Environmental Design for Major Resource Developments

Norbert R. Morgenstern, MCSCE,
Professor of Civil Engineering, University of Alberta

GENERAL PAPER

Engineers involved in the development of natural resources and transportation systems, perhaps more than anyone else, interfere with the natural systems that have evolved through processes of selection. Few can visit a large dam, mine or power plant, or drive along a highway without being conscious of the effects of our undertakings. We are usually gratified in the knowledge that these effects are generally benevolent. While mistakes have been made in some projects, usually through oversight, the remarkable standard of living enjoyed by most people in developed countries is to a large measure made possible by the efforts of engineers and in this we have a certain professional pride.

Traditionally, design of resource and transportation developments has employed economic and social criteria. In the private sector, a benefit/cost ratio greater than unity, is a necessary condition for investment. Social benefits and costs are also assessed to varying degrees, usually together with the assistance of government or other regulatory agencies. In the public sector, many examples exist of developments undertaken at benefit/cost ratios less than unity. These are usually justified in terms of the social benefits that accrue, sometimes quantified in terms of dollars.

In the past few years we have witnessed a remarkable growth in public concern for the well-being of the environment. This has resulted in all sorts of meetings from local to international levels, new legislation, new technologies and new design criteria for engineers. The almost universal acceptance of the environmetal ethic now makes it mandatory for engineers to add environmental criteria to their traditional consideration of economic and social costs. In the design of resource and transportation undertakings, in the design of any development that impinges on the natural environment, we are obliged to consider environmental costs, as well as economic and social costs. The most striking illustration that this is now the case was the approval in the United States on January 1, 1970 of the National Environmental Policy Act. (NEPA)

Following are the major components of this Act, since it is instructive to see how the United States has reacted to the concern that environmental values be considered if a project is to be found acceptable in the public interest. The NEPA has had a substantial influence on the exposure to the public of the decision-making process and we will inspect how some federal agencies have responded to it. The litigation that has followed in the wake of the passing of the NEPA has resulted in several decisions that are novel for us in Canada, and we will note these since they may be indicative of the kind of debate over environmental issues in which we might become involved in Canadian courts.

After reviewing some of the pros and cons of the NEPA, this paper will summarize the state of comparable Canadian legislation and show that Canadian practice with regard to environmental protection acts is not well-defined. Our practice relies more on ministerial discretionary powers and is clouded by jurisdictional issues. This has both advantages and disadvantages.

Concern for environmental values has generated new possibilities for the designer and promoter of projects. In this sense, environmental concern should not be regarded as a new constraint to design, but as a new degree of freedom for it. Novel solutions to the problems of resource development should be possible and some illustrations will be given. The environmental impact study is one tool that has been developed to assist the engineer in evaluating a project.

The National Environmental Policy Act

The National Environmental Policy Act of 1969 became law in the U.S. in January 1, 1970. It included the following objectives:

1) to assure that all Americans will have safe, healthful, productive and aesthetically and culturally pleasing surroundings,
2) to attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences,
3) to preserve important historic, cultural and natural aspects of their national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice.

In order to meet these objectives the Act;

1) gives the federal government a mandate to manage the environmental impacts of its actions,
2) establishes the Council on Environmental Quality in the Executive Office of the President to provide senior decision-makers with environmental advice,
3) calls for formal statements of the environmental impact of proposed governmental actions.

The passing of the Act was followed by the issue of a Presidential Executive Order in March, 1970 entitled "Protection and Enhancement of Environmental Quality" and a Council of Environmental Quality Guideline in April, 1971 for "Statements on Proposed Federal Actions Affecting the Environment". Some of the contents of these documents are of interest to us in Canada because of the principles inferred relating to the control of environmental quality.

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For example, the Executive Order instructed Federal agencies as follows:

1) to monitor, evaluate, and control on a continuing basis their agency's activities so as to protect and enhance the quality of the environment. (this is amplified in the original),
2) to develop procedures to ensure the fullest practicable provision of timely public information and understanding of federal plans and programs in order to obtain the views of interested parties. (this is amplified with regard to the use of public hearings whenever appropriate),
3) to insure that information regarding existing or potential environment problems and control methods developed as part of research, development, test, etc. be made available to all interested parties as appropriate.

Council on Environmental Quality

The Executive Order also outlines the responsibilities of the Council on Environmental Quality (CEQ). The main responsibilities are advisory in nature, although the CEQ is also to:

1) determine the need for new policies and programs for dealing with environmental problems not being adequately addressed,
2) conduct public hearings or conferences on issues of environmental significance,
3) promote the development and use of indices and monitoring systems to a) assess environmental conditions and trends, b) predict the environmental impact of proposed public and private actions and c) determine the effectiveness of programs of protecting and enhancing environmental quality.

The latter document issued by the CEQ provides guidelines to Federal departments and agencies for preparing detailed environmental statements on proposals for legislation and other major federal actions significantly affecting the quality of the human environment as required by the NEPA. The policy statement in it is of particular interest. It reads:

"As early as possible and *in all cases prior* to agency decision concerning major action or recommendation or a favourable report on legislation that significantly affects the environment, federal agencies will, in consultation with other appropriate federal, state, and local agencies assess in detail the potential environmental impact in order that adverse effects are avoided and environmental quality is restored or enhanced to the fullest extent practicable. In particular, *alternative actions that will minimize adverse impact* should be explored and both the long- and short-range implications to man, his physical and social surroundings, and to nature, should be evaluated in order to avoid to the fullest extent practicable undesirable consequences for the environment."

The Guideline also outlines the content of an environmental impact statement and among the points of special interest to be covered are:

1) the probable impact of the proposed action on the environment, including impact on ecological systems such as wildlife, fish and marine life. Both primary and secondary significant consequences for the environment are to be included in the analysis. For example, the implications, if any, of the action for population distribution or concentration should be estimated and an assessment made of any possible change in population patterns upon the resource base, including land use, water, and public services, of the area in question,
2) any probable adverse environmental effects which cannot be avoided (e.g., water or air pollution, damage to life systems, etc.),
3) alternatives to the proposed action. A *rigourous* exploration and objective evaluation of alternative actions that might avoid some or all of the adverse environmental effects is essential,
4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. This in essence requires the agency to assess the action for cumulative and long-term effects from the perspective that each generation is trustee of the environment for succeeding generations,
5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. This requires the agency to identify the extent to which the action curtails the range of beneficial uses of the environment,
6) where appropriate, a discussion of problems and objections raised by other federal, state, and local agencies and by private organizations and individuals in the review process and the disposition of the issues involved.

Most Important Conservation Measure

While the NEPA is a remarkable piece of conservation-oriented legislation, indeed its co-author Senator Henry M. Jackson has claimed it to be "the most important and far-reaching conservation measure ever enacted", it is important to note that nothing in the law gives anyone veto power over any project or decision; nor is there any language which says explicitly that an agency must *use* an impact statement once it has gone to the trouble of writing one.

The Act applies to over 40 federal agencies and therefore impinges on almost every aspect of government's relation to society. Most federal agencies with substantial involvement in environmental change have responded by opening environmental assessement offices and developing staff and procedures to meet both the letter and spirit of the law.

For example, the U.S. Corps of Engineers, which is one of the United States largest agencies in the spending of billions of dollars annually on projects that impact on the environment, has issued regulations dealing with the planning, preparation, and co-ordination of environmental statements. The policy statement issued by the Corps recognizes that in formulating plans for federal water resource development or management activities, impact in the environment will be fully considered from the initiation of pre-authorization planning through post-authorization planning design, construction, operation, and management. It further requires that early and continuing co-ordination with appropriate government agencies and the interested public be accomplished in order to consider all reasonable alternatives and measures which will mitigate environmental damage. By extending the terms of reference of public participation to include economic and social considerations, the Corps has expressed its concern to insure balanced decision making in the total public interest. The regulations require environmental statements for all Corps projects whether embraced by NEPA or not. They stress further that during project planning and the related decision making process a systematic interdisciplinary approach be utilized to achieve a balanced

view of the often conflicting demands of technical, economic, social, and environmental aspects of major resource developments. The regulations outline in detail recommended practice for preparing environmental impact studies and procedures for ferrying the statement through the government administration. One cannot help but be impressed by the special care taken to permit both intra-governmental review and public participation at various stages of project planning and licensing. Comparable regulations have been drawn up by the other agencies like the Federal Highway Administration and the Atomic Energy Commission.

Although the NEPA has generated much controversy it is not yet clear that it is producing intended results. For example, as is well-known, billions of dollars worth of capital projects have been held up by both the Environmental Protection Agency that administers NEPA and by litigation in the courts. Perhaps the most dramatic example is the delay forced by environmental considerations of the trans-Alaska oil pipeline. Following criticism by government agencies and conservation groups, the final environmental impact statement has grown from a 200 page report to many volumes weighing some 20 pounds. NEPA has also had considerable influence on the commissioning of new power plants. Conflict between power utilities and environmentalists has become common in recent years and NEPA has provided new weapons for conservationists. Even if a new power plant does not meet with any confrontation, it is estimated that complying with NEPA can add as much as two years to the planning and design stage. The Associated General Contractors of America have estimated that about $5 billion worth of power plants is being held up at present by environmental questions. This coupled with performance standards for air quality that have been put into effect by the EPA is aggravating the so-called "energy crisis" in the United States. These and other effects have invoked the displeasure of some members of the U.S. Congress. Discussions have taken place on how to amend or evade the NEPA but so far (to my knowledge) no action has been taken.

More Informed Decision-making

Literally thousands of impact statements have now been prepared and filed. It is difficult to isolate cases where environmental studies have prompted changes in a project. The trans-Alaska pipeline is one case in point. Another less dramatic example is the Waterville Valley Management Plan which was concerned with multiple land use of an area in New Hampshire. The final environmental impact statement issued by the Forest Service of the U.S. Dept. of Agriculture reveals clearly how government attitudes were modified when divergent views were expressed on how the area under concern should be developed and managed. (There is some parallel in this case with the Lake Louise development) I am sure that other examples are readily found. As the chairman of the CEQ has pointed out, at the very least, the result of the mandatory analyses and the interagency and public consultation can only result in more informed decision-making.

The NEPA has created a new industry concerned with the preparation and review of environmental impact statements. By virtue of the need to process these statements prior to the final decisions and the need to consider alternatives to the proposed action in them, those concerned with resource development are being subjected to unaccustomed public exposure. This has the benefit of reducing governmental secrecy in a most remarkable manner and of forcing the administration to express clearly the reasoning behind much of its activities. This effect of NEPA has in the main been salutary.

Access to the courts has made the American environmental movement a much more effective force in influencing environmental policy than it would otherwise be. This access has been provided by NEPA as well as other legislation such as the Department of Transportation Act. While American jurisprudence differs from our own, it is instructive to note how the American courts have responded to the environmental litigation that has arisen. This might provide some pointers to the direction in which we could move if substantial financial backing supported some conservationist issue in Canada.

The most fundamental factor has been the response of the courts on the issue of standing to sue. It appears that it is no longer necessary to be threatened with some sort of direct tangible harm, economic or otherwise, to have standing to participate in proceedings before federal regulatory agencies. According to the courts, you are "aggrieved", and therefore have standing if you are able to demonstrate through your activities and conduct a special interest in the subject matter of the proceeding in question. Hence it would appear that a *bona fide* environmental group with no other kind of harm flowing to it as a result of proposed governmental action, does have standing to contest that action. I am advised, that this is not the case in Canada.

With this access, it appears that the decisions resulting from environmental litigation are making government officials more answerable for their actions in ways that the courts have not previously required.

Typically the government used to argue that you had no right to sue the government unless it agreed to be sued. There are several examples that indicate that now, faced with a challenge to American federal action, a court will say that the plaintiff really is claiming that the action was outside the scope of federal authority. Thus, the court will hold that the suit may be brought, even though the government hasn't consented to it. The courts are also becoming increasingly loathe to treat administrative decisions as beyond judicial reach and government is being called to court to account for its discretionary decisions. NEPA and other environmental legislation has greatly expanded the role of the federal judiciary in American environmental decision-making at the present time. Whether Canadian developments are similar or not remains to be seen.

Canadian Environmental Legislation

This paper has outlined the current state of affairs in the U.S. at some length in order to provide a better background for understanding the situation in Canada as well as to indicate the situations that may arise if we pass similar legislation and if Canadian environmentalist groups become more aggressive. I have refrained from drawing too many conclusions from the American experience; this would be premature; however, it is clear that their approach is meeting some of its objectives although it is not without pitfalls.

In gathering material for this paper, I became interested in summarizing the situation in Canada regarding comparable legislation. I wrote to each Provincial Department of the Environment and the Federal Department of the Environment and asked the following questions:

1) Does your Department administer any legislation such as NEPA which makes mandatory the filing of environmental impact statements? (If so, I asked for a

copy of the legislation and a typical impact statement that had been submitted to comply with it.)

2) If such legislation did not exist, I inquired whether any is contemplated and requested a position paper if one had been published.

The results of my survey reveal that neither provincial governments nor the federal government has passed legislation making mandatory the submission of an environmental impact statement for proposals that impinge on the environment. It is not that our governments have been neglecting environmental legislation; in fact, this has been an extremely active area with most governments passing new environmental acts in the past few years. Our governments have chosen an alternative approach to the problem.

Typical provincial legislation gives broad discretionary powers to the Minister responsible for the Environment. In several provinces regulations have the effect of requiring the approval of the Minister of the Environment before a permit could be issued by any agency of the government for any development or undertaking. This could ensure adequate study of the environmental impact. The Minister has very substantial powers in that he may recommend to Cabinet that the permit be denied or issued on a conditional basis, he may recommend that certain critical areas be set aside as restricted development areas, and he may issue "stop orders" against any action or process he considers is causing or likely to cause destruction, damage or pollution of natural resources.

Most provinces have also established advisory bodies such as Alberta's Environment Conservation Authority. These bodies usually report to the Minister of the Environment and their responsibilities which vary from province to province range from a continuing review of government policies on environmental matters, to assisting in the co-ordination of government programs, undertaking public hearings and advising the Minister of recent research developments in environmental control. One province has created a Cabinet Committee which can hold public hearings into matters which have significant local interest. This Committee would be in a position to assess a proposed development in its initial stage before any substantial action is taken.

At the federal level, the main thrust of new legislation appears to be an attack on emission standards on an industry by industry basis.

Both provinces and the federal government are commissioning public hearings on environmental matters. In Alberta hearings have been held on subjects as diverse as surface mining and the conservation of historical resources. The Lake Louise affair is an example of federally sponsored hearings.

Impact studies are also being undertaken by both provincial and the federal government. For examples, studies have been mounted on strip mining, the proposed MacKenzie Valley pipeline corridor, and refineries and ports on the east coast.

I believe that as air, water, and land-use criteria become more clearly specified, the administrative machinery that we are developing is likely to be adequate to make private industry accountable to the public for environmental quality. The ecological damage associated with some power and extractive projects in the past was often unnecessary. It resulted from understandable ignorance of the effects or from a lack of knowledge about alternative methods that would have been less destructive. Often, incentives to minimize damage were absent because public policies failed to provide for recognition of the ecological implications of industrial practice. Whenever it is technically possible to pursue industrial activities without adverse effects on other values the required public policy is simply to prescribe clear rules of behavior and provide adequate surveillance. Even if protection of the environment involves some small extra cost, industrialists are likely to co-operate willingly to avoid adverse criticism. If the cost is excessive, the industrial activity will disappear. In some cases, this might be beneficial to the public as a whole.

I am less optimistic about one arm of government protecting us from the projects of another arm. Can government act as both policeman and judge while promoting projects at the same time? I am aware of one case where public hearings on a highway project were called well after the planning and design decisons were made. Hence only objections could be raised without a sensible discussion of alternatives. At this instant the petroleum industry is spending millions of dollars on environmental studies in support of an application for a pipeline down the MacKenzie Valley. This application will almost certainly have to face lengthy governmental hearings, in the public eye. That in my view is entirely appropriate. At the same time the federal government has accelerated its plans to build the MacKenzie Highway down the MacKenzie Valley to Inuvik and the Dempster Highway from Dawson to Inuvik. To the best of my knowledge no special studies had been undertaken at that time or hearings sponsored to study the impact of the highways on the northern environment, both human and natural. The Territorial Land Use Regulations became law on Nov. 15, 1971. Will federal departments now observe their own guidelines and study the impact of their own developments in order to minimize the ecological and sociological damage?

The response of government to the environmental implications of the James Bay Project is also not encouraging. If the complete scheme is built, a substantial portion of the total land mass of Quebec will be flooded as rivers draining into James Bay are dammed to produce hydropower. The task force set up to assess the environmental impact of the project stated that it had to assume that before the decision to proceed had been taken, the authorities had answered all questions about whether the project was really needed and whether there were more economical and less environmentally disturbing ways to meet Quebec's power requirements. It is these questions, whether the environmental costs outweigh social or economic benefits, that are of primary concern. Is it enough for environmental studies to proceed along with engineering and economic studies or do they need special status to insure an adequate degree of protection?

Environmental concern is generally concern over the use of air, water, and land. Legislation such as the Canada Water Act and the Clean Air Act, and other regulations specifying waste emission standards provide an objective framework for protecting the first two resources. However, much discussion between the public and all levels of government is needed to properly formulate a land-use policy. In the United States, many states have adopted land use planning and control measures. Whether such strong measures are needed in Canada to protect the environment, only time will tell. At the very least we must debate these issues at the regional level. To this end, as an example, I am pleased to see that the Alberta Environment Conservation Authority will be holding public hearings to examine land use and resource development in the eastern slope and foothill areas of the Rockies.

Implications for Design

The requirement that environmental costs be introduced into the design equation means that new, novel solutions to problems of resource development become possible. Proposals that might in the past have been rejected on simple economic grounds become viable because society is stating that it is prepared to pay more if some measure of environmental protection is included in the development. This constitutes an exciting challenge to the engineering profession to recognize the new possibilities that are presented. It will be through our innovation, our research and development that reasonable solutions that minimize the various costs of resource development will be found. About a year ago, during a meeting on Pumped Storage Power Developments I heard a paper that illustrates the type of thinking to which I am referring. The paper describes a potential power park in the state of Washington. A steep long coulee has been located just off the Columbia River at a level some 200 feet above it. The coulee is isolated, almost uninhabited, void of significant investment in transportation arteries and capable of supporting only sparse vegetation. It is proposed to build two dams in the coulee to create an upper and lower reservoir with water pumped up from the Columbia River. Some six thermal generating stations would be located around the reservoirs using them for cooling water. The reservoirs would also provide the peaking power needed to optimize the base load capacity of the thermal generating stations. In this way the development of some 7,500 MW of thermal generating capacity and some 1,500 MW of pumped storage capacity appears practicable. The cost is estimated at $2.2 billion, exclusive of transmission. The use of man-made pumped storage reservoirs in out-of-the-way locations should overcome environmental objection to the use of natural bodies of water for this purpose. The economy of scale associated with such a project may make the idea attractive on a regional basis.

The energy industry in the United States has borne the brunt of the conflict between developers and environmentalists, particularly on the issue of siting new power plants. The U.S. National Academy of Engineering in response to a need expressed by their Committee on Engineering Aspects of Environmental Quality has undertaken a study of this issue and it is interesting to note their statement "The fundamental premise which motivated the program is that good engineering can do much to mitigate the conflict, more apparent than real, between society's demands for electric energy and its wish to preserve the environment." The study recognizes that other professions and processes, such as law, science, public discussion, politics etc. have contributions to make but it points out that it is nevertheless clear that the process of resolution of the conflict must obviously be consistent with the possibilities of nature and economics, in other words, on matters intrinsic to engineering. A recently published summary of the study gives detailed recommendations for administrative changes and research and development priorities.

Critical Standards Needed

The environmental impact statement is one of the tools that is developing to help assess these new concerns. Even though guidelines for preparing these studies for submission under NEPA have been published, many impact statements are poorly prepared. In Canada, where there is almost no guidance on the part of government regarding the contents of such statements, we run the risk of reading reports on the obvious. It is time for our designers, consultants, and regulatory agencies to establish the same critical standards for these studies that they employ for other engineering investigations.

Undoubtedly a characteristic feature of an environmental impact study is that it is multi-disciplinary. It is appropriate that it be the engineer who co-ordinates the activities of all the disciplines that are brought to bear on a study. He is best equipped to make a coherent picture out of the disparate data that is collected, at least until we have produced an "applied ecologist". For example, recent environmental studies for a pumped storage-nuclear station power complex required the following studies to describe the existing environment.

a) Physical – geology, surface hydrology, water quality, ground water, meteorology.
b) Human – census, labour supply, relocation, etc.
c) Wildlife – flora, fauna of both the terrestrial and aquatic ecosystems.

In addition to establishing the baseline characteristics of the site environment and assessing the impact of the development, a continuing program of monitoring had to be designed. This included sampling aquatic and terrestrial life, complex radiation studies, and monitoring water quality. It is clear that such studies and subsequent monitoring programs are costly and time-consuming. If they are unnecessary in part, they are extremely wasteful. If they are inadequate then we fail to meet our responsibilities as engineers.

Social and environmental values are difficult to quantify, yet we must continually be making value judgements in he development of our resources. For example, we might imagine the consideration of several alternatives for highway development. One alternative might take an area of parkland while another might require a substantial number of families to be moved and a third might have the highest motor vehicle running cost to the road user. We can reasonably expect to have our alternatives clearly defined but we can not yet convert the trade-offs in selecting one choice over another into a neat benefit/cost ratio.

Even this problem is under attack by engineers and economists. Sometimes the solutions are naive; there is a tendency to estimate wildlife and fish values on some water resource development projects in terms of $/hunting or fishing trip/day, implying that the game or fish are of no value unless they are being caught. However, much more sophisticated environmental evaluation systems are under development. Among agencies that have published such systems are the U.S. Geological Survey, U.S. Bureau of Reclamation and the Water Resources Council. Clearly this is an area worthy of much detailed attention.

Concluding Remarks

In this presentation I have been concerned with drawing attention to the problems associated with environmental considerations in the design of major resource developments. There are

1) problems of legislation,
2) problems of communication, particularly to insure adequate responsible public input,
3) problems of engineering design,
4) problems of evaluation.

There are also problems of education because the engineering decision maker must develop a broader outlook if he is to maintain his role in major resource development. This presents a special challenge to the engineering educator which is not easily met.