic conditions to develop in the gravity sewers. It will accordingly be necessary to provide effective

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ventilation of pumping stations receiving sewage that may be septic in order to ensure a safe atmosphere for maintenance personnel. Many of the pumping stations are situated in densely built up areas and preventive measures are required to avoid offensive odours in the vicinity of the stations. Ozone generators are being installed in the stations and ozone will be injected into the exhaust gas to neutralise the odorous substances that would otherwise be discharged into the atmosphere.

Treatment of the sewage is by long retention activated sludge process with mechanical surface aeration. Excess sludge is discharged to aerobic digestion tanks and is subsequently dried in open beds, the dried sludge being applied to land for agricultural purposes. Effluent is further treated by sand filtration and chlorination to render it suitable for irrigation purposes thus making a valuable contribution to the water resources in this arid area. Initially the use of the treated effluent will be confined to amenity purposes; the reason is that it has a relatively high chloride content arising partly from infiltration of extremely saline groundwater but more significantly from the practice of pumping directly into sewers when de-watering building excavations.

Rangeland Development - Somalia

It is encouraging to find that attention is now being given to the control of catchments in order to combat the problems that can arise from denudation, eg reduced retention of rainfall, soil erosion, siltation, extreme river flows and the seasonal drying-up of rivers. In one scheme encountered recently an integrated approach to development of a river basin was proposed where problems had already developed in a limited degree. This consisted of limitation of livestock numbers and rotational grazing in the upper catchment, the construction of an impounding dam and a seasonal storage reservoir, irrigation and drainage developments in the lower valley again with cultivation designed to resist soil erosion.

In Northern Somalia, agricultural and rangeland developments are being instituted under the control of National Agencies in order to improve the lot of the largely nomadic inhabitants of the area, who suffered severely during the drought of 1972-74. This region varies from arid to semi-arid in climate and has been noted as vulnerable to the encroachment of desert conditions. Over-grazing and sporadic cultivation have caused loss of soil in many areas and incipient gully erosion is apparent on sleeper slopes. Rivers are dry for the greatest part of the year but rise rapidly after storms and carry a high silt load.

A region corresponding to the southern half of the former British Somalia and covering an area roughly equal to that of England and Wales is to become a controlled livestock range. The first operation to be undertaken is one of informing and educating the nomadic population so as to gain their acceptance to an idea that will involve a significant change in their way of life. They will be encouraged to limit their herds, marketing will be facilitated to enable them to dispose of surplus animals and cooperative organisations will be fostered.

Rotational grazing will then be instituted in individual sectors of the rangeland. After a period of grazing in one area, the herds will be moved on and the vegetation in that area allowed to regenerate. The livestock movement will be in some measure controlled by the availability of water.

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Watering points are to be established through the region and these will be opened or closed according to the condition of the pasture in the vicinity.

In addition fodder banks are to be established to provide feed for the animals in times of shortage of natural pasture. Various areas will be set aside throughout the rangeland for the intensive production of fodder crops. Basically the water for this will be obtained by two methods. The first is known as water harvesting and is possible on gently sloping land where there is moderate rainfall. In this part of Somalia rain generally falls in short and relatively sharp storms. By forming lines of contour bunds it is possible to retain and pond the run-off. The concentrated depth available against the bunds is sufficient to sustain growth of vegetation which is subsequently cut and dried for storage.

The second method is by the flooding of land with water diverted from rivers whilst they are flowing in spate. For this method to be successful a large volume of water must be handled in a short time. Canals are constructed to lead water from the river to the fields. Careful consideration has to be given to the location and design of the offtakes from the river so as to minimise the carrying of silt into the canals. Traditionally, earth embankments are pushed up across the river channels to divert the water into the offtakes but these are overwhelmed in a relatively short time dependent upon the severity of the spate. It is necessary to draw-off as much water as possible before this happens and, of course, to rebuild the barrier before the next flood. From tests presently being carried on, it is expected that designs can be established for rock embankments that will have a fair degree of permanency without being too expensive in first cost.

The input required of the engineers is to establish the hydrology of the region; locate and design watering points from either surface or underground sources where water may be stored without undue loss from evaporation and seepage; to design and set out the water harvesting bunds to give the required concentration of rainfall; to locate and design the river diversion works, canals and distribution systems for flood watering; to assist in the management and supervision of direct labour construction operations; and finally, but of considerable importance, to train local personnel in the techniques involved in this type of work. Close cooperation is necessary with those responsible for planning the management of the range and with all manner of specialists. In addition, all concerned must develop a close affinity with the local population in order to gain a proper understanding of their needs and of their reaction to this project.

ENVIRONMENTAL CONSIDERATIONS IN RESERVOIR DEVELOPMENT

The environmental implications of major reservoir development have rightly received a great deal of publicity, in many instances due to the emergency measures that have had to be instituted as a result of failure to appreciate and anticipate various effects of the impounding operation.

On the African continent, the larger man-made lakes of Kariba, Volta and Kainji lie in bush country which presented enormous land clearance problems prior to impounding, whilst by contrast Lake Nasser formed by the Aswan High Dam in desert country presented problems of a different kind, including the re-siting above water level of ancient temples.

From the human point of view, the displacement of the inhabitants of the flooded area and the need for their relocation and resettlement is one of the

least satisfactory aspects of reservoir projects. In the case of Kariba the number of people involved was seriously underestimated and the cost of relocation escalated to more than three times the original estimate. Large reservoir projects are usually the result of decisions made by a relatively autonomous development authority and may be the most expensive projects within long-term national development plans. Partly for this reason, the remote lake basin population are largely excluded from the planning of their future and insufficient preparation is made for the shock of being physically uprooted and resettled in a strange and sometimes hostile environment. This lack of preparation has been the situation on some major projects where relocation has been undertaken on a crash programme to remove the population only shortly before inundation. In the case of Kariba, Volta and Aswan, it was necessary for the respective governments to arrange for food relief for several years after resettlement before new production systems became effective.

In general the health situation for the resettled population has improved due to the establishment of health clinics in the newly provided settlements. Also with improved communications, access is easier to facilities outside the lake areas. In contrast, however, fishermen living in isolated villages around the new lake shoreline are now exposed to riverine diseases, and their situation has worsened. The incidence of bilharzia occurs widely amongst the population living around the Volta and Kariba lakes. The bays and inlets particularly where the concentration of population is greatest also harbours the most stable population of the snail vectors. Control of the disease is difficult since the snails are often transported from infected localities on aquatic plants.

The breeding places of the *Simulium damnosum* blackfly, the vector of river blindness formerly widespread on the river have been eliminated by the formation of the Volta lake leading to the eradication of the disease in that region. Unfortunately, it remains prevalent in settlements located by the river downstream of the Volta dam and on major tributaries to the lake. Also the lake has flooded over the riverine forest breeding places of a species of tsetse fly that is the vector of sleeping sickness.

The impact of lake Kariba on wildlife has been investigated and much published data is available. Research on the effects of the lake on animal populations in a reserve area indicated that hippopotamus, waterbuck and bushbuck initially suffered loss of habitat, but at the same time the dense growth of vegetation along the lake margin after heavy seasonal rains attracted elephant, impala and buffalo. There was considerable impact on birdlife following the drowning of the Zambezi Valley vegetation. This was somewhat offset by the creation of open ground areas and grasslands in the form of new roads, airstrips and so on, encouraging access by birds more characteristic of open environments. During the period when the lake waters were rising, more than 6000 animals were moved from the area. Named "Operation Noah" this project generated considerable interest throughout the world and was of great value to the cause of wildlife conservation. Much information on animal behaviour under conditions of stress particularly in strange new habitats has been accumulated and published.

Relatively little is known about the precise influence of major reservoirs on weather and climate. Satellite imagery has potential application for some man-made lake studies, in that the development of local cloud and weather effects can be observed on a large scale. Gross soil moisture and vegetation changes adjacent to new lakes can be observed by infra-red

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imagery, and the overall effect on cloud climatology can be assessed. Since August 1964 four separate Nimbus satellites have provided valuable data. The Nimbus 3 satellite has recorded observations of cloud cover and rainfall over two man-made lakes, one in an area of moderate seasonal rainfall (Volta Lake) and the other in a desert area (Lake Nasser). In the former, a reduction in cloudiness but with no reduction in rainfall has been observed, whilst in the latter there appears to have been no effect on cloudiness or rainfall. At the micro-climatic level, most of the evidence required to predict possible effects comes from comparison with existing natural lakes and their influence on precipitation, wind direction and frequency and other phenomena.

Other significant effects have subsequently given rise to concern, for instance, induced seismic effects, depletion of the reservoir storage due to siltation, channel erosion and nutritional deficiency of the controlled river downstream of the reservoir, the incursion of salinity and changed patterns of shoaling at the river mouth, variations of water quality within the reservoir. With increasing knowledge such matters are increasingly being taken into the design repertoire of the engineer.

CONCLUSIONS

The foregoing examples indicate that water development projects of whatever nature have certain environmental implications. When planning such projects it is essential to identify these implications and then to examine them in greater or lesser degree according to their relative importance.

For this identification of secondary effects, the engineer can exercise his experience, judgement and indeed his imagination in searching out the potential consequences in the areas within his technical competence. It is necessary that he should be aware of the limitations of his knowledge and he should be prepared to consult "general practitioners" and specialists in other relevant subjects. Indeed, it is becoming standard practice to involve a multi-disciplinary team from the earliest stages in the conception and development of a project. A great deal of particularly relevant expertise and knowledge is usually to be found locally in the country where the work is to be carried out. In many instances, extensive research will have been made on the effects of existing projects of a similar or allied nature.

Some useful comments on the methods of consultation are given in the OECD document (1). This document also refers to the use of a matrix designed to show possible interactions between development activities and a comprehensive list of environmental characteristics. Although it is possible to indicate on the matrix the relative importance of any interaction, perhaps the most practical application of such a device is as a systematic check list in order to ascertain the potential areas needing further examination.

Assessment and evaluation of secondary effects follow after identification. The assessment may involve detailed studies with the objective of determining the full nature and extent of the changes brought about by the development. Where unacceptable situations arise, it may be necessary to devise countermeasures to remedy or mitigate them. Quantification frequently involves mathematical simulation and whenever possible a monetary value should be ascribed. It is equally important to take credit for incidental benefits as to allow for adverse effects, for many projects may not

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show a positive economic return until the indirect advantages are taken into the account. If all factors are quantifiable and capable of being costed, a normal economic analysis can be applied to provide a further item of information for consideration when arriving at a decision.

It is possible, however, that some factors will defy quantification and it becomes necessary to exercise judgement. An engineer must consider carefully whether he is competent to exercise unbiased and objective judgement in relation to a scheme to which he may have developed a serious personal commitment. In any case it is essential that he should have available to him and to others involved in the decision-making process the fullest possible range of data and relevant information on both the direct and secondary effects of the enterprise.

Acknowledgement is made to those colleagues of the Authors who have provided information relating to the projects described in this Paper.

REFERENCE

1. Organisation for Economic Co-operation and Development, Environment Directorate, Paris 1973, "Water Management and the Environment", 34 et seq.

DISCUSSION

Authors' Introduction

MR. J.L. BEAVER, in introducing the paper, said that they had briefly discussed environmental factors associated with several different types of water projects world-wide. In the field of impounding reservoir developments both for hydro-electric generation and irrigation supplies, they had illustrated how varied were the environmental effects resulting from these impoundments, depending principally upon their geographical location, climatic conditions, and terrain.

The Muda Irrigation Project in West Malaysia was a project financed by the World Bank in the mid-1960s and was implemented at that time with little consideration to environmental impact. It was a project required solely to satisfy need for the enhancement of the country's rice harvest to meet increased demands from an expanding population.

He was fortunate to have been involved with the construction of the works and also to have visited the project area some 3 years after the commissioning of the scheme. His comments in the present paper on the environmental effects were drawn from his personal observations and discussions with the operating staff. He considered himself privileged to have had an opportunity to view the successful operation of a large and complex project on which he had had intimate knowledge of the engineering works.

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In contrast to the Muda Project they had included in the paper some comments on major reservoir developments in Africa which, in contrast, had had considerable environmental effects. It was easy, in retrospect, to criticize the promoters of schemes such as Kariba, Volta, Kainji and Nasser, on the insufficient measures taken to resettle the displaced inhabitants of the flooded areas, but at the time of implementation, the development authorities viewed these projects in the context of long-term national development plans. The inadequacy of resettlement schemes could not be condoned and was solely the result of short-sighted planning, but the increase of Bilherzia in the lake-side population and the dramatic weed growth particularly on Lake Kariba could possibly have been predicted in pre-construction studies. Whether or not information on possible adverse environmental effects would have changed the decision on the size of reservoir to be constructed, or indeed, resulted in the abandonment of the project altogether, was doubtful, since the schemes mentioned above were of considerable national importance.

He thought it was possible that, although we in the developed countries of the world were broadly in favour of some form of EIA (whether by legislation or by intent), it appeared in many cases to be a non-starter in developing countries with fastgrowing populations, lower per capita income and rich in actual resources. The entrepreneurs and "get-rich-quick" merchants were in the short-term more attracted to the regimes of these countries, with their promises of the good-life and employment for the masses. In this atmosphere there was little hope for instant EIA success. We were now learning from the mistakes of the past, and in some cases paying heavily for them. As practising water engineers and managers in this country, we believed that we were naturally sensitive to matters of environmental importance, and EIA was no spectre for us. Perhaps we, as part of the family of mankind, should consider seriously how to impart our knowledge to those who were emerging into a fastgrowing technological world.

Verbal Discussion

DR. D.F. BARTON WORTHINGTON (Sir William Halcrow and Partners), in opening the discussion, felt that the authors had introduced a new dimension of time and space. Time was compressed because the development process which took centuries in Europe had, overseas, to be crowded into decades. Space had expanded because in many developing countries there was still plenty of room. Much depended on the transfer of technology: the first was the technology of administration, law and order; then came health services and agriculture leading to population explosions in more favoured areas. Engineering in the form of water technology - reservoirs irrigation, water supply, and sewerage, was late, except in a few towns. The human problems also sometimes took on new orders of magnitude: the drowning of settlements at Craig Goch would include but four farms; that of a bigish reservoir in the tropics may run to hundreds of villages!

The authors had stated that "conservation for its own sake is a far less pressing consideration than in a developed country". He himself did not quite agree and recalled a statement by President Nyerere of Tanzania to an international gathering a few years ago, "We Africans want to conserve our scenery and wild life, not only for ourselves, but for the enjoyment of our children's grandchildren".

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The examples in the paper were admirably varied. The 19 small impoundments in Antigua for domestic water and cattle were significant, for the time for vast reservoirs flooding hundreds, even thousands of square kilometres was drawing to a close. The opportunities for small reservoirs holding back precious flood waters for local dry season use were, however, practically unlimited. Moreover, the smallish water body could often clean up a polluted stream, and it could provide fish and amenities as well. Admittedly, the medical profession did not always approve of them, but that was another story.

The example of range lands in Somalia introduced the huge problem of desertification which was sometimes accelerated by too close a network of water points for cattle. All must agree with the authors' plea for an integrated approach to the development of whole river catchments, but unfortunately too often the water course was the boundary between countries, counties, estates, and individual farms. Co-operation between land holders was more difficult to achieve than sound technological design.

It was pleasing to see emphasis laid on the beneficial environmental effects of development projects. There had too often been a tendency to exaggerate the bad effects and minimize the good ones; an example being the High Dam at Aswan. However, an important statement in the paper was that "the absence of an informed and critical public throws even greater responsibility on those required to make technical decisions today". The need for an assessment of the environmental effects of all schemes to be financed by the World Bank was emphasized by Mr. McNamara some 10 years ago, and it was good that most other funding agencies had now followed his example.

MR. J.M. HASELDINE (John Taylor and Sons) said that he had found the paper very interesting since it described a wide variety of different types of scheme in various parts of the world. The emphasis of the paper was on describing the effects on the environment of the construction of reservoirs and the use of water for irrigation purposes. The biggest danger of producing adverse environmental difficulties would seem to arise from irrigation schemes in rural arid countries, and serious mistakes had been made in the past in that various water-borne diseases (such as Bilharzia) had been introduced into areas where they did not exist previously.

There was one important aspect of environmental change brought about by the introduction of a new water resource which had not been referred to, and that was the effect on urban communities of introducing a plentiful piped water supply. As soon as a community had a good supply of water difficulties arose immediately with the disposal of waste water. This had certainly been the case in this country, and all the big towns and cities in England and Wales met this problem and started to deal with it during the 19th century. However, there were many large cities in the world where the needs for a good water supply had been met but no steps had been taken to provide a proper waste water service.

As far as his firm was concerned, their first experience of this problem was in Baghdad. The water supply of Baghdad was improved very greatly during the 1930s and the result was that the existing septic tanks and soakaways gradually became overloaded and the natural ground-

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water level in the city started to rise so that many of the older houses with basements found that flooding was occurring and that conditions were becoming intolerable.

More recently, the firm had completed an investigation into similar problems in Tehran where again the groundwater level in the city had risen to dangerous levels and was highly polluted. For a city the size of Tehran the provision of a complete sewerage system and proper sewage treatment facilities would be a very costly operation and it had been estimated that about \$400 million would have to be spent.

He was interested in the description of the scheme in Sharjah and conditions there seemed to be very similar to the conditions in Abu Dhabi where his firm were working. In Abu Dhabi, a sewage treatment works had been in operation for a number of years and the effluent was used for irrigation of municipally owned sites in the town such as central reservations on dual carriageways, roundabouts, and parks. The system worked well and the vegetation was of an almost tropical nature providing a welcome relief from the drab and dusty desert landscape.

MR. J.H. FLEMING (Sir Murdoch Macdonald and Partners) said that although the title of the paper referred to "overseas situations", this had been interpreted by the authors as referring only to lesser-developed countries. Of the examples given, three referred to agriculture or livestock projects. These differed from most others in that the whole purpose of the project was to alter the environment, sometimes profoundly.

The Muda project involved intensification of cropping in an existing rice growing area, and it was rightly stated that substantial changes in the way of life and extra agricultural inputs were needed if the capital cost was to be justified.

Blackbushe was fundamentally a drainage scheme, which might be compared with 17th century operations in the Fenlands.

The Somalia Northern Rangelands project was to improve output in a pastoral economy; the need for grazing discipline was emphasized, once again a change in the established way of life.

However, many agricultural projects involved much greater environmental and social change. For example, the irrigation schemes based on the southern rivers of Somalia where nomads were being resettled. If the environment was related to the people (and how else should it be related?), then the environment of these nomads was being altered completely; but the history of recent droughts seemed to show that the choice was between this and starvation.

In the Sudan, between the 1920s and the present day, a million hectares of land had been brought under perennial irrigation from the Blue Nile; so that where formerly rain-fed sorghum was grown after cultivation by hand hoe, now cotton and groundnuts were produced on an industrial scale with a high degree of mechanization.

If such projects were to be economically and financially successful, then it was essential that the environment be transformed; but such transformation although financially beneficial to those within the scheme,

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could be disastrous to those just outside, whose traditional economy might be destroyed by the new developments. Against such environmental impact our own little difficulties in this country could be seen in perspective.

He concluded by referring to an instance from a highly developed overseas country - Switzerland. When he was working there in 1950 a hydro-electric station was being promoted at Rheinau, which would have had the effect of diverting the normal flow of the Rhine across the neck of a scenically beautiful river meander. The project had gone through all statutory stages and had been considerably modified to meet all objections. Then a popular "initiative" led to a cantonal referendum and the project was vetoed! Two lessons could be learned (1) in spite of Mr. Oldfield's remarks in the discussion on Paper 5, national efficiency and prosperity did not require any curbs on democratic protest; and (2) perhaps this was a way to put earls and commoners on the same level when public opinion was assessed.

Authors' Reply to the Discussion

The authors, in reply to the discussion, wrote that in its simple meaning of "that which surrounds", the environment required a core or focus and by implication that core was man. The environment had a connotation of comprehensiveness; it comprised all those elements that were open to the awareness of man's senses.

These two factors had been recognized by other authors contributing to the Symposium. Mr. Reed had defined environmental impact as being "about the total effect of man's activities on human life as perceived by individuals". Mr. Thirlwall, in his wider interpretation of the environment, wrote of "the whole picture of the surroundings and conditions in which people live and work".

Mr. Reed did not deal with the environment in abstract but related it to human welfare and human perception. He took as accepted the central importance of man, stating that in developed countries the emphasis in environmental considerations had moved from those aspects which were essential to the normal requirements of everyday living to the "quality of life".

As Mr. Fleming had observed, the present paper related largely to the developing countries and these might be broadly divided into two categories. On the one hand, there were those with recent realization of wealth arising from the exploitation of mineral resources. There the demand was for satisfaction, not only of essential needs but also for a quality of life equal to any in the world.

On the other hand, in poor countries it was an inescapable fact that quality of life had little meaning for the majority of the population and their whole endeavours were concerned rather with raising their condition of life to a tolerable level and, at times, with sheer survival. Their primary concern was to secure food and water supplies reliably from season to season, irrespective of variations in climate, followed closely by improvements to health. Their essential need was freedom from tyrannies of hunger and sickness. Their problems were frequently compounded by an almost entirely hostile environment. The observation in the paper that

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conservation for its own sake might be a less pressing consideration was made in relation to such a background.

Mr. Fleming had given further examples of developments that were specifically designed to change or temper a hostile environment so as to provide security to a large sector of the population, but warned of possible adverse secondary effects to others. Clearly, there was a responsibility upon the promoters and designers of such projects to examine so far as possible all the potential effects whether beneficial or adverse. But then the problem arose as to how to assess and evaluate those effects. It was normal practice to endeavour to ascribe a monetary value to them and require that overall the project showed an adequate rate of return. To be fair, this was frequently compared with some alternative, but in cases known to the authors the alternatives were quite unrealistic. Quantification simplified judgement, but what value did one place upon human life, relief from hunger, and sickness? As in so many social problems today we needed to define and agree appropriate humanitarian standards.

Mr. Haseldine had mentioned the need to give attention to sanitation and waste disposal following the development and improvement to water supplies that had occurred in most developing countries over recent years. This need had been recognized, and undoubtedly waste disposal would receive greater emphasis and encouragement from Funding Agencies in the future. Realistically it would be necessary in many instances for such developments to be at an "appropriate level" which for economic reasons would fall short of complete sewerage, treatment, and reclamation. It would be essential to adopt some intermediate system, but Mr. Haseldine pointed out potential dangers in the longer term. Good practice required that intermediate measures should be capable of development and upgrading. Designers should keep in mind the requirements of 20 years hence for, with the expansion of communication and knowledge, it would not be long before the intermediate measures were seen as entirely inadequate.

In summary, it appeared that in developing countries as well as here in Britain, we must be aware of all the potential effects of any new development upon the environment. It sometimes appeared that the exponents of concern believed that such an awareness was something that had emerged only in recent years, perhaps with the popularization of the study of ecology. In fact, the discipline of water engineering had always been concerned with the improvement of man's environment, and whilst in the past developments might have occurred on the basis of expediency, the whole background and training of a water engineer tended to make him aware and concerned for the environmental consequences of his activities. He was accustomed to working closely with members of other professions, with scientists and specialists of all kinds. The title of the I.W.E.S. was testimony to the fact. Visitors to this Institution should not therefore be surprised that it came easily to our members to accept the concept of E.I.A. and the collaboration with specialists in the variety of subjects that this might involve. To most water engineers this widening of their more immediate experience into other subjects was stimulating in the extreme.

7. EFFECTS OF NATIONAL ENVIRONMENTAL POLICY ACT ON WATER RESOURCES PROJECTS IN THE USA

C. Grant Ash, BSc, MSc, PhD*

INTRODUCTION

The Chief of Engineers manages and executes the Civil Works Program of the U.S. Army Corps of Engineers under the direction and supervision of the Secretary of the Army. The Corps of Engineers has responsibility for: investigating, developing, and maintaining the Nation's water and related land resources; constructing and operating projects for navigation, flood control, major drainage, shore and beach restoration and protection, hurricane flood protection, hydroelectric power production, water supply, water quality control, fish and wildlife conservation and enhancement, and outdoor recreation; supporting emergency relief activities directed by other federal agencies; administering laws for the protection and preservation of navigable water and for emergency flood control and shore protection; and conducting research and development related to Civil Works planning, design, construction, operation and maintenance, and regulatory activities.

The experience of those in the Corps of Engineers with the implementation of the National Environmental Policy Act of 1969 (15) are typical and representative of the findings of those in other federal agencies with responsibility for water resources projects in the United States.

BACKGROUND INFORMATION

During the approximately last 200 years, the Corps has completed more than 4,000 civil works projects. The Corps has participated in the construction of 25,000 miles of inland and intracoastal waterways now in commercial use, 107 commercial port facilities, 400 small boat harbors, and 261 locks. Domestic commerce on these waterways moves 16 per cent of the Nation's tonnage and ton miles of intercity cargo, almost 60 per cent of which is energy producing commodities. The Corps of Engineers has completed over 1,000 flood control projects, a figure which includes both large dams and small local protection projects. In Fiscal Year 1976, for example, these projects prevented an estimated \$15.9 billion in flood damages. Sixty-three of the Corps dams include facilities for the generation of pollution-free hydroelectric power. Corps facilities produce 82.2 billion kilowatt hours of electrical energy annually. Recreation attendance at the Corps 350 reservoirs has exceeded 350 million visits per year. The 11 million acres of land and water at these lakes are managed for recreation, fish and wildlife, and related purposes.

ENVIRONMENTAL MISSION

The environmental mission (15.21) of the Corps of Engineers is to carry out the mandate of the National Environmental Policy Act 1969 (hereafter referred to as NEPA) to ".... encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation;" and as further defined in Section 101 (a)

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"..... to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

Implicit in this mission are four general environmental objectives:

- a. To preserve unique and important ecological, aesthetic, and cultural values of our national heritage.
- b. To conserve and use wisely the natural resources of our nation for the benefit of present and future generations.
- c. To restore, maintain, and enhance the natural and manmade environment in terms of its productivity, variety, spaciousness, beauty, and other measures of quality.
- d. To create new opportunities for the American people to use and enjoy their environment.

ENVIRONMENTAL DECISIONS

In the early days of our country, Americans saw the natural environment both as the means to enhance their national well-being and as an obstacle to be overcome. Rivers and natural harbors presented opportunities for commerce and provided routes of communication. They also had to be defended. Army Engineers provided defences needed to help protect American harbors and waterways from potential foreign enemies from the beginning.

A gradual shift in national awareness eventually led to appreciation of our natural environment as a less than infinite resource. Thus, today in the Corps of Engineers they discuss environment in terms formerly reserved for national "economic development" and "growth" syndromes. Economic competitiveness is still vital and will always be a factor, but "growth-at-all-costs" is no longer taken seriously. Environmental protection is now an equally important consideration in any agency decision and ranks high in national value.

A nation's first obligation is to insure its survival. At the survival states of man's existence, concern for preservation of the natural environment is largely irrelevant. At the point where economic well-being is marginally achieved, environmental considerations have limited meaning and environmental effects are likely to be brushed aside. Not until a nation achieves a healthy economic situation and a self-realized portion of the "good life" will its citizens also manifest serious concern for the quality of their environment. But what is the proper balance between environmental and economic values?

NEPA was a dramatic statement on this problem. The feature of NEPA with which the public is most familiar is the requirement for the preparation of an assessment of the environmental effects of future projects. This is displayed in the form of an Environmental Impact Statement (EIS) under the requirements of that Act's Section 102 (2) (C). The EIS requires the decision maker to consider and evaluate all environmental aspects of a proposed action. He must also make all the factors considered a matter of public record and conduct "give and take" sessions in the court of public opinion. After

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competitive views are discussed and needed decisions modified as appropriate, the entire record is placed in the hands of the Council on Environmental Quality (CEQ) and before the Congress.

Perhaps the most important lesson learned in the Corps, as they have implemented NEPA is that the environmental considerations of a project must be an integral part of the planning and decision making process in exactly the same way that social, economic and engineering considerations are a part of that same process.

Decision making is a continuing and repetitive procedure dealing with matters of small consequence, as well as those of major significance. Decisions are made almost daily during the planning phase of a project, and become fewer in numbers as they go into the design, construction and operation and maintenance phases of a project.

The requirement to prepare an EIS has had the salutary effect of continually reminding the decision maker that environmental factors must be given adequate attention in all phases of planning. By its own terms, however, the main focus of the EIS is on a detailed examination of the environmental factor of alternative actions, without commensurate attention to social, economic and engineering factors that may be of lesser, equal or greater importance depending on specific circumstances. For these reasons, the Corps position has been that the EIS can serve as only one of the documents upon which a decision on a major federal action should be based.

Critics of the Corps (5, 6) frequently charge that their decisions are arbitrary and capricious and that citizens are pushed aside as the Corps pushes and promotes construction. Those who make these claims are frequently poorly informed as to the elaborate and complicated procedures which the Corps must follow in order for a project to be authorized by Congress for construction. In addition, little publicity is given to the number of proposed projects which are found not in the public interest or to the number of projects recommended for deauthorization.

When the people on a river, lake, or ocean have problems connected with the water, they can petition Congress for a study of remedial measures. The people may be concerned about navigation, flood control, hydroelectric power, water supply, water quality control, recreation, fish and wildlife protection or shore protection.

If Congress authorizes and appropriates funds for a study, the District Engineer will investigate the situation thoroughly and try to make a good plan to meet the people's need. He will examine all the practical alternatives and select the plan which provides the most benefit for the least cost and with the least harm to the environment. The Corps gives special attention to minimizing ecological disruption during construction and to enhancing fish and wildlife and recreation resources of the completed project.

The District Engineer will recommend a federal project only when the benefits exceed the cost, the environmental impact is acceptable, and he finds the overall project in the public interest. In the course of his planning he will hold public meetings and consult local, state, and federal officials. He transmits his analysis and recommendations to Washington in a project report and environmental impact statement. In over half of such reports District Engineers recommend against any federal project.

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In Washington, the Board of Engineers for Rivers and Harbors, the Chief of Engineers, the Secretary of the Army, and the Office of Management and Budget all review the report and the environmental impact statement to decide whether or not to recommend a project. Based upon their recommendations, the Congress makes the final decision on project authorization and funds for design and construction are included in the annual public works appropriations act.

Throughout the planning and coordination process the Corps pays a great deal of attention to the views of the people whom the project will effect, the economic justification for the project, and its effect on the environment. Every plan necessarily involves some compromises. The Corps planning staffs include experts in project design, economics, and environmental preservation and enhancement. Since passage of NEPA, the Corps has intensified its efforts to make plans that balance the need for water resources development and the need for environmental protection in the overall public interest.

In spite of these rigorous check and balance procedures, situations change and new priorities are established which sometimes indicate that a reevaluation of a project is appropriate. In accordance with Section 12 of the Water Resources Development Act of 1974 (24), the Corps of Engineers has reevaluated a large number of authorized projects under their jurisdiction, and has recommended to Congress the deauthorization of 395 projects. These projects are those having been authorized for at least 8 years but not funded during the past 8 years and come within any of the following five categories:

- a. lack of economic justification.
- b. not adequate to meet current or prospective needs and obtaining adequate improvements would require additional funding authorization from Congress.
- c. significant and unacceptable adverse environmental impact.
- d. general opposition or lack of cooperation from local interests.
- e. part or all of the project has been accomplished by other means or is no longer required.

The following types of projects were recommended for deauthorization: 145 channellization, 160 levee, dike or floodwall, 41 navigation structures, 37 dam and reservoirs and 12 with other types of construction. Of the 395 projects recommended for deauthorization by the Corps, Congress has now deauthorized approximately 275 projects.

ENVIRONMENTAL IMPACT STATEMENTS

The effect of NEPA on federal agencies has been dramatic. Extensive modifications in point of view and procedure are evident. In the Corps of Engineers alone, over 2900 Environmental Impact Statements (EIS), draft and final, have been prepared and filed with CEQ and Environmental Protection Agency (EPA).

The Corps of Engineers evaluated the effects of this Act on its current projects and found they had performed reasonably well when it comes to identifying adverse effects and eliminating the effects, or otherwise solving the problem. In an assessment of over 500 projects in the construction and design states, one-third were modified to accommodate environmental considerations. Similarly, of 200 studies investigated, about one-third of the final

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alternatives proposed had been significantly changed during the course of the study to minimize the impact on the environment. In 43 per cent of the 103 completed projects investigated in the operation and maintenance category the operators had adopted new procedures to help protect the environment.

Based on these data, about one out of every three active projects in Civil Works has been modified because of NEPA. The implementation has included a host of actions ranging from complete elimination of a project to minor project modifications; dams have been resited, elevation of pools adjusted, spoil areas relocated, fish and wildlife losses mitigated, fish passage structures added, highways relocated, levees set back to avoid channellization of natural streams, greenbelt floodways established, etc., just to name a few of the kinds of modifications involved.

The requirement to produce these statements is good! The Corps has re-oriented its thinking and now consider more alternatives and non-traditional alternatives to solution to the Corps mission problems. They work more closely with the public, civic minded groups, elected officials, etc. Their concepts and procedures have been modified and changed. The environmental considerations are now an integral part of planning and decision making.

President Carter (3) in his environmental message to the Congress, May 23, 1977, emphasized the importance of NEPA to the development of sound federal decisions and to public involvement in government. He stated: "This Act is best known for requiring federal agencies to prepare environmental impact statements before taking actions having significant environmental effects. In the seven years since its passage, it has had a dramatic, and beneficial, influence on the way new projects are planned. But to be more useful to decision-makers and the public, environmental impact statements must be concise, readable, and based upon competent professional analysis. They must reflect a concern with quality, not quantity. We do not want impact statements that are measured by the inch or weighed by the pound."

Under the direction of Charles Warren current Chairman of CEQ public hearings were held in Washington, D.C. June 6-8, 1977 as a first step in implementing President Carter's environmental message to Congress. The following problem areas were considered:

1. Real issues instead of paper production. How to concentrate less on paperwork and more on substance in implementing NEPA. Include discussions of how to focus on real alternatives and on mitigation measures that offer decision makers real choices and less on bulky accumulations of background data. Make impact statements more useful.
2. Ways to streamlining the process. How can project planning and impact statement processes be integrated to save time? How can statements by covering whole programs reduce the scope of needed coverage in subsequent site specific statements?
3. Ways to eliminating conflicts and duplication. What can be done to reduce conflict between agencies as to which is to take the lead? How can duplication be eliminated when there are both federal and state impact statement requirements?

Other problem areas considered included impartial preparation, application to legislative proposals, insuring that mitigation is carried out, the consideration of economic and social factors, and environmental impacts out-

side the United States caused by federal agency action.

These actions are typical of the constantly changing, dynamic process NEPA initiated. There are certainly more changes and refinements to come. Of significance was the recent publication (4) by CEQ, June 1978, in the Federal Register of new proposed regulations for implementing the procedural aspects of NEPA and their replacement by CEQ guidelines (1). These regulations are written to accomplish three principal aims: to reduce paper work, to reduce delays, and to produce better decisions.

PUBLIC PARTICIPATION

Concern for the environment is not new to the Corps, then what has changed? Many things, of course. Basically, it is a matter that not only does the nature of a problem change over time, but the perception, understanding and concerns of the people change as well. This is very important to an organization such as the Corps of Engineers. The Corps, as a public agency, must be responsive to the public interest. While determination of the public interest is never simple, every public agency must meet this issue or lose the confidence and support of the people. The "loss of credibility" is the term sometimes used.

The Corps is sensitive to public reactions (13, 16). Few agencies of Government work with people so directly as the Corps of Engineers, through elected representatives or private citizens and at many levels of concern and involvement. Obtaining the views of people is generally difficult. Reaching consensus is an even more difficult task. Being responsive to the overall public interest within the constraints and authorities imposed on a public agency becomes more difficult with each passing year. This difficulty is largely a function of the increasing complexity and multi-faceted society in which we live. It is also a function of priorities. In the early years of my country's development the natural environment was viewed as an obstacle to our national well-being. The natural unaltered environment stood between a young nation and its desire to achieve economic and political viability. The Corps mission, as prescribed by the public interest at that time, was to develop the rivers for navigation and construct harbors to improve our commerce and routes of communication.

The views of the public sometimes seem to swing like a pendulum from one extreme to another. For example, today, the environment is referred to in "morality" terms reserved years ago for "commerce" and "growth" when "nature" was the enemy. Public interest can sometimes change rather rapidly. It depends to a certain extent where the individual sits at the time and the pressures imposed by his immediate surroundings. This is best illustrated by realizing that besides protecting the environment, the Corps of Engineers is foremost in protecting people. Every time the Corps looks away, Mother Nature reminds them not to turn their backs on flood protection or other natural disaster problems.

The Corps has traditionally provided a public forum for the voicing of opinions on proposed projects. The forum is most often a public hearing. To a great extent this practice satisfies the procedural requirement for citizen participation in the preparation of environmental impact statements under NEPA. The CEQ guidelines (1) and new regulations (4) go beyond the traditional Corps practice, however, in requiring early notification that an EIS is being prepared, that a draft of the statement be made available prior to public hearing, and that all citizen comments be made a part of the final statement. Nevertheless, one would expect that the Corps would follow a consolidating

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strategy concerning NEPA requirements for citizen participation. That would be to essentially continue with its standing practice of holding hearings to elicit the views of the public, but little more. Given the vagueness of NEPA on this point, this would be a reasonable strategy. This has not occurred. In fact, some of the strongest criticism of the Corps traditional policy of public participation, as well as innovative counter-proposals, have come from within the Corps itself. The Corps traditional citizen participation policy is depicted, in-house, as legally acceptable but sometimes grossly inadequate.

Encouragement of greater public involvement in district level planning has met with mixed results. A number of districts have taken advantage of Technical Assistance Programs, and some have undergone fundamental re-orientation in their planning process. Some districts have adopted a far reaching program of hearings, workshops, and information dissemination regarding their studies and projects, but room still remains for improvement.

Tension between the Corps top echelon, which is pushing for greater citizen participation, and many of the divisions and district engineers, who are sometimes more comfortable with the status quo, is evident. For the leadership greater citizen involvement at the early planning states is a rational method for reconciling competing local interests, thereby preventing later controversies, confrontations, executive and congressional reprimand, and possible court suits. Yet some division and district engineers sometimes appear to be less eager to follow this changed orientation completely. From their point of view they are being asked to expose project plans, for which they are personally responsible, to the stringent and often hostile scrutiny of many potential opponents within a community. Asking this of any group of planners requires a sharp departure from past practices.

While the Corps headquarters is pushing for change its complete adoption throughout the agency has not occurred. That it will occur is just a matter of time.

ENVIRONMENTAL LITIGATION

As of July, 1977 the Corps of Engineers had been in 75 major lawsuits filed against 49 Corps projects and 27 permit actions. All of this litigation involved environmental issues and had occurred since passage of NEPA. There were 2622 water resources projects where an EIS had been filed with CEQ in at least the draft form. There were 134 additional EIS and hundreds of environmental assessments prepared for permit actions. Of the 49 lawsuits involving Corps projects 26 were pending, the Corps had been enjoined on 12 and 11 had been dismissed in favor of the Corps of Engineers. Of the 27 lawsuits involving the regulatory authorities (19, 22, 23) of the Corps 15 cases were pending, the courts had ruled in favor of the Corps position in 10 cases and ruled against the Corps stand in only one case and part of another.

These figures would indicate that only 2.7% of projects where an EIS was filed were challenged in court. This percentage rate is about one half of that experienced over the nation as a whole (2).

In examining the cases in litigation involving water resources projects, it was not surprising to find that in all of the cases the plaintiffs alleged violation of NEPA (15) or CEQ Guidelines (1) and most often by declaring the EIS to be inadequate. In 25 to 50% of the cases the following specific violations were alleged: (a) failure to consider appropriate alternatives, (b) violations of status other than NEPA - Fish and Wildlife

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Coordination Act (9), Federal Water Pollution Control Act (FWPCA), (8), Marine Protection Research and Sanctuaries Act (12), Preservation of Historic and Archeological Data (17), etc., (c) federal actions were arbitrary and capricious, (d) illegal actions associated with the acquiring of lands, and (e) pollution of waters or degrading water quality.

The following additional complaints were found in 15-25% of the cases: (a) lack of adequate coordination with other federal agencies or inadequate review of EIS (20), (b) specified loss of one or more specific natural habitats, (d) inadequate determinations and acquisition of appropriate mitigation measures to compensate for environmental loss, (e) improperly calculated benefit/cost ratio or challenge of the interest rate used in the determination, and (f) alleged Corps did not follow Congressional mandates or obtain consent of Congress.

Examples of some of plaintiff allegations which were found only occasionally up to 15% are as follows: (a) inadequate assessment of secondary effects, (b) failure to qualify environmental factors, (c) loss of historical or archeological sites (17), (d) violation of Endangered Species Act (7), (e) failure to adequately describe hazards from earthquakes, (f) potential for undesirable underground water movement, (g) failure to adequately assess the effects of economic development and other sociological impacts, (h) failure to adequately consider future and expected future needs (traffic, commodities, equipment, etc.), (i) inadequate assessment of impacts from dredging and dumping of soil, (j) creation of a salt barrier, (k) failure to consider energy needs of the country, (l) public rights and public hearings violated, (m) loss of aesthetic beauty, and (n) encroachment of farming or water projects on wetlands.

The above lists serve only to illustrate the complexity and wide variation in issues associated with court cases involving water resources projects. The final court decisions and actions show that the Corps was guilty of very few of these allegations. In some instances failure to comply with only one allegation resulted in a judgement that the project should not continue. When NEPA became law the Corps had over 300 projects in varying states of construction where an EIS had not yet been prepared. In many of the earlier court decisions the cases were dropped when the Corps completed the final EIS. Over half of the court cases against the Corps were initiated during the first three years after passage of NEPA. The rate at which cases are filed has diminished rapidly in recent years.

The regulatory function cases were equally complex but allegations tended to be less repetitive, more specific and each case an issue unto itself. The majority of cases in the permit area alleged violation of the Federal Water Pollution Control Act (8) specifically section 404, rather than NEPA per se. Section 404 deals with the dredging and placement of dredged materials into waters and contiguous wetlands of the United States.

In order to give an idea of the difference found in regulatory cases as opposed to Corps project cases and provide an appreciation of the types of complaints, what follows is a list of allegations which appeared in at least two or more of the cases examined: (a) questioned the Corps jurisdiction over navigable waters or waters of the United States, (b) EIS inadequate and there was a contrary determination as a result thereof, (c) failure to hold public meeting under section 404 FWPCA, (d) failure to conduct appropriate actions required by State laws, (e) water quality effected by dredging and deposit of materials into waters of the United States, (f) further violations under sections 401, 403 or 406 of FWPCA which deal with water quality and EPA

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responsibility, (g) not allowing construction of trailer parks or housing units in wetlands, (h) questioned the Corps jurisdiction in relationship to tidal mean high or higher water mark under section 10 of Rivers and Harbors Act of 1899 and section 404 of FWPCA, and (i) section 404 regulations invalid because they attempt to regulate land use and activities unrelated to water quality.

The Corps of Engineers in responding to court cases has made every effort to promptly comply with judicial orders and may have tended to over-react by preparing excessively detailed EIS. In controversial cases they may have also tended to resort to filing voluminous statements in anticipation of legal challenges to comprehensiveness and adequacy in the courts. Given the circumstances, without a clearer legislative or judicial definition of what constitutes an adequate EIS, there appears to be no realistic solution to the time-consuming and lengthy EIS process for many proposed actions, especially actions that are expected to be controversial. The Corps experience in litigation indicates, however, that the Corps EIS have met with substantial judicial approval, and it is not clear that less detailed EIS would have proved equally successful.

SUMMARY

In the United States today most of our citizens have developed at least a degree of concern for environmental quality. Public opinion polls regularly disclose that a majority of Americans want to breathe clean air, enjoy waters free of pollutants, have access to parks and open space, preserve wildlife, and so forth. Of course, most of us realize that these goals of environmental protection must coexist with the functioning of our economic system: with measures to produce energy, house and feed our growing population, and so on. But most of us want to balance economic development with environmental quality. These beliefs follow from our realization that, if we cannot have both a functioning economy and a liveable environment, there can be little real value in an ever-increasing Gross National Product; if the average American's "quality of life" must deteriorate as our economy and population grow, then "growth" can hardly be desirable.

Because some degree of this "environmental consciousness" is commonplace today, some of our citizens find it hard to understand why many of our institutions and government agencies have not always been closely identified with these currently accepted environmental policies. In fact, the more strident environmentalists (5, 6, 18) do not hide their distaste and contempt for large segments of American industry and for many governmental agencies which traditionally have emphasized economic development goals rather than environmental preservation.

Although I think I understand the more extreme environmentalists' point of view, I would remind them that institutions, economic systems, and agencies within democratic governments almost always reflect the predominant economic and social forces of their age; very rarely indeed can a government agency give complete deference to the values of a future generation in preference to those of the current generation. And the fact is that "environmentalism" has become a truly powerful force in the United States only in relatively recent times.

Today the environmental movement is becoming institutionalized at all levels of American government and in innumerable private organizations such as the Sierra Club, the National Wildlife Federation, the Natural Resources Defence Council the Environmental Defence Fund, the Audubon Society, Zero

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Populations Growth, etc. Nevertheless, the battle to save what's left of the American environment is far from won. Even today we have no truly effective government programs in the U.S. to preserve our remaining farmland let alone the wetlands from sprawling suburbs and recreational-home developments, to reduce the rate of U.S. or world population growth, to enforce widespread conservation of energy, to regulate strip-mining, etc. Reviewing the history of the American environment, one can only conclude that the American environmental movement has been "a long time coming" and has by no means achieved even a minority of its objectives to date.

Unquestionably, the Corps of Engineers carried out many vital missions from 1900 to 1970, but most of them were "developmental" rather than "environmental" in nature. From Corps efforts in World War II to Corps contributions to the U.S. space program; from continued work for flood control, water supply, and navigation to creation of hydroelectric energy, the Corps had an important role in building the U.S. Economy; but because the public interest priorities were focused primarily on development, the Corps was less frequently ordered to preserve the American environment during this time period than to develop and utilize its resources.

The growing "environmental movement" achieved a signal victory in 1969 with the passage of the National Environmental Policy Act - NEPA (15). That now-famous statute created the Council on Environmental Quality (CEQ) and required preparation of a thorough environmental impact statement for every major federal action which could have a significant impact on the human environment.

An objective evaluation of the Corps of Engineers' record during the 1960s and '70s demonstrates conclusively that the Corps not only accepted the environmental policies adopted by the Federal Government, but provided environmental leadership (10, 11, 13, 14, 16). Before and after the enactment of these federal environmental laws, the Corps worked to redirect national attention to programs that balance the objectives of development and conservation, rather than merely emphasizing development.

In this article an attempt has been made to explain some of the ways in which the Corps of Engineers has accepted and advanced relatively new national goals and policies of protecting the environment, while continuing to perform the Corps traditional missions of developing and using wisely our country's water resources.

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DISCUSSION

Author's Introduction

DR. C.G. ASH, in introducing his paper, showed a series of slides (not reproduced) illustrating the types of project the U.S. Army Corps of Engineers had undertaken over the past 200 years: inland and inter-coastal waterways, port facilities, small boat harbours, locks and dams, flood control structures, hydro-electric power, recreation facilities, and fish and wildlife refuges in connection with projects.

He emphasized the all-inclusiveness of the Engineering Corps's mandate: to preserve, conserve, restore, maintain, enhance, and create environmental amenities, and summarized some of the points involved in environmental decision-making as follows:

- (1) decision-making was a continuing process involving small and major matters;
- (2) environmental considerations must be an integral part of the planning process at all phases;
- (3) the environmental statement was only one of the documents to consider in the decision-making process; and
- (4) in spite of rigorous checks and balance procedures, as time passed and projects were not built, it was sometimes important to re-evaluate the need for such projects.

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A slide was shown of the numbers and types of projects that had been de-authorized as a result of re-evaluation.

He then highlighted some points with regard to environmental impact statements. There had been 2,900 draft and final EIS prepared and filed; one out of every three projects had been modified because of NEPA; and the Corps now considered more alternatives in planning projects than they had in the past.

There were 197 full-time and 378 part-time employees involved in preparing EIS in the Corps of Engineers during the fiscal year 1977. The estimated cost for producing EIS for that year was about \$26 million which was about 1.5 per cent of the annual budget for the year. This was the cost for labour and materials. The money was spent on the basis of 60 per cent internal to the Corps and 40 per cent by contractors. Since the passage of NEPA the Corps had averaged about 200 contracts per year with architectural engineering firms, universities, etc., for environmental data collection and analyses. He said that President Carter was concerned that the EIS should contain less paper and more substance; environmental issues needed to be better integrated into the planning and decision-making process; there was a need to reduce unnecessary conflict between agencies; the programme should include more mitigation considerations; economic and social factors should be considered along with environmental issues; and there was a need to extend the programme to cover U.S. activities outside the nation's boundaries.

In connection with the public participation section of the paper four points were made in summary:

- (1) the agency must be responsive to public needs;
- (2) it was sometimes hard to identify who represented the public;
- (3) the public was encouraged to participate in the planning process by an early notification of the EIS in preparation; and
- (4) early participation of the public was distressing to some of the Corps planners.

The alleged environmental violations which appeared most frequently were listed as:

- EIS inadequate
- failure to consider appropriate alternatives
- violation of statutes other than NEPA
- federal actions arbitrary and capricious
- loss of specific habitat
- inadequate mitigation measures
- improper B/C ratio and interest rate
- inadequate secondary effects given
- violations of endangered species act
- loss of aesthetic beauty
- invalid attempt to regulate land use
- violation of water quality standards.

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There were 13 legislative statutes and three executive orders which could apply to the preparation of impact statements. The Corps had prepared 31 engineering regulations which provided guidance for field organizations implementing these 13 statutes and orders. It was not unusual, therefore, for many court cases to involve alleged violations of statutes other than NEPA.

By far the most precise and difficult piece of legislation for developing agencies in the USA to deal with, was the Endangered Species Act passed in December 1973. This act required that no actions be taken that would jeopardize the continued existence of endangered and threatened species or adversely modify their habitat. On 10th November 1978, the President signed the Endangered Species Act Amendment 1978. This amendment was passed in an attempt to reach a compromise between conservation groups and developers. The amendment established a fact-finding board of three, whose job it was to assist a committee of seven that was authorized to grant exemptions when the federal interagency consultation process failed to arrive at a satisfactory solution to the loss of endangered species versus the advantages of other public interests. The amendment also provided a solution to two historic court cases: the Teleco Dam versus the Snail Darter, which was a Tennessee Valley Authority project on the Tennessee river, and the Gray Rocks Dam versus the Whooping Crane, which was a Corps permit case in Wyoming on a tributary to the North Platte river. The amendment required the committee to grant the exemption within 90 days unless another reasonable alternative could be justified. The question in the Gray Rocks case was the extent of damage which would result from changes in hydrological patterns at a wildlife refuge 275 miles downstream from the Gray Rocks dam. The refuge had been declared a critically important habitat for the whooping crane.

He then mentioned several other Corps projects where the Endangered Species Act was an important factor. The Corps had been constructing the New Melones dam in California for some years and the dam was now more than 80 per cent complete. An investigation of the fauna and flora of the caves in the project area revealed in some caves a new species of arachnid (spider), which looked like a miniature white "daddy long legs". Because these arachnids were uncommon, and perhaps because some people in California opposed the New Melones project, the U.S. Fish and Wildlife Service had received a petition to declare this creature an endangered species, and to declare specific caves in the project site as its critical habitat.

A more widely publicized endangered species problem existed at the site for the Dickey-Lincoln School Lakes Project in Maine, a proposed hydro-electric dam on the St. Johns river. During the summer of 1976 a Corps contractor had found the first Furbish lousewort (a rare snapdragon) observed in the wild since 1948. On 21st April 1978, the Department of Interior published a final ruling listing it as an endangered plant. A significant number of Furbish louseworts are found at the Dickey-Lincoln project site.

The Corps also faced complex endangered species problems at a number of projects on the Lower Mississippi river and its tributaries, where they were dredging and improving channels. The southern bald eagle nested in trees near the proposed channels, so the Corps had to try to

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plan the projects to avoid disturbing them. There were a number of mussels on the endangered species list which might be found in this area. Recently, the dredges were stopped because of the discovery of a fat Pocketbook Pearly Mussel in the St. Francis river, in Arkansas. There was also the likelihood of encountering rare fish such as the snail or leopard darters. The Corps had built and maintained the Libby dam on the Kootenai river in Montana. Below the dam the tailrace of fast water never froze in winter; surrounding the project was a protected land area; and there were fish in the tailrace. These three assets had attracted increasing numbers of wintering and migrant bald eagles to the Libby project area. The Corps had begun construction of a re-regulation dam downstream from Libby dam to double the 420 MW of electric power already generated. When the re-regulation dam was eventually closed, it would inundate some of the trees on which the eagles perched and from which they could easily take prey. Under threat of an injunction the work at Libby dam had been stopped. The Corps was quite willing to modify the Libby re-regulating dam project, but the environmentalist must be satisfied with less than absolute certainty if the Corps was to build and close the Libby re-regulating dams, as Congress had directed.

Finally, he made three points in summary: (1) the American environmental movement was a long time coming, but by no means had the objectives been achieved; (2) NEPA was the first single victory for the conservationist and the Endangered Species Act was a second victory; and (3) there must be a balance between development and conservation. At present, they were like the old circus trick-rider standing upright on two horses with a leg on each. But at the present time, one horse - "Environment" - was going one way, and the other - "Development" - was going in the opposite direction. The rider was in a precarious position. The controversy was certain to continue, and getting the two horses together would require a compromise between the development necessary to meet the aspirations of today and the preservation necessary to insure that they could meet the reasonable aspirations of the future.

Verbal and Written Discussion

MR. D.L. WALKER (National Water Council), in opening the discussion, said that three important differences between the government of the United States and the United Kingdom should be kept in mind when considering the relevance of US experience to the UK. Firstly, their separation of the power to make laws from the duty to execute laws meant that US legislation appeared to allow less flexibility to the executive. Secondly, the strength of the individual States seemed to mean that the Federal government had to rely on more explicit powers than the UK government. Thirdly, US citizens appeared to have a remarkable ability to challenge government decisions in the Courts.

President Carter's environmental message, referred to in the paper, had placed a new emphasis on the need for water conservation and his more recent water policy message of 6th June 1978 encouraged the rehabilitation of water supply systems, realistic pricing policies, and the provision of technical advice on conservation. According to the President, "using water more efficiently is often cheaper and less damaging to the environment than developing additional supplies". The intention was that a primarily non-structural plan would be required

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as an alternative to structural projects in future, and he invited the author's comments on the effectiveness of the Corps of Engineers in preparing and implementing "non-structural" projects directed towards water conservation.

The President's latest message also echoed a theme which had been repeated over the years since 1936, namely, the need for beneficiaries to pay a higher proportion of the costs of water resource projects and the Federal government to pay less. While the paper emphasized the attention paid to project appraisal, it was interesting to note that Congress made the final decision on project authorization. This could lead to pressure for a continuation of Federal spending on traditional projects in traditional regions, in contrast to the situation in this country, where water resource projects were not subsidized by central government. He asked whether the author agreed that Federal assistance could create a bias in favour of structural projects, at the possible expense of the natural environment.

Environmental protection could be very costly and, although it was sometimes argued that this created useful employment, it needed to be kept in mind that this extra expenditure would generate inflation unless people were prepared to sacrifice other goods and services to pay for improvements in the environment. It could further be argued that the most necessary protection of the environment was a reduction in the use of energy and other natural resources in the US. Recently the President's Council on Wage and Price Stability had criticized the Environmental Protection Agency for attempting to enforce higher standards of drinking water quality without thorough analysis of the potential benefits, and he asked the author whether this Council had turned their attention to other expenditure on the environment with the object of obtaining better value for money.

He concluded by endorsing the emphasis in the paper on the need to balance environmental and economic values. It was clear that the Corps of Engineers could make a first-class evaluation of individual projects but, to obtain harmony rather than conflict between engineering and the environment, it was also necessary to consider the wider questions outlined above.

DR. R.D. HEY (University of East Anglia) said that one of the major points in the paper was the need to consider the environmental implications in the planning and decision-making process in exactly the same way as social, economic, and engineering considerations. However, to justify this role, it was vital that the environmental implications of a proposed project could be assessed accurately. Were present techniques involving the use of matrices sufficiently rigorous to predict accurately the direction, degree, and rate of change resulting from a proposed development? Indeed, had any post-project evaluations been carried out to test their predictive capability?

It was also stated that the Corps were now considering more alternatives and non-traditional alternatives to solution of the Corps Mission problems. In view of Mr. Reed's fear that environmental legislation would curtail the introduction of innovative design methods, could the present author offer any explanation?

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BRIGADIER C.C. PARKMAN (Ward, Aschcroft, and Parkman) felt that the author had made two valuable points: firstly, if the definition of environment excluded economic, social, and cultural factors, then the impact analysis was incomplete, and secondly, if the process was made statutory it could often involve irrelevant paper production aimed at satisfying the requirements of the statute. A recent EIA study with which he himself had been concerned, had ranged widely but relevantly in a way which would have been impossible to build into a statutory process. It had resulted in a five-volume report which was summarized in the decision-maker's documents on 12 pages - nobody had been sued and nobody had complained that the work was incomplete. He did not pretend that everybody was happy, but at least they felt that they had had a fair consideration.

Author's Reply to Discussion

DR. C.G. ASH, in answer to Mr. Walker, said that the Corps of Engineers' policy was that planners and decision-makers considered all practicable means and measures, including "no development" and "non-structural" plans. This policy had been in existence for a relatively short time, but the results had been very encouraging. Two "non-structural" plans approved by Congress were the Charles river project, in eastern Massachusetts, and the Prairie duChien project in northwest Wisconsin.

The Corps were to acquire 8,422 acres of natural valley storage areas located in 16 communities of the middle and upper watershed of the Charles river. This land would be maintained in its natural state, in perpetuity. No man-made structures were required. The natural valley storage contained in the many swamps and wetlands of the Charles river basin modified the high and low flows in the same manner as a system of reservoirs. Local interests would prevent modification or alteration of existing roadways, utilities, bridges, culverts, and any other improvements that might affect the drainage characteristics of the natural storage areas and adopt and enforce regulations to restrict development of flood plain lands.

A portion of the city of Prairie duChien, Wisconsin, was located on St. Friol Island in the Mississippi river. Since 1880 this island had been flooded 16 times, for example, in 1965 the island was covered with 8 ft of water and over 1000 people were evacuated from 250 homes, and about 25 businesses were damaged. The new plan called for the relocation of everyone, their homes and businesses from the island to another section of the city above the flood plain. The island would be maintained as a recreation park.

He agreed with Mr. Walker that Federal assistance could sometimes create a bias in favour of structural projects, and on occasions had affected needlessly the natural environment. This was one of the corrections intended by the passage of the National Environmental Policy Act. A further refinement to this corrective process was the proposal by the President to change the cost-sharing policy for water resources projects to allow States to participate more actively in project implementation decisions and to equalize cost-sharing between structural and non-structural flood control projects. These changes included a cash contribution from benefiting States of 5 per cent of construction costs associated with non-vendible outputs and 10 per cent

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of costs associated with vendible outputs. The President had also proposed that the present cost-sharing requirements for flood control projects be modified to require a cash or in-kind contribution equal to 20 per cent of the project first costs associated with flood control benefits. Application of this policy would require that non-federal interest make, in addition to State contribution, a cash or in-kind contribution. The combined non-federal share would be 25 per cent of project first costs.

Concerning the inflation issue raised by Mr. Walker, the impacts on environmental protection were difficult and complicated. They could only scratch at the surface of the inflation problem through pragmatic decisions such as to reduce the use of energy or other natural resources. The increased concern in the US about inflation, unemployment, and balance of payments had resulted in increased attention being given to the economic implications of government regulatory programmes. Part of this effort was focused on reviewing longstanding economic regulatory programmes such as those for monopolies, transportation, and communications. Part was focused on reviewing the implementation of the newer regulatory programmes which were primarily directed toward such social issues as environmental and worker protection. The regulatory reforms were intended to make the regulation development process more efficient, comprehensive, and open to the public. The need to balance environmental and economic values was only a small increment in this entire equation.

He made the following comments in response to Dr. Hey's interest in matrices type analyses in the Corps planning process. A number of matrix approaches had been developed and at least partially tested by post-project evaluation. Any of these methods could be an effective tool if properly used in the planning process. But each suffered from certain disadvantages such as: too complex for routine use; difficulty in adopting parameters and weighting factors to local conditions and non-economic resources; subjective inputs could control results; high cost in acquiring data and reducing it to proper form for calculation; low understandability; and inability to project the public and community policies and preferences.

Matrix analyses were used fairly extensively throughout the Corps, particularly for large complex projects. But their use was limited mostly to the early stages of planning. In a few instances the matrix analyses had been carried through to a point of assigning comparative numerical values to different alternatives. Such figures had assisted the district engineers in making their decisions, but these figures had not been the only factor which influenced the final recommendation. There was no substitute for trained professional subjective judgements in the evaluation of construction effects on the environment, nor was there likely to be for some time. But matrix analyses should not be precluded from immediate use on a selective basis and work should continue to refine current evaluation systems.

In view of the fear expressed by Mr. Reed in his paper that environmental legislation would curtail the introduction of innovative design methods, he said that the Corps experience showed just the opposite - that more innovative design methods were developed as a direct result of the implementation of environmental laws.

SUMMING UP THE SYMPOSIUM

MR. A.S. ROBERTSON (Chief Executive, Northumbrian Water Authority) began by summarizing what the principal contributors had said.

Lord Sandford's message had come over loud and clear. He had been in the position of the decision-maker in a number of complex cases and had never been in doubt that the existing planning machinery provided enough data; on the contrary, it had often produced too much. EIA seemed to him to be unnecessary; instead one should follow the example of the North West Water Authority, as outlined in Mr. Oldfield's paper, in working out problems with potential objectors during the project planning stage. The right kind of engineers to do this were required, and this Symposium was a good start to making engineers think in these terms.

Eric Reed stated that he had remained deliberately neutral on the virtues of EIA. He did, however, point out that a lot of very good engineering had been done in the last century, by engineers who had never heard of EIA but who had managed to meet the problem of providing for a major social need - like sewerage and water supply, where none had existed - with solutions that were, sooner or later, accepted as monuments of good environmental taste.

Even today, the engineering manager was faced in his daily task, with fitting his policies and practices, for small as well as large-scale work, into the environment in a publicly acceptable way. He took account of the needs and perceptions of people.

Activists, who were in a minority, although growing, were not necessarily right. If EIA were to be a tool for a limited number of projects, then let each group of activists produce his own and, in due course, the decision-maker could take these into account. Beware, he said, of stifling engineering genius: beware also of producing water in the humps of camels designed by committees. Encourage objectors to quantify and keep your eye on the time and money consumed in your environmental considerations. The manager, in the end, must decide and get on with the task of meeting the primary need, in good time.

Mr. Thirlwall explained the terms of reference he had been given for his report on whether a form of EIA was necessary in the UK. He made it clear that the EIA which he concluded was necessary, was not the American kind. It was to be non-statutory: an adjunct to the planning processes which already existed and coped satisfactorily with the vast bulk of the 650,000 developments which each year were the subject of planning applications. He advocated a process which would apply only to 25 to 50 of those large scale and complex proposals which could have unusually extensive impacts on the environment. By this means, and only when it was necessary, additional talent would be brought into studying the problem, which would be advantageous to the designers, the developer, the planners, and to all involved in explaining the preferred solution to the public.

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Professor Broady explained how sociologists such as he could be employed as advocates of a particular viewpoint by objectors to a project, or as impartial analysts, contributing to the EIA chapter of a project appraisal. In the former case, the "I" of EIA would be IMPACTS; in the latter, IMPLICATIONS. He explained that although EIA could not always be numerate, it could, nonetheless, be logical, and he gave examples of his work on Craig Goch - a personal, but non-subjective assessment of where the main sociological problems were likely to lie, followed by fact-gathering, analysis and then, most important of all, a conclusion which would assist the decision-maker. His conclusions would be reached as so often were engineer's conclusions, by applying his judgement, arising from his experience.

Professor Edwards explained that the traditional role of the engineer had changed, because of a number of factors:

- there was the substitution of science for intuition,
- the growth of specialization, which made more decisions a matter for a team, rather than the individual,
- the state of development in Britain that called for substitutive change, rather than the development of entirely new facilities,
- but most important, perhaps, the increased public awareness of the environment and the need to compromise between the most economical and the most acceptable solution.

He had outlined the various classes of environmentalist that would have to be accommodated and pointed out one of the problems of public consultation; that the public were likely to be concerned with the here and now, but the engineer had to think of the future. He was most concerned that the formal university training of engineers did not provide them with the skills that were now, and increasingly would be, needed to design and manage, in a situation that required a multi-disciplinary approach. In-service training might be the answer: and the engineer as such, would have to adapt or yield to a manager who was better equipped.

Backed by Professor Herbert and Mr. Johnson, Mr. Oldfield described his practical experience of a form of EIA as part of project appraisal in the North West Water Authority, for a future water resource development. The process had been to bring together the engineers and the planners under the co-ordinating management of environmental consultants. The field of potential solutions was narrowed to a manageable four, as a result of engineering and economic studies and the objective was to deal with all potential problems of a decision-maker in sufficient detail and no more. He explained the problems of controlling the timescale; the avoidance of going into too much detail; of keeping the political masters informed of, and associated with, progress. He was satisfied that the method had been effective in producing an objective report that would be useful to

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the decision-maker. No one from the floor had taken great exception to his conclusions.

Messrs Lloyd and Beaver had recounted their experiences abroad and brought out the fact that, although environmental impact could not be ignored in under-developed countries, the priorities and the scale of the problems were quite different. Many countries could not afford the luxury of the detailed concerns we had in the UK which, in some ways, were comparatively trivial. The resident of a sterile desert was more concerned with getting a water supply than preserving the virgin sands. The engineer was often engaged in projects to positively improve the environment. They had described a number of projects in which the engineer abroad today had the freedom and power of his Victorian predecessors in England. They had used this freedom in a generally effective yet sensitive way, and although there had been some unforeseen difficulties, the economic state of some countries and the dire needs of their citizens forced the engineer to press on and use his experience and judgement and such specialist advice as was necessary and available, as best he could, to get things done quickly and effectively.

Finally, Dr. Grant Ash had described the role of the US Army Corps of Engineers as a Federal service agency. He told of the impact of the National Environment Protection Act on its activities such as the revision of 1 in 3 active projects. He told of early problems from lack of experience and methodology of EIA. But only 2.7 per cent of the Corps' projects with EIA had been challenged in court, and, generally, the senior management of the Corps now accepted the process to be a good one, although district engineers were still sceptical. But, the system was still dynamic and greater effort would be applied to streamlining the process; considering real issues rather than producing paper; combining EIAs with the project appraisal process rather than as a separate task. He made two interesting points in his introduction: one on costs of EIA, which, as near as could be assessed, had been 1½ per cent of the budget for labour and materials; two, on non-structural solutions, which meant moving people from a development site could be cheaper than trying to cater for their needs if they remained.

In summing up the Symposium, Mr. Robertson said that he would have to identify some factors to disregard.

He disregarded all that had been said about engineering in the last century. Times had changed and our engineering must take account of the tail-end of this century and the beginning of the next. If engineers had a hankering to build large dams without public participation and understanding, they'd have to practise in those countries which were still struggling for survival - at the development stage.

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He disregarded also the risk of stifling genius. There weren't too many geniuses around and, by definition, they'd find a way round, over, or through any obstructions placed in their way. The main body of professionals were not geniuses and yet had got to deal with the environment in their daily engineering. It was their cumulative effect that mattered.

He said he would also disregard the fact that although the title of the Symposium was "Engineering in the Environment : Harmony or Conflict?", the discussion tended to be governed by a different title: "Engineering in the Environment : Enhancement, Harmony or Conflict?" - and covered the whole range of possibilities.

He thought that Mr. Reed "got it right" when he reminded them that the engineer and engineering manager made value judgements almost every day when designing, constructing, and operating quite small works. If he didn't employ a fair degree of skill in these judgements, not only would there be a lot more ugly buildings and structures than at present, but the public would soon express dissatisfaction with the mess made while laying watermains, the smell that came from badly operated sewage works, and so on. There were, of course, some bad examples of small works design, construction, and operation, but these only served to highlight the fact that, generally, good standards were achieved. Everyone in the Institution, engineers, scientists, academics, and other professionals alike, must do their share to help educate and inspire the young engineer to continue to keep the needs of people and the environment firmly in his mind when doing the very smallest of his tasks.

The new Regional Water Authorities (RWAs) gave some engineers the first opportunity that they had had of working closely with other professionals. This was being promoted by the management of the RWAs as a means of getting the best available solutions to many day-to-day problems. The recognition by engineers of the role which others had to play would help to produce more senior engineers who knew when to consult others, rather than attempting to do it all by themselves. RWAs were already doing multi-disciplinary training as well as problem-solving and Mr. Robertson personally believed that it was not possible to teach all the skills which an engineer needed to have as part of a first degree course. Some had got to come later, as "in-service" training.

If this course was pursued, it would mean that when the occasional large-scale project, the 25/650,000 occasion arose, it would be natural to turn to the type of solution favoured by Lord Sandford and already being done in the Welsh and North West Water Authorities. He suggested that it was not called EIA even if this meant IMPLICATIONS ASSESSMENT rather than IMPACT ANALYSIS but just considered as an extension of rational project appraisal; not an abrupt change in status compared with other projects just outside the range of qualifying size or complexity, but the end of a continuum, in which the intelligent manager employed his judgment as to the degree of expert assistance needed to provide an adequate identification of the problem; an analysis of alternative solutions; and an opportunity for the decision-making body to reach a conclusion which could be explained and justified to the public.

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He concluded by saying that there had been no conflict in the Symposium but, on the contrary, there had been clear evidence that the water industry had already accepted the need for specialist involvement to varying degrees and had begun to form new tools for coping with environmental interests; this process did not need a new name.

Fearing that this conclusion sounded too comfortable and comforting for the engineering manager, he wished to remind the audience of the point made by Baroness White, that they might get an EEC directive which required a form of EIA. They should, therefore, use any opportunity open to them to ensure that such a directive was as sensible and flexible as possible.

Mr. Robertson then referred to the suggestion that they all might benefit from having matters of general interest debated centrally and, hence, better understood, with some of the more extreme misconceptions eliminated. The example given of "sea-outfalls" seemed to him a good one.