AUDIT AND EVALUATION IN ENVIRONMENTAL ASSESSMENT AND MANAGEMENT: CANADIAN AND INTERNATIONAL EXPERIENCE

VOLUME I Commissioned Research*

Proceedings of the Conference on

Follow-up/Audit of EIA Results

Organized by

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and The Banff Centre,

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Editor:

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VOLUME I

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Recognizing there are limits to growth has moved society into a new mode of thinking about the environment. Business, government and other stakeholders are now addressing impacts and the interdependence of resource development and environmental management. As is discussed throughout this volume, the conceptual framework, principles and guidelines, and new tools and techniques for assessing projects have been traditionally confined to the planning phase. There have been few systematic attempts to follow up on impact predictions to assess the accuracy and effectiveness of these predictions toward improving environmental management techniques.

In this context, the objectives of the 1985 Banff Conference were to provide a neutral forum for the balanced discussion of policy and institutional issues of evaluating project environmental assessments and to suggest general directions for dealing with present and future opportunities to improve the field.

Volumes One and Two, constituting the proceedings of the conference, are a result of many people. Bob Slater, Assistant Deputy Minister, concerned with increasing pre-investment costs of projects, potential duplication of assessment efforts and stakeholder relations, conceived the idea for the development of an audit trail to review what has happened to environmental impact assessments. Bob Baker, Chairperson, Program Committee, and other individuals from Environment Canada and FEARO undertook much of the initial work developing the scope of the conference. Jim MacLaren served as Chairman of the conference and was responsible for coordinating the workshop process. Small group facilitators and authors all contributed greatly to bring forward the recommendations to advance the field. The final output, of course, was the result of all the assembled individuals whose personal commitment and vision brought forward these recommendations in the Agenda for Action.

R.H. Weir
Chief
Environmental Protection Service
Environment Canada
on behalf of
the conference organizers

FOREWORD

Current environmental policy in Canada and elsewhere is based largely on "react and cure". As a characteristic of public policy, this is expensive in environmental, economic, social and political terms. There is recognition of the benefits available from a complementary, second policy track based on "anticipation and prevent". The federal government's Environmental Assessment and Review Process is one of the longest established planning systems in this category. While many examples of the application of the Process are known and well described, the resulting social, political, economic and scientific/technical benefits are not. Follow-up to environmental assessments should be used, in part, to persuasively demonstrate these benefits and is essential if broad public awareness and acceptance and credit is to accrue to the Process.

R.W. Slater
Assistant Deputy Minister
Environment Canada

SETTING THE STAGE

James W. MacLaren

Introduction

The history of environmental impact assessment in North America began with the passage of the United States Environmental Policy Act of 1969; five years later in Canada the Federal Cabinet passed the Order In Council creating the Environmental Assessment and Review Process. This process was considerably strengthened by guidelines issued by Order In Council in June 1984. Most Canadian provinces have instituted similar procedures over the past ten years; some as informal arrangements, while others have enacted legislation. The EIA process has also extended to include some economic and social issues.

These programs were set up to respond to a growing public concern over the environmental and ecological changes that were occurring across the continent, especially in relation to mega-engineering projects. Initially the process was a "buzzword" which had little sting. It was misused and overused in the fanfare of environmental rescue and wasted considerable time and money. Slowly the process assumed a more acceptable and useful form.

Today, the different assessment processes vary considerably in procedure and relative value. The U.S. system requires federal programs to be subject to an environmental assessment in sufficient depth and detail to satisfy any court to which it may be subsequently referred. This does not, however, prevent the proponent from proceeding with the project under his terms. On the other hand, the Canadian Federal Environmental Assessment Review Process, although open, still is not employed on all federal undertakings and its findings are not necessarily binding on the proponent.

Provincial systems are usually binding on the proponent but the initiation of the process is still determined by ministerial discretion. None of the programs have yet been incorporated in the initial planning stages of project development and most do not formally state the need for follow-up analyses through monitoring and audit of impact predictions.

After more than 15 years of experience, the need for and usefulness of the process has become well accepted. Much has been learned about the advantages and weaknesses.

Environmental analyses and impact prediction can both alter a project design to protect the environment and at times, contribute significantly to the reduction of project costs.

Completeness. Generally the terms of reference of an assessment apply after the fact of the decision to proceed with the project and therefore economic and social factors are not considered. In weighting the wisdom of the project, environmental impact statements have revealed better alternatives to project design, but after the fact, too late to effect overall benefit.

Predilection to planning and approval. Far too much time and research is given to planning the approach to EIA and the approval procedure. Sufficient time is given to establishing the yardsticks on which the project impacts can be measured in relation to the baseline data. Little attention is also given to methods and procedures for that measurement - in operation as well as construction phases.

Procedural snarl. Too frequently the EIA procedure has followed a regulatory policy that includes: determining the need for the assessment; questions to be considered establishing guidelines to follow; and decisions to be made. This does not provide for an innovative approach. It results in extended periods in preparing and reviewing the document, followed by a prolonged and expensive hearing in which intervenors find themselves responding to project decisions that frequently have been taken already.

Inadequate decisions. Many hearings have resulted in decisions of approval that embody generalized statements on impact mitigation and project control that cannot be measured.

The legitimacy of the process is at stake if we cannot properly answer these questions:

Why do we need an EIA and what should it tell us?

What have we been able to predict well and what can we not yet predict?

Are audit procedures necessary and should they be explicit and mandatory in EIA?

Are we flexible in EIA to addressing all project phases?

Are new projects benefitting from EIA audit history?

What do we require of environmental impact management for the future?

The answers to these questions were sought at the Banff Conference. It was intended that the workshops would first address the completeness of EIA and the required follow-up audit requirements for the current EIA procedure, suggesting specific changes in the process where necessary.

In their second phase, the workshops addressed the future: how can environmental management and impact mitigation procedures be built into the project planning and development phase so it achieves real legitimacy?

Frankly, the process has developed to the point that if real benefits cannot be incorporated into project development, implementation and operation, its future is bleak. There is real risk that a reaction to this inability to deliver may cause the demise of EIA. Indeed, there are recent examples where the "hoopla" surrounding the EIA has confused the real needs of a project, causing resentment and resistance among the users.

The environmental issues that relate to a project or a policy can only be resolved through:

a) the provision of adequate baseline data,
b) the formulation of impact prediction,
c) the definition of impacts foreseen,
d) the prediction of impacts,
e) the monitoring procedure, and
f) the objectives and procedure of the audit.

The definition of these needs commences with an initial appraisal of the project or policy in relation to its potential environmental effects and thence follows an iterative process that continually refines the definition of the background conditions, the project effects and mitigation requirements, the monitoring of the action and the audit of the actual success of the process.

The real need, therefore, in any EIA is to foresee the anticipated impacts, to ensure that they are measurable and can be monitored to permit their control and eventual audit.

Audits therefore should only be undertaken with the specific objectives of the EIA in mind, for they are expensive and time consuming procedures. They must:

a) Check the accuracy and authenticity of the predictions of the environmental consequences of the project.
b) Determine the effectiveness of the mitigation procedures for reducing the adverse effects of the project and, where there are significant variations to

the predictions, recommend procedural changes to control the impacts to the intended levels.

c) Evaluate the effectiveness of surveillance and monitoring and recommend changes where necessary.

d) Examine the measures adopted to involve the public.

e) Assess the response of the project control system to the EIA requirements and recommend improvement where necessary.

f) Provide published data to permit others to benefit in future projects of a similar nature.

Since experience with project audit and evaluation procedures is still limited, much of the effort of workshops must be directed at determining the value of this approach.

To that end, the Conference was organized into four themes:

Session I dealt with the accuracy of impact predictions in the planning and design phase as compared to the actual experience of implementation and operation;

Session II examined the effectiveness of mitigation procedures under actual field monitoring activities;

Session III reviewed the value and effectiveness of public involvement; and

Session IV considered the effectiveness of the management procedures adopted for project mitigation.

There was, in fact, considerable overlap among sessions. The results of the workshops conclude the two volumes of the proceedings. Many of the questions posed for discussion could be only answered partly or obliquely.

What broad conclusions might be drawn? We appear to be on the threshold of two disparate directions with respect to the evolution of EIA. One is a search for how to improve the basic process of impact prediction, measurement, mitigation and management, based on audit and evaluation; the other is how to alter and incorporate the process to embrace full project planning, development, implementation and operation.

LEARNING FROM EXPERIENCE: AUDITING ENVIRONMENTAL IMPACT ASSESSMENTS*

David A. Munro

Introduction

Environmental Impact Assessment (EIA) is widely used to predict and mitigate the adverse effects of development. Since the early 1970's, EIAs have become more comprehensive in scope and are being undertaken for a greater variety and larger number of projects. Many studies have been undertaken, numerous lengthy reports have been prepared, and detailed guidelines have been issued for the construction and operation of projects in ways that are intended to minimize environmental damage.

EIA is perhaps the best known component of environmental management, using that term in the same sense as Eagles (1984), to refer to the entire process of planning, managing and conserving the environment and natural resources. There is ample evidence that EIAs are regarded as essential, but their effectiveness and efficiency are now being questioned. The extent to which they serve their purpose is in doubt. It is suspected that they may be too limited in terms of time and space, and therefore in ecological comprehensiveness: better scoping and cumulative impact assessment are proposed as the remedies. They are thought to be imperfect in their reflection of the impacts of environmental change on people and communities: social impact assessment has therefore become an increasingly important adjunct of EIA. There is widespread concern that EIAs continue to be add-ons to the planning process, that the early, important decisions on projects do not adequately reflect environmental considerations: what is proposed is that environmental considerations should become part of the continuing flow of development policy-making and planning. Serious questions have also been raised about the accuracy and precision of environmental prediction, the efficiency of institutional and administrative arrangements and the overall cost of EIAs.

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* This paper is based upon a longer study entitled "Learning from Experience: A State of the Art Review and Evaluation of Environmental Impact Assessment Audits", by David A. Munro , Thomas J. Bryant and A. Matte-Baker, prepared for the Canadian Environmental Assessment Research Council (CEARC).

Clearly the way to improvement is to evaluate what has already been done - to determine if the adverse effects of development are predicted sufficiently well and effectively mitigated. The follow-up studies of EIAs commissioned by the Environmental Protection Service of Environment Canada (see Appendix I) and the state-of-the-art review of EIA audits conducted under the auspices of CEARC (Munro, Bryant and Matte-Baker, 1986) are first steps in that direction.

The present paper draws on the follow-up studies and summarizes the state-of-the-art review. Its purpose is to contribute to environmental management by examining and evaluating some aspects of impact assessment. The focus is on environmental impact assessment, in the comprehensive sense, and on mitigation. The point of departure is auditing.

Terminology

The processes to which such terms as "monitoring", "audits" and "evaluation" refer are all concerned with examining natural phenomena, usually modified by human intervention, and all have overtones of surveillance and judgment. They are closely related terms and it will be helpful to consider their meaning in some detail because current usage is sometimes confusing.

Post-project analysis has been used as a very broad umbrella term (ECE, 1982). EPS used the rather imprecise term follow-up to refer to the commissioned studies that are a major source for this paper.

Monitoring is repetitive measurement (Beanlands and Duinker, 1983) or, less satisfactorily, repetitive qualitative observations. The term baseline monitoring or pre-project monitoring can be applied to the measurement of environmental variables during a representative period of the pre-project phase, before disturbances occur, to determine the normal range of variation of the system. The term effects monitoring is used to describe periodic measurement of environmental variables to determine changes attributable to the construction and operation of projects; it can be further subdivided into operational monitoring or post-project monitoring. The usefulness of effects monitoring depends to a great extent on the existence of baseline data against which to measure change. Compliance or regulatory monitoring and surveillance which take place during the operational or post-project stages are directed towards ensuring that regulations are observed or standards met. These types of monitoring do not necessarily involve measurement and need not be repetitive.

Monitoring is the indispensable base for audit and evaluations.

In business usage, audits are a searching examination of accounts to ensure that financial histories accurately represent the performance of an organization. In that sense an environmental audit simply catalogues and verifies the actual effects of a project; i.e., collates the results of monitoring. Again, in business usage, comprehensive auditing goes beyond normal auditing and looks at procedures employed to carry out the mandate of an organization. It examines compliance with those procedures. Comprehensive audits may examine personnel issues, procurement systems, even records management practices. A comprehensive environmental audit, or post-development audit, the term used by Rigby (1985), would relate the actual effects of a project to the predicted effects of the project and whatever mitigation measures were undertaken. On the basis of scientific evidence, it would define and analyze the causes of variance between the actual and the expected. The subject of the audit is thus both the project and the EIA. An audit is, so far as possible, free of value judgments. Audits can be single or periodic events. In this paper, the term "audit" is used to refer to a comprehensive environmental audit as discussed above.

Evaluation is aimed primarily at questions of effectiveness. As a development of financial accounting, it asks whether the procedures examined by the comprehensive auditor have achieved the objectives set by the policymaker. It looks at all of the results of a program or project and compares them to policy goals. In this sense, evaluation develops a causal analysis of program effectiveness. Its purpose is to find out what happened and why, and to provide the basis for judging the desirability of the results. If well done, it should delineate changes which would make results more in harmony with policy goals.

An environmental evaluation, or hindsight evaluation, the term used by O'Riordan (1971), would interpret the results of a comprehensive audit with reference to the objectives of the project and/or assessment. Taking further account of the results of the audit, and on the basis of public consultations, it would re-examine and perhaps re-define the values attributed to elements of the environment, to social structures and their functioning at the time of project approval, and to the expected outputs of the project. An evaluation is undertaken in the light of policy and may result in further evolution of policy. It is based on more than scientific evidence, although it may be limited by the availability of scientific evidence. It is not value-free. Evaluations can also be single or periodic events.

The Nature of Audits

Few audits have been undertaken and reported and those that have have emphasized different aspects of EIA. Some have been concerned mainly with mitigation, some with administrative procedures and others with assessing the precision of predictions. There is no established methodology for audits, but the process should include at least the following steps:

- review EIAs to identify a) verifiable forecasts of effects, b) recommendations for mitigation, c) recommendations for monitoring, surveillance or other follow-up, and d) evidence of the administrative procedures and institutional relations that surrounded the assessment process;
- examine records of monitoring, surveillance, and evaluation and commission special investigations if baseline data are not complemented by monitoring data;
- examine records relevant to mitigation;
- consult publications and reports on similar projects;
- interview persons involved in the EIA project construction, operation, etc.;
- collate and analyze data;
- subject analyses to peer review; and
- report.

An EIA audit must, of course, be related to the structure and characteristics of the EIA itself and to the availability of relevant data. If baseline data are inadequate and if the EIA lacks precision, the audit will be difficult to undertake and its results unsatisfactory.

The purpose of audit and evaluation is to learn from experience. Audits should reveal:

- the accuracy of EIAs as forecasts;
- the effectiveness of recommended procedures for mitigation;
- the utility of recommended regimes and techniques for monitoring and surveillance; and
- the effectiveness of procedures for environmental management of projects.

Evaluation should extend the enquiry to relevant areas of policy.

The Beginnings

While the notion of formalizing a learning process by requiring that EIAs be subject to later audit or evaluation is not yet widespread, the roots of the idea are well established.

One of the earliest analyses of changes in the environment resulting from human action was by Marsh (1864). He not only traced the causes of different environmental impacts but also suggested protective and mitigative measures and stated the need for more careful development practices. The comprehensive volume edited by Thomas (1956) dealt mainly with the assessment of mankind's impact on the environment. The authors cited many examples of apparently unintended consequences of environmental interventions to demonstrate that our understanding of ecosystems was inadequate. A modern work similar to Marsh's, but more sophisticated and quantitative, is by Goudie (1981).

Farvar and Milton (1972) edited a provocative collection of case studies of development projects in which they proposed and documented the theme of a "careless technology" by examining the negative implications of many projects, particularly dams. While they concentrated on the ecological costs of those projects, Bryant (1982) and several others have shown that other aspects of such projects may also be beyond the control of planners and managers. Even economic benefits, generally seen as the driving force for projects and the yardstick against which ecological costs are measured, often fall short of expectations.

The evolution of environmental audits and evaluations has been lengthy and no seminal event marks the advent of formalized and sophisticated audits and evaluations. But with the passage in the United States of the National Environmental Policy Act (NEPA) (1969) and the formalization of the process of environmental impact assessment, it was inevitable that closer attention to audits would eventually follow. During the past five years there has been an increase in the number and quality of both audits of specific projects and more general evaluations of the assessment process. Yet only in two Australian states, apparently, is a requirement for audit mandatory. In view of the attention currently being given to the process, other jurisdictions may follow that example.

There is ample evidence that worthwhile audits can be conducted. The earliest audits were probably the most difficult ones since they referred to assessments which were not designed with an audit process in mind. But the assessments themselves have progressed now to the point where, for many of them, sufficient basic information to support an audit is available. Certainly it should be possible to undertake future assessments in such a way that audits could be made later without undue difficulty.

Scientific and Technical Issues Arising From EIA Audits

The Role of Science

Environmental impact assessments are undertaken to assist the people who make and implement decisions about development. Science, specifically ecology, constitutes the underpinning for EIAs and it must play a significant role in their design and execution. But EIAs are not made to advance science, even though the knowledge obtained in the course of assessments may have that effect. Similarly, while audits are undertaken to assist in evaluating processes and decisions in which science has played only a supporting role, the information that is yielded by audits can be used to improve the scientific and technical aspects of those processes and decisions.

There are important questions about the scientific and technical aspects of EIA that audits should be expected to answer. The scientific questions are:

- were sufficient baseline data acquired?
- was effects monitoring properly planned and undertaken?
- were the major effects of development correctly identified?
- were the direction and magnitude of the effects adequately forecast?
- were multi-stage and cumulative impacts correctly predicted?

The technical questions are:

- were the mitigation measures proposed as a result of the assessment undertaken?
- when mitigation measures were undertaken, were they effective?

Scientific issues, as yet unresolved, have an important bearing on the extent to which audits can be expected to provide the answers to those questions. The main issue is the degree of precision that is possible in assessing and predicting environmental parameters. To the scientific issue of how accurate is the prediction likely to be, can be added the operational question of how accurate it needs to be and other questions about the technical feasibility of proposals for mitigation.

There is also a question about the usefulness of auditing predictions that are imprecise. Finally there are questions that arise from the relationship between a prediction, a mitigating action, and an audit. The intent of a mitigation is to reduce the impact of a project or, put in another way, it is intended to invalidate the prediction. So what then is the purpose of the audit? It may assess the overall, post-mitigation effects of the project but, unless another set of predictions is based on the likely effects of mitigation, the audit cannot assess the accuracy of prediction.

Baseline studies and effects monitoring provide the essential basis for accurate assessment of environmental impacts and enable the audit of prediction and mitigation. The importance of both activities has been emphasized repeatedly in the literature (e.g., McCart, 1982; ECE, 1982; Beanlands and Duinker, 1983) and again by the authors of the follow-up reports. It seems self-evident that both baseline studies (pre-project monitoring) and effects monitoring are essential to any managerial function. How can you manage any enterprise without knowing the relevant conditions when you begin and without checking on the results of your actions as you go along? Yet the fact often is that neither baseline studies nor monitoring are undertaken or, if they are, they are inadequate or begun too late.

For example, the first studies of the social and environmental effects of the James Bay hydroelectric project (La Grande complex) were undertaken by native groups, funded by the federal government, only after the project was initiated. Zallen et al (1985) conclude that the residual impacts of pipeline construction in the Coquihalla Valley would never be fully identified since no formal monitoring programs were undertaken. Hecky et al (1984) state that the major lesson from Southern Indian Lake is that the current approach to assessment, which is largely a pre-development activity, is incomplete and unacceptable; predictions should be recognized as planning aids that require testing in the post-development period to establish their veracity and complete the environmental assessment process.

Even if baseline studies are undertaken, too frequently a major problem is that too few data are gathered, sometimes because the period of data collection is too short, sometimes for other reasons. In any event, if too few data are obtained, there is no assurance that the inherent variability in certain parameters will be satisfactorily defined. Thus it will not be clear if variables detected after the project are within the range of natural variability or are the result of the project. Ruggles (1985) notes that no amount of post-development sampling could make up for the lack of a suitably precise pre-development estimate of juvenile salmon abundance.

Everitt and Sonntag (1985) state that biophysical sampling procedures and statistical techniques are not sufficiently developed to determine conclusively that changes have occurred as a result of a development activity. It nevertheless remains important that project planning and management allow for the effective application of the sampling procedures and statistical techniques that now exist. It is only through continuing field experiments that these procedures and techniques will be improved.

Predictions

The most noticeable characteristic of environmental predictions is their imprecision. Few are quantitative. The majority are qualitative and employ phraseology that is tentative and uncertain.

As a consequence of the Wreck Cove development, for example, changes in nutrients, pH and primary production were expected to show a noticeable, very slight, slight, large or very large increase. It was predicted that the "salmon resource would not suffer" Ruggles (1985). Preimpoundment predictions for Southern Indian Lake, while qualitative, are expressed in greater detail and with more confidence, e.g.:

> "No thermal stratification...Deoxygenation only in immediate vicinity of flooded soils...No increase in offshore primary productivity over most of lake; probably lower primary production nearshore on exposed areas of high wind fetch. In protected areas with high transparency, production will increase in the short term"...Hecky et al (1984)".

The fact that predictions are usually imprecise does not mean that they are not useful. They must have been of some use since the case studies suggest that there were no major disasters as a consequence of any of the projects undertaken. The impreciseness of predictions does make them difficult to audit with any degree of confidence. What is a "slight reduction"? What are "minimal effects"? These are not the sorts of predictions that can be scientifically assessed with any degree of precision, although they may be satisfactory for operational purposes.

In addition to impreciseness, there is the question of general accuracy. In the case of the James Bay project, predictions of major ecological change were generally well established. As more detailed information is being accumulated, however, some predictions are found to be incorrect (Roy 1982; Rosenberg et al, in press; see also Berkes 1982). Dorcey and Martin (1985) in the review of case studies of the Utah and Amax mines, report that for Utah 4 out of 10 impacts were correctly predicted, and for Amax, 14 out of 15. A review of EIA predictions in the United Kingdom found that 43 out of 76 predictions that could be audited were accurate (Clark, 1983). Fifteen predictions were made for Southern Indian Lake, of which 13 were correct; 7 post-project phenomena were unpredicted (Hecky et al, 1984).

The Southern Indian Lake study is instructive in its suggestions of the reasons for error in specific predictions. It suggests that existing models of environmental responses were much too limited in their consideration of major systematic factors, such as the effects of heat impact, erosion and leaching on trophic activity, turbidity, temperature, etc. If the basic paradigm or systems view is faulty, then many of the parameter estimates it produces and applies to species reproduction rates, for example, will also be faulty.

In view of the paucity of information, it is imprudent to be categorical with respect to predictions but the following conclusions seem appropriate:

- major effects have been correctly identified more often than not and so have their directions. Errors in predicting the magnitude of change are common
- multi-stage and cumulative impacts are correctly predicted less frequently if at all
- the most satisfactory predictions relate to phenomena such as oil spills and temperate-climate reservoirs which have already been much studied and monitored, although there are exceptions
- first-order effects (e.g., changes in water quality or air quality, and habitat loss) are the easiest to predict; second-order effects (e.g., primary productivity, population changes) the next; and higher order effects (changes in animal behaviour and socio-economic effects) the most difficult. Complex systems with many linkages are not usually well understood.

Mitigation

Mitigation is at the heart of environmental management at the project level. It is an exercise in pragmatism: on the whole, it seems to have worked well and to have been well received. The evidence of the follow-up studies is that mitigation has evolved in a progressive fashion. Jakimchuk et al (1985) summarize the situation well: "Information availability and practical experience appeared to be the key factors that affected the evolution of recommended mitigative measures."

Mitigation is an intermediate step in project management. The general sequence of activity is assessment, identification of potential impacts in general terms, design and implementation of mitigating measures, re-assessment and, if the potential impact has been avoided or minimized, adoption of the mitigating activity as a standard procedure in comparable circumstances.

Many mitigations deemed to reduce adverse environmental impacts are minor modifications to construction procedures or operating regimes. For example, highway construction at stream crossings on the Shakwak project was scheduled to avoid periods when the impacts on fisheries would be most severe (Spencer, 1985). Many of the damaging effects to soil noted as a result of earlier pipeline construction in Southern Ontario have more recently been avoided by suspending the operation during wet weather (Moncrieff et al, 1985). Perhaps the greatest concern aroused by the Wreck Cove hydroelectric project was the expected impact on salmon of reduced flows of the Cheticamp River. Mitigation was achieved by devising and implementing a riparian flow policy to provide a base flow not lower than the one-year-in-four mean July flow. The evidence suggests that the policy was effective (Ruggles, 1985).

Relatively simple tasks, such as stabilizing disturbed areas by seeding and fertilizing and restricting the operation of vehicles in streams, are important in mitigation and represent no more than good construction practice.

Predictions of the effects of mitigation are not usually stated; most often it is simply assumed that they will result in improvement. If predictions are explicit, they are couched in general terms. The indicators of success tend to be integrative (e.g., fish populations have been maintained, or social, e.g., highway design is considered aesthetically attractive) rather than analytical and scientific. Such indicators are satisfactory from an operational viewpoint but do not provide much basis for scientific audit.

Where mitigations have been audited, the results are expressed in general and pragmatic terms. In respect of the Shakwak, Spencer (1985) notes "The construction program was generally successful in improving on the undesirable fish passage conditions that existed at crossing sites prior to construction...Revegetation efforts in the right-of-way were generally successful..."

Accuracy and Precision of Environmental Science

It is generally agreed that better predictions of environmental effects would be worthwhile. There are two reasons for this. One is based on the assumption that adverse environmental effects would be avoided if they could be accurately predicted. The second reason is the human desire to improve performance; the need to predict is seen as a challenge to skill and knowledge.

The two sorts of expected benefits are not incompatible but giving priority to one or the other can have significant operational and cost implications. If priority is given to improving the quality of environmental science, there will be an emphasis on procedures that will facilitate the experimental approach and ensure the collection of adequate and timely data. On the other hand, a prior concern with saving time and money and concentrating on "practical" measures is likely to mean that there will be less emphasis on precision and on scientific aspects of the work generally. What is most likely is that the two approaches will be adopted concurrently so far as they can, but the emphasis will tend to swing from one to the other.

The question of what accuracy and precision one can reasonably expect from environmental prediction remains. For many of the projects which cause major environmental impacts, from five to fifty years or more may be taken up by planning, implementation, and operation. Since there is really no such thing as a completely closed social or ecological system, particularly over an extended period of time, it is unreasonable to expect a high level of accuracy from predictions. What is important is the ability to forecast the general direction and magnitude of the change, to predict whether an environmental factor is likely to move into a range which holds serious implications for other parts of the ecosystem, and whether the factors affecting the process are well understood in that particular ecosystem.

The application of linear forecasting techniques to dynamic multi-faceted phenomena has been strongly criticized. Alternative forecasting techniques, such as system dynamics (Forrester et al, 1976), have been developed to avoid the problems of linear models. Simulation methods, of which system dynamics is a particular variant, can be used to build both simple and complex models of interactive systems (Larkin, 1984). Modular structures allow simple formulations of one part of a model to be replaced with more complex ones to improve resolution. As knowledge improves, simple structural relationships may be replaced by richer and more accurate depictions. The modular nature of many simulation models makes such changes quite straightforward. But we must keep our feet on the ground. In a review of the lengthy controversy over the impact of electric power generation on the Hudson River striped bass populations, Barnthouse et al (1984) cautioned that, "shortcuts to solutions cannot be found through elaborate modelling exercises...simple, empirical models designed to fit the available data are more useful than complex, process-level models that require unavailable data." Failure to draw definitive conclusions about long-term effects on fish populations was because of "insufficient understanding of underlying biological processes."

Physical scientists are used to a form of investigation which is based on clearly stated hypotheses and requires precise data to reach conclusions. Many social scientists have found that attempting similar precision may lead to absurdities. Environmental science may be in much the same situation. From the analysis of Hecky et al (1984) of the Southern Indian Lake experience, it appeared that the basic paradigm, derived over a period of years from investigations of reservoirs elsewhere, was appropriate for predicting some effects but not others. It was inadequate in its consideration of the nature of the area to be flooded and it failed to predict, or predicted incorrectly, responses above the primary trophic level.

Some authors have assumed that if forecasts are to be audited they must include explicit statements of expected effects. Clear, sharp forecasts certainly make an auditor's job easier, but they may be misleading. If they are to be expressed within the usual bounds of scientific confidence, they must be relatively limited in scope and complexity. As a result, they may be too narrow to contribute significantly to a comprehensive environmental assessment.

Conclusions

The science and techniques that are vital to environmental management and to the conduct of EIA have progressed, but need to be improved. Three main recommendations follow.

1) Research should concentrate on establishing a more securely based environmental science, through clarification of:
   - ecosystem dynamics and paradigms;
   - the nature and dynamics of cumulative impacts; and
   - the responses of specific ecosystem components to different impacts.

2) Data for decision making and management should be more thoroughly and systematically gathered and carefully recorded:

   - Pre-project monitoring and operational and post-project effects monitoring should be carefully scoped and designed in accordance with the concept of valued ecosystems.
   - Monitoring should begin as projects are being planned and should extend over an adequate period of time to allow for proper planning and management.
   - Monitoring plans should aim at establishing statistically significant conclusions.

3) Mitigation should be undertaken and managed more systematically notably by:

   - keeping precise records of the institution of mitigation and observed effects;
   - evaluating and recording the effectiveness of particular measures; and
   - incorporating successful mitigation measures into routine practice.

Procedural and Administrative Issues Arising From Audits

The case studies indicate that the best ways to manage environmental assessment are yet to be worked out. We still need to define the characteristics of structure and function most appropriate to reviewing and managing complex political and technical processes involving different interest and actors. The questions raised by the case studies relating to administration and procedure can be summarized as follows:

- How should EIA relate to broader and more fundamental planning processes?
- What are the most appropriate institutional arrangements, allocations of responsibility and procedures for EIA?
- How can contributions to the public interest of competing groups be maximized?
- Can EIA be made more effective and efficient?

EIA and Comprehensive Planning

The role of environmental assessment in developing planning has received continuing and intensive attention. Reviewing the environmental assessment of hydrocarbon production in the Beaufort Sea, Rees (1983) commented: "As a mechanism that is external to the project and essentially reactive in mode, the present Environmental Assessment and Review Process is simply not an appropriate vehicle for project planning and design." Rees noted further that the EARP panel was precluded from considering the go/no go option: in the view of the initiating department the most critical decision, namely that development would proceed, had already been taken.

While EIA began as a discrete process associated with a particular project, the view that it should be an integral element of comprehensive planning is becoming more common. O'Riordan and Sewell (1981), for example, "contend that EIA should be regarded as basically a symbol of a much more profound and exciting development in government, that of clarifying national priorities in all aspects of environmental management..."

We may be moving in that direction. Boothroyd and Rees (1984) contend that "...the most important roles for EIA are increasingly seen to be in two directions relevant to public policy: first, in evening the odds - between proponents and impactees, between the larger society and the local community, and between society's immediate and long-term interests..." They suspect that activities now labelled as "EIA" may be "organically incorporated into both project design and community development planning." EIA as a discrete add-on activity, with only marginal impact on project implementation, "will disappear".

Turning to the procedural characteristics of EIA that relate to planning, there is a tendency to follow either an administrative process or an organic planning model.

Administrative Process Model

The administrative approach to environmental assessment has concentrated on ensuring that orderly, clearly defined steps are taken throughout the process. It may include a regulatory system in the legal sense and it usually involves a set of rules by which the need for an assessment can be determined and a set of guidelines about the type of assessment which is to be conducted. The fundamental assumption of an administrative EIA process is that following all the right steps, as outlined in the rules, will result in the most environmentally acceptable project possible. That assumption is clearly open to challenge. The case studies related to the development of pipelines in Canada have shown that the rules are often imperfect. Following the rules results in a design which meets the rules without solving, or even identifying, problems which a less codified approach might turn up. At the same time, an administrative approach tends to standardize the EIA process and the roles of the participants. The result is more order, less confusion. There may also be less flexibility and creativity in response to the unexpected.

Organic Planning Model

In adopting the "organic planning" or "integrated planning" model, sound environmental principles are built into the project design from the beginning and at each stage of the plan. Environmental assessment becomes so integral to the design that a separate process for project assessment is deemed unnecessary. This approach works if environmental skills and perspectives are always represented on the design and development team, e.g., by having an applied environmental scientist as part of the planning group, or by having ecological education included in the training of planners (an even more integrated form). This approach also has its weaknesses. The biases and knowledge limitations of the planning group will be reflected in the plan. If the group is strong on hydrography, but weak on soil chemistry, that weakness is likely to be shown in the final design. Although the Wreck Cove project is perhaps not an example of organic planning, the conclusion of the Wreck Cove case study (Ruggles, 1985) that the assessment of water quality did not make proper use of existing knowledge of water chemistry illustrates the point.

A fundamental problem with the organic approach is that when it is followed, the need for an external assessment may seem less apparent and support for environmental assessments is reduced. Since the assessments are not done, there is little incentive to review the projects later; there is nothing to follow up on. There may be a denial that an ex post facto evaluation has any purpose. The danger is that flaws in the planning process can go undetected, and evidence of their existence can be denied, for a long time.

Questions of Responsibility, Institutions and Procedure

Responsibility for environmental management in Canada is divided between and within governments and between the public and private sectors. Mandates and the ways in which they are discharged are well documented (Couch, 1982). Since the environment is not divided in ways that parallel the constitutional division of responsibility, we must ask what sorts of procedures and institutional arrangements will meet environmental needs while fitting into our governmental system.

The EARP process, though relevant only to federally sponsored or funded projects, is important because of the number and significance of such projects, particularly in the territories. Also, the Federal Environmental Assessment Review Office (FEARO) may collaborate with and influence environmental institutions and procedures in the provinces. There are also frequent interactions between Environment Canada, the National Energy Board, the Department of Fisheries and Oceans (DFO), and provincial and territorial organizations responsible for EIA. There are further complexities in the territories where the Department of Indian and Northern Affairs (DINA) and the line departments of territorial governments have very similar responsibilities.

The division and exercise of responsibility is a complicated matter. In the Coquihalla Valley corridor, for example, two federal departments, Environment and Fisheries and Oceans, and four provincial departments, Environment, Energy Mines and Petroleum Resources, Forests, and Transportation and Highways, have been involved in environmental assessments of two pipelines and a highway. Other case studies reflected similarly complex situations.

The duplication of effort needed to meet the requirements of several agencies is a cause for concern. In some cases, proponents were faced with more than one agency hearing on the same issue. Some inter-agency conflicts have been sorted out. There remains some confusion, however, about the role of environmental concerns and agencies in those projects, such as pipelines, which are regulated primarily on some basis other than environment.

A clear definition of responsibilities for all phases of EIA is needed to avoid unproductive institutional and interpersonal conflict and to minimize confusion, delay and error.

Given the jurisdictional complexity of the Canadian scene, and the need to draw upon skills and intellectual contributions from a range of different sources, special institutions must be established to design and manage procedures for undertaking EIAs and designing appropriate mitigation activities and monitoring processes. Panels or committee structures, often at two levels representing proponents, regulators, scientists, clients and affected publics, are the usual institutional response. An environmental coordinator may serve the committee or committees and help expedite the program. The Shakwak (Spencer, 1985) and the Banff Highway projects (Janes and Ross, 1985) provide examples of such structures. Referrals, consultations and meetings, resulting in advice and decisions, are the usual regulatory procedures and products. There is great variation in the minutiae of structure and procedure, most often the result of the interplay of personalities and permanent institutions involved, but the general pattern is fairly constant.

In addition to a committee structure established for the life of a project, joint industry/government/university working groups to resolve difficult technical or scientific issues may also be set up. This was the case, for example, for drilling mud disposal on the east coast (Everitt and Sonntag, 1985).

A finding of most of the case studies was that it is very important that there be continuity of membership in committees and responsibility for coordination.

Several case studies reported difficulty in determining coordinating arrangements, procedures followed, etc. through the course of projects because full records were not available. Reports are important as a record of what is done and learned; they should be submitted as scheduled. Relevant information about experience at other sites should be sought out and utilized.

Human and Organizational Relations in the Assessment Process

From the case studies of the Beaufort Sea exploration and Ontario pipeline projects, a common message emerged about the significance of human relations in the assessment process. Initial hearings were marked by a sense of suspicion, of confrontation among different organizational interests. Developers and regulators experienced mutual distrust. There were also conflicts among government organizations. In Ontario, they were often between federal and provincial agencies. In the territories, the conflicts were between federal agencies, a reflection perhaps of lesser vocal authority there. Over time, both the human and organizational relationships have smoothed out and jurisdictional confusion has been reduced.

An interesting finding from several of the case studies is that important changes occurred in the interactions of individuals representing different organizational interests. Representatives at first assumed that their primary responsibility was to defend the interests of their own organization in the face of aggressive efforts by others. Over time, those attitudes modified. Several years of contact between industry and government officials at the working level led to the establishment of greater understanding. The interaction not only put "a human face" on the representatives of other organizations; it also helped create an understanding of the technical assumptions, limits, and credibility of the various parties. As a result, members of long-standing working groups, or persons who have come together a number of times to discuss different issues have established an easier rapport than was the case when they first met.

Concern has been expressed over the implications of this socialization process for organizational interests. Does the rapport develop at the expense of dangerously compromising the interests each person is there to represent? To what extent is compromise in the interest of resolving issues beneficial or harmful to society and to the participating organizations? How do new interests, arising as a result of social, economic, political, or scientific changes, enter the circle? Those are some of the questions provoked by the findings and they are worthy of considerably more attention and research.

The case study by Dorcey and Martin (1985) deals with ways to handle difficult situations by developing a bargaining technique for planning and development. Bargaining is held out as both a useful means of understanding the myriad adjustments which occur in project design, and as a more positive model through which the adjustments can be made more smoothly.

The case studies also report that if public involvement is arranged at an early stage of a project, it has a twofold benefit. Firstly, it ensures that the information and opinion contributed by the public can be usefully incorporated in the decisions; secondly, the earlier information is given to the public and the earlier the public has a chance to react, the greater the possibility that friction and confrontation can be minimized and time saved. The question of how the public can contribute is also important. It was generally noted that if information is presented to the public in a very technical manner, the ability to understand, comment and contribute to the decision process is limited. In spite of these difficulties, there is evidence "that following a logical comprehensive and open procedure" in which the public can participate, will produce more "satisfactory results" overall (Moncrieff et al, 1985).

Questions of Efficiency and Effectiveness

It is clear that there has been little systematic analysis of the effectiveness of environmental assessment in the overall management of resource development projects. In some instances, that has been a result of the short time since the assessment. In others, it has been caused by a lack of institutional continuity to support a sustained monitoring and evaluation process. In addition, there is a widespread presumption on the part of development agencies that their responsibility has been met by undertaking the assessment of any mitigative measures subsequently required.

The best test of the effectiveness of EIAs would undoubtedly be provided by monitoring in accordance with a plan designed to establish the relationship between what is predicted and what actually occurs. The realization that that seemingly simple process is fraught with difficulties has led to the notion of tracing the history of environmental issues (Everitt and Sonntag, 1985). This is more than a surrogate for a rigorous prediction and scientific re-assessment; indeed, if the conditions of most projects were such that a scientific re-assessment was feasible and effective, it would still be desirable to track the issues since that process is more useful than any other in evaluating the effectiveness of institutions and procedures.

Perhaps the most fundamental conclusion derived from tracking the issues associated with selected frontier oil and gas projects is that environmental assessment is an ongoing process, within which issues are continually being raised and resolved, perhaps later to re-emerge as a consequence of new information, heightened awareness or unexpected events (Everitt and Sonntag, 1985).

Related to the idea of tracking issues is the concept of issue management. There is a practically infinite number of situations which could turn into "issues" needing attention on most large development projects. Insofar as environmental implications are concerned, what leads some to become politicized while most never reach that stage? Can environmental assessment be used to minimize controversy while maximizing environmental protection and the sustainability of resource use? Some of the case studies have touched on this subject, but it does not seem to have been the focus of any of them.

Issue management is a concept which, although derived from EIA, goes beyond it in using the opportunities presented by assessment to minimize both adverse environmental effects and unproductive controversy. The aspect of issue management that has received most attention in the case studies is the use of issue containment strategies; for example, by seeking to put the best possible environmental solutions into proposals, by conducting research, monitoring, and community information programs in advance to ensure that the potential issue was always seen to be an immediate concern of the proponent, and by quick response to issues raised by communities or regulatory agencies.

Conclusions

The general sense of the case studies is that the process of EIA has lessened the impacts of development and reduced the controversy aroused by environmental issues. But there is also much dissatisfaction about the management of EIAs and a belief that the process can be greatly improved. Particular improvements would flow from:

- a closer integration of environmental impact assessment with development planning;
- clear definition and continuity throughout a project of responsibility, and elimination or reduction or overlapping responsibilities;
- simplification of administrative procedures; and
- placing greater emphasis on the development of skills in dealing with interpersonal and group relationships.

Policy Implications

Concerns about EIA and the role in environmental management arise from limitations in knowledge and, probably of more importance, in organization. These concerns must be met before impact assessment can achieve its potential as a strong tool of modern environmental management. It is at the level of policy these issues can be addressed most effectively, by providing the framework for necessary change and improvement. Some policy recommendations follow:

Promote Environmental Science

A major rationale for the case studies in this volume is concern about the scientific quality of the hypotheses and data upon which environmental assessments are based. While the ultimate bases for policy-making are the ideological positions of society or of groups within it and the assumptions and implications that flow from them, policymakers use scientific knowledge to make their decisions practicable, efficient and credible. If assessments are to be used in the policy-making process, their quality needs to be understood. What levels of confidence should be attributed to their predictions?

The predictive capacity of environmental science will improve only with practice and with adequate provision for information feedback. While EIAs, monitoring and EIA audits are undertaken for operational purposes, they can contribute greatly to the progress of science if they are utilized as a vehicle for relevant research. Every opportunity should be taken to do so.

But seizing such opportunities for research is not enough if environmental science is to serve economic development and human health and welfare satisfactorily. Governments particularly, but universities and industry as well, should recognize that environmental research must be maintained and expanded in accordance with a carefully designed set of priorities. **Research policies should be adopted which reflect the fact that many ecological processes unfold over decades and that the impact of some environmental perturbations may only be revealed at a similar pace.**

Integrate Environmental Assessment With Development Planning

Environmental concerns should be on the same footing in long-range planning as other aspects of development, such as social impacts, economic effects, market requirements, financing and construction technology. All such factors need to be taken into account in the decision-making process. To ensure that this occurs, environmental requirements should be embodied in social goals and reflected in development plans (Munro and Matte-Baker, 1984).

There are three levels at which environmental impacts may be felt and they should be assessed.

One level is sectoral or regional, e.g., agriculture, forestry or a watershed. Sectoral activities are not often subject to EIA and land use plans that have been prepared are not always the main basis for management. Nevertheless, the preparation of regional and sectoral plans in which environmental considerations are taken into account can provide a comprehensive context within which specific projects may be more meaningfully and easily assessed.

The second level is the project, on which EIAs seem to have been focussed almost exclusively. Where sectoral or regional plans are the basis for management, the preparation of a project EIA should be a much simpler task than elsewhere and decisions on projects should be less subject to controversy.

The third level is that of the numerous, dispersed, discrete actions that have an impact on the environment. These actions individually have small impacts, but the sum of their impacts may be large and significant. To the extent that these actions are regulated, it is by product standards, guidelines for use, etc. An overall assessment would be difficult and comprehensive control virtually impossible. The problem with that strategy of management is that it takes no account of the cumulative effect of many actions. There may be a need to work out an assessment procedure that will yield a better measurement of the impact of such interventions.

Canadian jurisdictions should consider putting into place a comprehensive environmental assessment process closely integrated with whatever process is used to guide and plan development and taking account of activities at all levels.

Provide a Better Information Base

Information is the basis for enlightened decisions; but the information about the environment upon which development plans and decisions should be based is widely dispersed and often inaccessible. Steps should be taken to ensure that all information relevant to environmental management is made more accessible through a central catalogue and referral system.

Particular attention should be given perhaps by the Canadian Environmental Assessment Research Council (CEARC), to ensuring the publication of valuable reports and to the best means of establishing a clearinghouse for information on EIA.

The literature and the case studies reveal concern that EIAs are started too late and ended too early. They yield little, if anything of the time-series information needed to establish patterns of variability in environmental parameters. Timely gathering of information - pre-project, operational and effects monitoring - is required as the basis for design, mitigation, audit and evaluation of projects.

Canadian jurisdictions should formulate and implement policies to ensure that environmental assessment and monitoring take place over periods sufficient to ensure that environmental parameters are properly defined and impacts effectively measured.

Present Information Effectively

Some EIA reports are overly bulky and almost impenetrable because of a tendency to measure and report on everything until time or money runs out. This is usually because no consensus has been reached on the critical issued to be examined. The resulting documentation is rarely read and hardly ever digested by decision-makers at any level.

A second reason for unwieldy assessment documents is poor writing, exacerbated by vague or non-existent guidelines on the formats for presentation of assessments to various audiences.

Proponents and review agencies should adopt policies and promulgate guidelines that will result in the presentation of succinct and readable EIAs.

Simplify Responsibilities, Improve Administrative Procedures

The diffusion of responsibility for environmental management between and within governments is certainly the cause of much of the complexity which frustrates proponents, consultants and the public. While some institutional fragmentation must continue, it may be possible to reduce the present burden, at least that which arises within governments if not between them.

One possibility would be to develop a different type of regulatory agency, one designed to serve more as an expediter or clearinghouse for development issues, including environmental aspects. Such a super-agency could usefully be an integral part of whatever organ of government is most concerned with economic planning and development.

An analysis of the options for simplifying responsibilities for environmental assessment within the Canadian system, should be undertaken by CEARC, and later considered by the Canadian Council of Resource and Environment Ministers (CCREM).

Improve Relationships

Canadian experience suggests that participants in EIA readily recognize the roles of different organizations, groups and experts in the assessment process and seek to minimize, not always successfully, the rigidities of regulatory processes. There seems to be an eagerness to improve. Consideration should be given to instituting a more routine, less elaborate and costly type of consultation, at each stage of assessment, with exchange of information and views between technicians and the public.

Practical techniques for solving problems and reaching agreement should be the subject of courses for training persons involved in EIA and should be promoted by governments and organizations having responsibilities in this area.

Audit and Evaluate More Projects

The results of audits and evaluations can be useful in improving EIAs and environmental management as a whole. So far, too little has been done. In future, audits should be undertaken as a regular aspect of the long-term management of all development projects. This would be made easier if guidelines for EIAs included directions to conduct them so that they could readily be audited later.

It is also desirable to begin a more concerted approach to auditing or evaluating projects already completed and ensuring feedback of the resulting information to regulatory agencies as an input to improving regulations, and to proponents for the improvement of project design and execution.

Consideration should be given to adoption of responsibility for fostering and facilitating audits by existing governmental institutions. This need not be a costly or demanding undertaking. FEARO is obviously a possible centre for such a function in the federal government. Another alternative is the office of the Auditor General, so that environmental auditing would be undertaken as an integral element of the audit of development projects and programs. Possibilities for assuming the same responsibility in each province should also be investigated. Another possibility is that governments might jointly mandate the Canadian Council of Resource and Environment Ministers to take on the task. Whatever mechanism were adopted it could be looked upon as experimental and subject to review after, say, five years.

Our society relies upon efficient use of financial and human resources as a vital test of economic activity. Audit and evaluation with reference to predetermined plans and budgets have proven to be essential in ensuring the efficiency of both private and public enterprises. Our environmental resources, upon which our survival totally depends, must also be used with care and wisdom. Environmental impact assessment has been accepted as a necessary element of developmental planning. **Audit and evaluation of environmental impact and the use of environmental resources must become as much a matter of routine as the comparable processes are in business.**

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FOLLOW-UP TO ENVIRONMENTAL ASSESSMENT FOR PIPELINE PROJECTS IN CANADA: THE MISSING LINK

R.D. Jakimchuk

Introduction

This paper summarizes the findings of a two-part study.[1] Part one addressed the evolution of environmental issues raised before environmental assessment and review of three northern pipeline projects, and analyzed changes in mitigative measures over time (Jakimchuk et al, 1985). It also analyzed and evaluated the implementation of mitigative measures recommended for the Norman Wells oil pipeline.

The second part of the study, funded separately by the Federal Environmental Assessment Review Office (FEARO), involved a comparative analysis of the Alaska experience with the Trans-Alaska Pipeline System (TAPS).[2] The overall objectives of the two-phase study were to identify how the EIA follow-up process might be improved and to recommend a suitable mechanism to achieve that goal.

Mitigation and Monitoring Programs for the Norman Wells Pipeline Project

The Norman Wells pipeline was the first northern Canadian pipeline project to continue beyond the federal Environmental Assessment and Review Process (EARP) to the construction and operation stage. The 324 mm pipeline was part of a proposal by Esso Resources Canada Ltd. (Esso) and Interprovincial Pipe Lines Ltd. (IPL) to expand the Normal Wells oil field and to transport oil 866 km from Norman Wells to Alberta. The proposal was reviewed by the Norman Wells Environmental Assessment Panel (1981) over a twelve-month period from February 1980 to January 1981 when the final report was released. Construction of the pipeline, buried along its entire route, began in 1984, and the first oil moved through it in March 1985.

In its final report, the Norman Wells EA Panel made a number of recommendations for mitigative and monitoring measures. In our earlier study, a total of 31 recommended measures dealing with vegetation, aquatic resource and wildlife issues was identified. We found that most of the Panel's recommendations on mitigation and monitoring programs had been implemented. The issues that the Panel identified as important were addressed by the existing regulatory and permitting process, through a variety of mechanisms. The most important of these were the numerous permits and approvals controlled by the federal and territorial agencies responsible for the project.

The National Energy Board (NEB) and the Department of Indian Affairs and Northern Development (DIAND) were the most powerful agencies in the post-approval stages. The NEB's Certificate of Public Convenience and Necessity included many terms and conditions that covered issues related to the Panel's concerns, and specified mitigative measures and monitoring programs that IPL would be required to implement in order to comply with the terms and conditions.

DIAND had two main regulatory mechanisms: the numerous permits, approvals and licences it controlled; and a separate Environmental Agreement with IPL. The Environmental Agreement set out responsibilities for undertaking environmental studies, monitoring and mitigative programs, contingency planning and other activities. In addition, land leases, water lot leases, easements, quarry permits, land-use permits, water licences and water authorizations were also administered by DIAND. These provided additional means to deal with issues that concerned the EA Panel.

Other agencies, including the federal Canada Oil and Gas Lands Administration (COGLA), the Department of Fisheries and Oceans (DFO), the Department of Transport, and the territorial Department of Renewable Resources, had minor regulatory roles. The federal Department of Environment's role has been almost entirely advisory (Dembicki, 1983). To improve project management, DIAND established the Project Review and Coordination Committee to receive input from federal and territorial agencies, industry, and private groups and individuals. The territorial government also established a project coordinator position for the Norman Wells project.

IPL has implemented monitoring programs to meet the requirements of its permits, licences and agreements. Other, non-regulatory, monitoring programs have been implemented primarily by federal and territorial agencies. These long-term monitoring programs address scientific issues regarding impact concerns such as those identified by the EA Panel and are being coordinated by the Norman Wells Research and Monitoring Working Group. This group comprises representatives of DIAND, DFO, DOE, Energy, Mines and Resources, NEB, the Government of the Northwest Territories, Esso, IPL, and the Dene Nation.

In our earlier study we concluded that, to date, the environmental protection and mitigation program for the Norman Wells pipeline project appears to have been successful, and has covered the EA Panel's most important concerns. Some of the main reasons for this success are:

1) the requirement by regulatory bodies for specific mitigative plans and actions from the proponent;
2) the opportunity for interested agencies to provide advice and recommendations to regulatory bodies, which have been receptive to those recommendations;
3) the flexibility within the regulatory process to change and adapt the regulatory requirements during construction as conditions dictated;
4) the opportunity for non-permitting agencies to deal directly with the proponent during preparation and implementation of plans;
5) the formation of the Norman Wells Research and Monitoring Working Group involving federal and territorial government agencies, industry, and native groups;
6) the two-year delay of construction, which allowed time to do more detailed mitigative planning and pre-construction monitoring; and
7) good project coordination and willingness of individuals involved at all levels of the project to cooperate.

However, our analysis also concluded that the Norman Wells model is not necessarily a reliable means of ensuring that follow-up of an EA Panel's recommendations occurs.

1) Although many of the Norman Wells mitigation and monitoring programs undertaken coincided with the Panel's recommendations, there was no clear "cause-and-effect" linkage between those programs recommended and those actually implemented.
2) While the Norman Wells structure addressed the Panel's concerns and recommendations, it did not provide a mechanism for dealing with broader regional environmental issues. The Norman Wells project involved a relatively small pipeline with relatively few serious technical or environmental concerns. The structure employed would not be well suited to dealing with broader problems such as cumulative effects or regional impacts.

3) The Norman Wells project was subjected to numerous, often overlapping, administrative and regulatory requirements. Although this complex structure contributed to the implementation of a wide variety of environmental measures, it does not necessarily follow that the process was efficient or satisfactory to all parties.

Despite these limitations, the basic conclusion of our review of the Norman Wells pipeline project was that most of the EA Panel's concerns and recommendations were satisfied, although there was no formal process for their implementation.

The Trans-Alaska Pipeline System

The Trans-Alaska Pipeline System (TAPS) was built between 1974 and 1977 by Alyeska Pipeline Service Company, a consortium of eight oil companies. The TAPS proposal encountered some major opposition and delays before approval was received and construction began. The pipeline proposal arose in 1969, just months before the U.S. National Environmental Policy Act (NEPA) became law and was one of the first projects to be reviewed under the provisions of NEPA.

Even after the U.S. Department of the Interior had prepared a detailed and voluminous EIS, the pipeline proposal remained held up in the courts. Approval to proceed with construction was not granted until November 1973, when the U.S. Congress passed the Trans-Alaska Pipeline Authorization Act which declared the EIS to be adequate and allowed the pipeline to proceed (Morehouse, Childers and Leask, 1978).

Although an EIS was prepared for the pipeline proposal, its effect on terms and conditions for pipeline construction and operation was minor. This was because the terms and conditions had largely been decided by the time the EIS was completed. However, an EIS did serve to point out information gaps and uncertainties associated with the pipeline's design and impacts (Morehouse, Childers and Leask, 1978). These gaps led to the development of terms and conditions for environmental protection that were relatively broad and open to interpretation.

Terms and conditions were implemented in the form of "environmental stipulations" attached to the federal agreement and right-of-way grant and the state right-of-way lease. Although the environmental stipulations were required under the authorizing Congressional legislation, that legislation established that construction of the pipeline was the first priority (Morehouse, Childers and Leask, 1978).

Design and construction of TAPS occurred under the scrutiny of a number of state and federal government agencies: the federal Bureau of Land Management, Fish and Wildlife Service, National Marine Fisheries Service, the United States Geological Service and the Alaska Department of Fish and Game. Early in the development it became apparent that a coordinated approach to regulation and surveillance was needed.

The approach chosen by both the federal and state governments was to create a pipeline coordinators office to oversee construction activities on federal and state lands respectively. The federal Alaska Pipeline Office (APO) was established under the terms of the federal agreement and grant of right-of-way for the pipeline. The head of the APO, the "authorized officer", had the authority, which was exercised through his field representatives, to halt construction along the pipeline if he felt that the terms of the environmental stipulations were not being followed. In addition, he had authority to vary the terms of the environmental stipulations if changes were justified. The State Pipeline Coordinator had powers similar to those exercised on federal lands by the authorized officer, and those powers could also be used by state "field surveillance officers".

Although there were separate surveillance entities at the federal and state levels, two factors tended to create consistency of environmental protection measures over the pipeline as a whole. First, the federal and state stipulations for environmental protection during construction "were nearly identical" (Morehouse, Childers and Leask, 1978). This meant that the basic regulatory framework for environmental protection was the same for federal and state lands. Second was the formation of a joint state/federal Fisheries and Wildlife Advisory Team (JFWAT) which provided technical advice to the authorized officers and conducted its own field inspections of Alaska's compliance with stipulations during construction. Although JFWAT had no authority to regulate construction activity, it had direct links to the state and federal authorized officers and their field representatives via JFWAT's own field monitors.

Significant features of the Alaska approach were:

1) Environmental protection measures were implemented by incorporating "environmental stipulations" into the agreements between Alyeska and the two levels of government. The EIS prepared for the TAPS did not contribute directly to the establishment of the terms and conditions of the stipulations.

2) Because of information deficiencies and lack of knowledge about project impacts, the terms of the stipulations were left relatively broad and open.
3) Special offices were created at both the federal and state levels to oversee construction by Alyeska on federal and state lands respectively.
4) JFWAT, a joint federal/state advisory board, was limited to an advisory role in construction surveillance. JFWAT acted through the APO and SPCO, but was independent of those officers.

The following sections analyze and compare the Alaskan experience with TAPS and the Canadian approach taken with the Norman Wells pipeline.

Comparison of Approaches - Alaska and Canada

Despite the physical differences between the pipeline projects (the small diameter buried Norman Wells pipeline versus the large diameter buried and elevated TAPS pipeline), they instigated common environmental concerns for aquatic and terrestrial ecosystems: siltation, erosion, slope stability, effects on wildlife, fisheries and their habitat. The physical environment also varied considerably, but the presence and implications of permafrost focussed attention on questions of pipeline integrity and terrain sensitivity in both cases.

Structures for surveillance, regulation and monitoring show many parallels and similarities between the two projects. This, in part, reflects the numerous, often overlapping, jurisdictions with responsibilities for land management. Both projects were characterized by parallel regulatory bodies for state and federal or territorial/federal jurisdictions. In addition, both projects had to accommodate input from agencies with environmental mandates but which were not normally involved in surveillance of industrial developments.

Assessment Versus Implementation: Problem of the Ad Hoc Approach

Although coordinating mechanisms were developed in both cases, the major differences in approach were functional - in Alaska, the assessment mechanisms were vested in specific legislation (NEPA) and were highly structured to reflect their legislative origin and judicial interpretation. Confrontation characterized many aspects of the process and the courts were the arbiters of those confrontations. In Canada, the environmental assessment was conducted within the EAR process which leads to recommendations reported to appropriate government ministries. There are many important differences in the approaches to assessment as exemplified by the public hearing/advisory versus legal/statutory process; however, for the purpose of this paper, the most significant was that there was no formal link between the environmental assessment and the implementation of monitoring and mitigation programs in either case. In Alaska, the development of environmental stipulations for the pipeline was essentially complete by the time the EIS was written (Morehouse, Childers and Leask, 1978). As a result, monitoring and mitigation plans developed in an independent and often ad hoc way, which led to the formation of the state and federal pipeline offices and JFWAT which acted in an advisory role to both offices on fish and wildlife matters.

In Canada, a similar lack of linkage existed between the Norman Wells EA and the implementation of its recommendations (Jakimchuk et al, 1985). However, in both cases, this lack of formal linkage was covered by other regulatory agencies with authority to ensure compliance with mitigation and monitoring stipulations. Although, in both countries, federal regulatory activity emphasized matters of construction and pipeline integrity as its first priority, compliance with environmental stipulations involved other agencies. In Alaska JFWAT monitored for compliance on an advisory basis. In Canada DIAND established an environmental agreement with IPL as the major vehicle for defining its requirements.

It is safe to say, however, that in the two case histories examined, environmental issues were not neglected because of the lack of a formal linkage between assessment and execution. On the contrary, northern pipelines have characteristically been the focus of considerable public environmental interest, debate and controversy, and this interest has been reflected in the attention given to them in the regulatory and public sectors.

Issue Resolution: Problems of Continuity

Once the TAPS project was completed, the major offices associated with construction including JFWAT were disbanded, leaving routine monitoring first to an office of special projects within the Bureau of Land Management, and recently, to the Branch of Pipeline Monitoring (BPM) within BLM. A scaled down State Pipeline Coordinator's Office has also continued operation. Field inspections are conducted by one field engineer and one field biologist who monitor the right-of-way to ensure compliance with original stipulations. Existing regulatory agencies in Canada perform a similar role.

Existing monitoring agencies in Alaska will remain functional over the life of the pipeline. It is unknown how the structure of the Norman Wells working group will change once certain programs of post-construction monitoring and research are terminated. Some of these programs are scheduled for completion as early as 1987.

Long term monitoring research, i.e., research to establish actual versus predicted effects and to test effectiveness of mitigative measures as opposed to routine "compliance" monitoring has been the most neglected aspect of the environmental process. In both Canada and Alaska it has not been formalized as part of the evaluation process and has been solely dependent on the initiatives of individual researchers and agencies with particular interests. For example, despite the numerous major wildlife concerns and conflicts in Alaska prior to the construction of TAPS, the only long term post-construction studies have involved caribou on the North Slope of Alaska, and a short term unpublished study of moose crossing success along the pipeline. In its 1981 report, the General Account Office of the U.S. Congress recommended a number of studies to determine the long term effects of the pipeline on the environment (Office of Special Projects, 1981). However, no such studies have been implemented to date.

In 1981, seven years after construction was completed, Alyeska Pipeline Service Company commissioned a series of post-construction monitoring studies on fisheries and wildlife. Those studies were designed to investigate actual impacts and effectiveness of mitigative measures as expressed by the status of wildlife and fisheries resources during the operational phase of the pipeline.

These studies represent the follow-up assessment of impacts and mitigation measures which are often discussed, but rarely followed up, with adequate scope and study design. In the absence of such "field testing" studies there can be no basis for either improving mitigation or eliminating standards that are unnecessary to attain environmental objectives.

One example of the foregoing point involves the major mitigation program of special big game passage structures incorporated into TAPS to facilitate crossing of the pipeline by moose and caribou. This $100 million program was implemented at a time when there were virtually no data available on the response of ungulates to an elevated large-diameter pipeline. However, subsequent post-construction studies showed that such special crossing structures were not necessary to ensure movements of ungulates across the pipeline corridor (Carruthers, Jakimchuk and Linkswiler, 1984). Such information would not have been available for future projects if appropriate studies, in this case sponsored by the Pipeline Company, were not carried out. However, the most significant point arising from the foregoing discussion is that in neither Canada nor Alaska is there a structure to ensure that such new knowledge is applied to future projects. This has, in the past, led to difficulties in resolving technical disputes and environmental issues during the review process. Moreover, it has hampered the transfer of new information between projects.

The Norman Wells project was successful in coordinating environmental protection, mitigation and monitoring despite the lack of a formal relationship between the assessment and implementation. In both Alaska and Canada this lack of continuity did not compromise environmental protection for the specific pipeline projects, in part because of their high public profile. There is no assurance, however, that this is an adequate approach for different types of development on a routine basis.

Accountability

Lack of accountability is a problem which arises from the lack of linkage between assessment and implementation. In the existing approach in Canada, the assessment panel is disbanded following submission of its report and other agencies gear up for project implementation. During this period, different priorities can be established for environmental protection by various departments. There is no requirement that such changes be consistent with the assessment, its recommendations or priorities.

The lack of an audit review has other implications - it reduces the significance of undertakings made during the panel review by proponents since there is no accounting as to whether those undertakings were fulfilled. The lack of feedback may also reduce the pressure on the initiating department to adhere to panel recommendations and to enforce undertakings made by the proponent. In time, this lack of accountability may foster an attitude that statements and commitments made before a panel need not be adhered to.

Another aspect of accountability is the record keeping function pertaining to monitoring actions, compliance reporting and problem resolution. In this regard, the Alaska approach was systematic and resulted in good record keeping by way of logs kept of all field actions involving environmental matters. However, decision making and implementation of field changes were slow because of the formal chain of command required to authorize change. This resulted in complaints of inflexibility from the proponent.

In summary, the fact that the existing assessment process is not linked to implementation creates problems of continuity and accountability.

1) It leaves the process open to ad hoc environmental protection measures which may be unevenly applied or incomplete.
2) There is no mechanism for objective evaluation leading to improved future standards.
3) It stifles improvement of the environmental assessment and planning processes.

Needs for Environmental Follow-up: A Mechanism for Audit

The post-assessment process should include the following components:

1. Audit of implementation of the panel's recommended programs for environmental protection and mitigation. This objective review is necessary to ensure that the review process is adequately reflected in the execution of developments.
2. A periodic and systematic review and update of criteria for mitigation and development of environmental standards.

We propose that these functions would best be met by expanding the role of EARP to include a post-development environmental audit.

Moreover, in an expanded role, FEARO could provide the sponsorship of a multi-disciplinary technical review workshop which would be designed as a peer-review forum for developing monitoring research programs. The role of the workshops would be to ensure adequacy in research design and intensity to:

a) assess effectiveness of mitigation;
b) determine accuracy of impact predictions;
c) develop new environmental standards and delete redundant or unnecessary measures.

The foregoing would achieve the larger goal of EIA, i.e., progressive improvement and change towards better environmental management within a dynamic system of evaluation and adjustment.

It is further proposed that the audit panel function as follows:

1. The audit panel for a given project should be, to the extent feasible, a re-convening of the initial assessment panel. This would maintain continuity and the historical background of the project and carry it into the audit function. A panel need not be active between the assessment and audit even if several years intervene, since its function would be evaluation rather than regulation.
2. The panel should have the option of conducting its audit by various means including public input where it is deemed to be necessary or desirable.
3. The audit panel should prepare a report to the appropriate ministers in a fashion similar to the assessment process.

Such an approach would achieve the following:

1. It would provide the all important linkage between environmental assessment and implementation.
2. It would introduce accountability into the system without requiring a new regulatory bureaucracy.
3. It would maintain the valuable mix of panel participants within the process - which includes non-governmental and lay representation.
4. It encourages a detached and independent audit process.
5. It could serve as a vehicle to establish suitable mechanisms for the other post-assessment functions discussed previously - notably systematic technical workshops on environmental standards and monitoring research design.
6. It would facilitate dealing with regional issues such as cumulative impacts for future projects, as audit reports would become part of the project documentation. Emphasis on successive FEARO panels would be on new issues, regional concerns and cumulative impacts - a role not readily filled by the regulatory agencies.
7. An audit report would serve an additional valuable function. It would inform the minister of the day of the performance of prior projects so that, where appropriate, policy or regulatory changes can be developed.

The main alternatives exist to join the feedback loop between assessment and implementation:

a) institutionalize the EARP process under special legislation with the requirement enforcement and regulatory powers;

b) expand EARP to include a post-development audit function and to initiate new roles for developing environmental standards.

A detailed discussion of (a) is beyond the scope of this paper. However, the apparent disadvantage of that approach is the inherent duplication of environmental regulation which is already performed by existing government agencies. Such legislation would also alter the "independent advisory" character of EARP panels which currently exists. Moreover, as discussed elsewhere, a NEPA-type system which was adopted in the United States can lead to a rigid legalistic and adversarial approach which can be counterproductive in achieving environmental planning goals. As a result, we view alternative (b) as a practical and effective means of joining assessment and implementation.

The lack of enforcement capability of the above mechanism is not a major problem since the audit panel's reports and recommendations would follow a process similar to that of assessment; i.e., recommendations to the minister which, if accepted, would be administered within the existing framework of environmental legislation and regulations. Public involvement would also add weight to the audit findings.

This expanded role for the federal assessment office would maintain the beneficial aspects of the present operations and address some of the deficiencies which exist in the process. The ancillary activities involving technical workshops would relieve the panel from its past role in trying to reconcile technical disputes in public meetings.

Adoption of such a role would not only join the missing link in the assessment process - it would provide a mechanism for change which is presently unavailable in Canada and which is vital to progress in the environmental management and protection process.

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1. I wish to thank Dr. Pat Duffy of FEARO in Ottawa for his support and advice on the studies undertaken as background to this paper. Dr. Brian Watson of EPS also reviewed our analysis of issues pertaining to northern pipelines. The studies on which this paper is based were funded by the Environmental Protection Service and FEARO, Ottawa. John Olynyk and Craig Schick provided a helpful review of this paper and participated in the background studies.

2. The analysis of the Alaska experience with the Trans-Alaska Pipeline System (TAPS) is based on interviews with government and industry personnel in Alaska as well as the experience of Renewable Resources Consulting Services Ltd. with post-construction monitoring along the pipeline.

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ENVIRONMENTAL ISSUE RESOLUTION IN CANADIAN FRONTIER OIL AND GAS EXPLORATION

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Introduction

This study compares the environmental assessments of the exploratory phase of offshore drilling activities in the Beaufort Sea and along the Atlantic Coast. It is concerned primarily with environmental issues, but considers directly related social issues. By following issues from creation to resolution or non-resolution, the responses of the various institutions (industry, government, and interest groups) are revealed. A number of interesting questions are raised because of the differing regulatory procedures operating in the two regions.

The recommendations for improvements in current EIA practice, whether technical or administrative, must be designed to help resolve public, scientific, or political issues. This paper examines the issues and draws conclusions on how issues were resolved successfully in the past. These conclusions provide the basis for recommendations for improvement.

Objectives and Approach

This paper has two major goals. The first is to assess the effectiveness of environmental regulatory procedures for identifying, prioritizing, and resolving issues. The second is to make recommendations for improvements in environmental regulatory procedures, if warranted.

The extent to which assessment procedures are successful at raising, prioritizing, and resolving issues is a measure of their effectiveness. Effectiveness relates to the number and significance of issues addressed. An environmental assessment is effective if it is able to address all issues raised in a fair and systematic fashion. Effectiveness implies that significant issues will be given considerable attention, while insignificant issues will be given little or no attention. An effective environmental assessment must have mechanisms for focussing on key issues rather than having to consider everything. It must also have procedures for directing time and resources to address these key issues. Defining effectiveness in terms of the ability of EIA processes to deal with problems, directs attention to the evolution of issues, from emergence to resolution. This perspective guided the general approach to our study. Selected frontier oil and gas projects were reviewed to identify major issues and the treatment they were given. This review was conducted in conjunction with industry and government scientists and environmental managers to obtain an integrated perspective on institutional arrangements for the environmental regulation of frontier oil and gas developments. Based on this review and the subsequent analysis, a set of conclusions and recommendations was developed.

Methods

The approach pattern was structured around four intensive workshops and intervening periods of data gathering, empirical research, and analysis.

Workshops

Because of the importance of frank discussions with those who had firsthand involvement with the issues, the study relied heavily on workshops. Detailed summaries of these workshops are provided in Everitt and Sonntag (1985). Workshops were held in Calgary and Halifax to define issues for the Beaufort and East Coast respectively. Issues were chosen partly because of their importance and partly because they illustrate the different approaches that have been taken towards the resolution of environmental issues. Once a specific set of issues was agreed upon, the workshops developed a preliminary chronology of events that could be ascribed to each issue. These chronologies became the main source of data for analysis. Once the chronologies were refined through interviews and literature review, workshops were held in Vancouver and Halifax to review the chronology of the issues and to discern how each issue was resolved. These workshops developed lessons for each of the issues and some preliminary conclusions and recommendations.

Analysis of Issues

Because a number of issues were analyzed for each of the Beaufort and East Coast regions, a consistent format for recording information was adopted. Each of the issues selected for detailed analysis is summarized in Everitt and Sonntag (1985; Appendices I and II) in the following format:

1. Statement of the Issue
2. Key Contacts/Actors

3. Chronology
4. Resolution
5. Lessons

Chronology

The chronologies included information on studies conducted, documents produced, workshops and meetings held, the effectiveness of the techniques used to resolve the issue, and the event that triggered the issue. They became the major source of information upon which the conclusions were drawn. The chronologies were used to form the answers to the following questions:

1. What is the basis and origin of the issue?
2. What was the response of the government and proponents during the assessment?
3. What impacts were predicted in the EIS? What mitigations were proposed?
4. What environmental terms and conditions were imposed as a result of the regulatory review?
5. What specific monitoring programs were designed to test predictions or to determine effects?
6. What follow-up studies were conducted to audit the impact predictions or to determine the actual effects?
7. Did the follow-up studies provide a definitive answer as to the adequacy of the impact prediction?

In most cases, it was not possible to answer all questions for all issues because of the lack of monitoring programs or follow-up studies.

Resolution Defined

During the discussions in the workshops and throughout the analysis it became necessary to carefully define what was meant by the term "resolution"; in other words, in the context of this study, what would have had to happen before it would be possible to state that an issue had been resolved. Arriving at an appropriate definition was not easy. After some discussion, the following restricted definition was established:

> An issue is said to be resolved if the regulatory agencies do not consider the issue an impediment to development, and if

the regulatory agencies do not require any additional action to be taken over and above existing commitments.

This definition requires some qualification, because environmental issues are imbedded in a larger political and social context. Scientific and technical issues that appear to be resolved in a regulatory context may remain unresolved in the view of the general public or those who might be most affected. Environmental issues are not resolved in the dictionary sense of the word but instead, for various reasons, are placed in a "quasi-equilibrium" state which could be destabilized through a number of unpredictable events (e.g., new knowledge, changes in the institutional environment, catastrophic events, etc.).

Resolution of Issues

The Issues

At the first Beaufort Issues workshop, the participants developed a cross impact matrix summarizing the key interactions between oil and gas activities and the valued ecosystem components (as defined in Beanlands and Duinker, 1983) that are (or were) of concern to government, industry, and/or the public (Table 1). The discussion focussed on each box in the matrix and identified, according to the indicated typology, whether the interaction was:

1) an issue, and if so, was it of a high or low profile; and
2) still an issue, and if so, is it of a high or low profile.

If the interaction was an issue, then two more questions were asked:

1) was the source of the issue political, scientific/technical, regulatory and/or social; and
2) was the issue the result of any particular triggering event(s).

The study developed detailed chronologies for the following Beaufort issues: oil spills, drilling mud disposal, flight corridors, vessel traffic, dredging, and shorebase development (Everitt and Sonntag, 1985; Appendix I). The first East Coast workshop also developed a cross impact matrix (Table 2). The East Coast matrix was devised using a slightly more refined typology in that the priority was classified as high, medium, and low. Because of the geographic location, the international category was added to the classification of the type of issue. The study developed detailed chronologies for the following East Coast issues: oil spills,

TABLE 1 BEAUFORT ISSUES MATRIX

	White Whales	Bowhead Whales	Migratory Birds	Seals	Polar Bears	Fish	Benthos	Ecosystem Level	Triggering Event
Seismic	L 4		L			H→L 2,3			
Oil Spills	H→H 1	H→H 1,4	H→H 1,4	H→L 1,4	H→H 1,4	H→H (in-shore)→ L (off-shore) 1,4	H→L 1,4	H→H 1,4	Torrey Canyon Spill
Drilling Mud Disposal						H→L 2,3	H→L 2,3		
Flight Corridor		L	H 2,4	L					
Vessel Traffic	H→H 4,2	H→H 1,2							
Shorebases			H→H 2			L→L 2,3 (Yukon Slope)			McKinley Bay
Dredging						H→L 3	H→L 3		
Offshore Islands (Physical Presence)	H 2	H 2			L→L 4				
HC & Heavy Metals (Harbor, Shorebases)						H→H 3,4	H→H 3		
Icebreaking	L 1,2			L 2					

<u>Key</u>

1 Political
2 Scientific/Technical
3 Regulatory
4 Social

<u>Priority</u>

H High
L Low

TABLE 2 EAST COAST ISSUES MATRIX

	Birds	Fish	Fishing	Whales	Seals	Sable Island	Coastal Zone	Triggering Events
Seismic		H→M 2,4,1	M→L 1,4,5	L→N 2,5	L→N 5,2	H→L 2,5		explosives to air guns
Large Spills	H→H 1,2,3, 4,5	H→H/M 1,2,3, 4,5	H→H 1,2,3, 4,5	M→L 2,3,4	H→L 1,2,4	H→H 1,2,3, 4,5	H→H 1,2,3, 4,5	Arrow, Torrey Canyon
Small Spills	M→L 1,3,4, 5	M→L 1,2,3, 4,5	H→L 1,4			H→H 1,2,3, 4,5		
Routine Discharges	L→N (OBM) 2	L→H→L 2,4,5	L→L 2,4,5			M→M 2,4	L→L 2,4	
Noise	H→L 2,4,5			L→N 4		H→M 2,4		
Flare/Light	H→L 2,3,4					H→L 2,3,4		North Sea drilling
Ship Traffic			M→M 1,4,5					North Sea & Gulf of Mexico
Exclusion Zone			M→M 1,4					
Debris			H→M 1,4,2					North Sea drilling, clean-up compensation fund

<u>Key</u>

1 Political
2 Scientific/Technical
3 International
4 Social
5 Institutional

<u>Priority</u>

H High
L Low
M Moderate
N Non-issue

Sable Island (a set of issues), compensation, seismic effects on fish, tainting of fish, and drilling mud disposal (Everitt and Sonntag, 1985; Appendix II).

Mechanisms for Resolving Issues

The detailed examination of the issues revealed a number of mechanisms that were used to help resolve the issues: mitigation, compensation, monitoring, research, problem solving meetings, joint industry/government scientific working groups, contingency planning, and changes in technology. Each of these is defined below.

Mitigation refers to those measures used to avoid or minimize the effects of development activities.

Compensation refers to remuneration paid to those parties affected for attributable and non-attributable damage caused by development activities.

Monitoring was defined as the repetitive measurement of variables to detect changes directly or indirectly attributable to a specific development activity. The primary purpose of monitoring is to determine casual relationships between development activities and environmental effects.

Research is scientific activity designed to gain greater understanding of the system being studied. It includes laboratory work as well as fieldwork. A good example of how research can help resolve issues is the extensive analysis that has been done on drilling fluid disposal and oil spills. This worldwide research has had considerable impact on the resolution of this issue in Canada.

Problem Solving Meetings require commitment from all parties to lay the problems on the table and decide which require action to be taken. Over time there are many meetings held on a given issue. Few of these could be called problem solving sessions.

Joint Industry/Government Working Groups are usually comprised of both government and industry scientists and environmental managers. To be successful, they must have sufficient resources to undertake first rate scientific research and must have the support of their peers in their respective agencies.

Contingency Planning refers to the whole gamut of procedures and agreements that are required to cope with environmental emergencies.

Changes in Technology may remove an issue from consideration.

How the Issues Were Resolved

A major part of the analysis that occurred during the study was trying to determine the primary mechanism used to resolve a given issue. While they present an oversimplified view of what occurred, Tables 3 and 4 present a summary of which primary mechanisms were used to resolve the Beaufort and East Coast issues. A more detailed description is presented in Everitt and Sonntag (1985).

Conclusions and Recommendations

In the foregoing section on methods, the term "resolution" was carefully defined. Because of the importance of interpreting the conclusions, this definition is restated here:

> An issue is said to be resolved if the regulatory agencies do not consider the issue an impediment to development, and if the regulatory agencies do not require any additional action to be taken over and above existing commitments.

With this definition in mind, a number of conclusions emerge from the analysis.

<u>CONCLUSION 1:</u> <u>Environmental assessment is an ongoing process.</u>

The resolution of an issue is often contained within a dynamic system which is susceptible to external forces beyond the control of the people involved. A resolved issue can reemerge as a result of:

a) new scientific, technical and public (popular) information;
b) increased public awareness and concern;
c) institutional changes in the regulatory apparatus; or
d) catastrophic events related to industry activities (in Canada or elsewhere in the world).

This conclusion emphasizes the importance of viewing impact assessment as a continuing process within which issues are continually being raised and resolved. Given this perspective, it is clear that the formal and informal workings of day-to-day regulatory activities are the major means by which environmental protection and management is brought about in Canada. More formal procedures, such as the

TABLE 3 PRIMARY MECHANISMS THAT CONTRIBUTED SUBSTANTIVELY TO RESOLVING ISSUES IN BEAUFORT EXPLORATORY DRILLING

	Oil Spills	Dredging	Drilling Fluids	Aircraft Disturbance	Vessel Traffic	Shorebases
Mitigation				X	X	
Compensation						
Research	X					
Monitoring		X				
Problem solving meetings		X				
Joint industry/ government programs	X		X			
Contingency plans and emergency response capability	X					
Change in technology						
Unresolved						X

TABLE 4 PRIMARY MECHANISMS THAT CONTRIBUTED SUBSTANTIVELY TO RESOLVING ISSUES IN EAST COAST EXPLORATORY DRILLING

	Oil Spills	Drilling Fluids	Sable Island	Compensation for Fisheries	Seismic Effects on Fish	Tainting of Fish
Mitigation			X			
Compensation				X		
Research	X					
Monitoring						
Problem solving meetings						
Joint industry/ government programs	X	X				
Contingency plans and emergency response capability	X					
Change in technology					X	
Unresolved						X

federal Environmental Assessment and Review Process (EARP), serve to consolidate and highlight the current state of the resolution of most of the environmental issues.

CONCLUSION 2: Current regulatory practice works, but there are problems.

Research, monitoring, and regulatory activity reduce the amount of time necessary to resolve an issue. However, there are a number of continuing problems that need to be addressed by government and industry to allow environmental issues to be dealt with more effectively and efficiently:

a) environmental issues are seldom adequately or clearly defined;
b) often there is inadequate use of existing information;
c) there appears to be a lack of people experienced in making assessments; and
d) there is a minimum time required for people to develop the expertise required to make an assessment.

Too often research and monitoring programs are launched without any rigorous attempt to ensure that the program structure is well thought out, or makes efficient use of government and proponents' resources. For example, this was the case with the issue of the impacts of dredging in the Beaufort Sea. The issue was created and a research program identified (by government) without ensuring that those calling for the effort had thought carefully about the degree of significance of the hypothesized impact. The result was that considerable resources were spent in establishing that the issue was insignificant when it probably could have been established through constructive dialogue.

Environmental assessment is fraught with examples of agencies (and often proponents) seeing their project as being unique and therefore requiring a complete research program to determine and evaluate environmental impacts. Such an approach fails to see opportunities to use related information available either from the same industry (in this case oil and gas) but in another geographic region or from another industry with some related activities. Again, a good example is the issue of dredging in the Beaufort Sea. Experience with dredging in numerous ports and river basins throughout North America was not adequately reviewed and evaluated during the McKinley Bay discussions. Some attempts were made by Dome Petroleum to utilize the experience in the Fraser River to help delineate the potential for fisheries impacts but it was not successful.

Resolution of most of the environmental issues associated with oil and gas development in the Beaufort and along the East Coast took considerable time (6 - 7 years for drilling fluids; 20 years for oil spills and still counting). As the assessments proceeded, political and scientific relationships were established and all parties learned a great deal about the industry and environment with which they were working. Often, inexperience led to directions being chosen that were not fruitful but did provide for an accumulation of useful experience that would help in future decision making. Unfortunately, since so much of this work was new, there were few people trained with all the necessary skills, and opportunities to gain the experience elsewhere (especially in the Arctic) were virtually impossible. As a consequence, when there was a staff turnover either in government or industry, the replacement was usually inexperienced and not equipped to take on many of the responsibilities required to do the job well. This resulted in a set of frustrations for all sides of any issue. Studies were often initiated without consideration of what had gone on before. Also, where there had once been a good (and efficient) working relationship, there would now be misunderstanding and frustration. A key lesson is that any new people should be brought on stream quickly and be given every opportunity to learn the history and the way things are done. Leaving it up to the individual to develop the skills is dangerous and naive. Education of personnel both in government and industry should be a first priority.

RECOMMENDATION 1: Early problem definition is necessary.

A systematic problem definition should be undertaken by the appropriate regulatory agency early in the evolution of the issue. All parties who have an interest in the issue should participate in its definition.

RECOMMENDATION 2: Information from other situations must be utilized.

Agencies should take every opportunity to learn from the experience in other situations and at other sites. Although it may be true that every new situation has unique aspects, that does not excuse one from learning from past experience.

RECOMMENDATION 3: Apprenticeship should be formalized.

Agencies should provide opportunities for new people to learn:

a) the existing informal arrangements for specific environmental issues;

b) the existing interpersonal network of individuals who are working on the issue; and

c) the necessary background technical and scientific information to deal adequately with the issue.

<u>CONCLUSION 3:</u> <u>Resolution of some issues is related to learning to live with the risks.</u>

Issues concerned with catastrophic and probabilistic events (i.e., oil spills) may be resolved by public acceptance of the risk. In the case of oil spills, a number of factors contribute to the perception of an acceptable risk:

a) an understanding of the fate of oil in the environment;
b) an inventory of the sensitive and vulnerable resources;
c) adequate contingency plans;
d) faith in the emergency response capability;
e) a perception that industry has adequate prevention measures;
f) a commitment by industry and government towards a reduction in risk through enhanced prevention and countermeasure capability; and
g) an awareness of the limits and degree of environmental impact.

Although the level of research effort on the effects of oil spills is likely not declining, there does appear to be an increased level of acceptance of the risks associated with oil and gas exploration as long as industry continues to be sensitive and responsive to public concerns. In the sixties and seventies, both industry and government were more oriented towards technical issues and solving them with various forms of regulation and control. The public, on the other hand, was more interested in issues centred on social choice; namely, how is an accident going to affect the individual; which option is the better choice for the community; and so on. Over the last few years, however, there has been a gradual shift away from focussing on what we don't know towards a more workable position of determining how development can proceed given what is known.

Recognition that it is not possible to predict the effects of major oil spills due to the inherent uncertainty associated with natural variability has made it necessary to establish procedures and techniques to respond to the event should it arise. Contingency plans and mechanisms for carrying them out have been evolved from commitments by both industry and government to deal with a spill should it occur.

Associated with the acceptance of the risk is an understanding of how the risks will be assessed. While some consider risk assessment strictly a technical task, the determination of the framework (analytical or otherwise) is subjective. This has caused conflict and disagreement where differing views of the appropriate method for assessing risk have been prevalent.

RECOMMENDATION 4: Develop clear, agreed upon frameworks before considerable time and money are spent in technical analyses.

For issues that are characterized by high uncertainty and have potentially serious environmental consequences, it is important to come to an agreement about how risks will be determined. While technical analyses are important, they can create more problems than they solve if some parties are critical of the methods used.

CONCLUSION 4: Issues associated with routine operations are often resolved through commitments to research and monitoring.

Issues concerned with routine operations of oil and gas development can be resolved through coordinated execution of appropriate research and monitoring activities. The steps in this process appear to be:

a) definition of the issue;
b) collection of baseline data;
c) establishment of a research program;
d) identification of the responsibility centres; and
e) an intermediate or long term monitoring program.

This conclusion has been well documented over the last few years. The major criticism has been that development has proceeded without an adequate assessment of the impacts. In some cases, the promise to perform the research and/or monitoring was the condition of approval, irrespective of the results of the research. While this is a fair criticism of the process that produces environmental impact statements, it fails to recognize other regulatory mechanisms. The steps outlined above explicitly recognize that impact prediction is an imprecise science. This has brought about research to reduce uncertainty, and monitoring to determine effects and trigger mitigation responses.

CONCLUSION 5: Mitigation can substitute for assessment of the impacts.

Some issues can be resolved by mitigative measures that reduce the need for extensive scientific research. In these cases, some form of continued monitoring directed towards providing reassurance that the industry activities are not having an effect may be required.

CONCLUSION 6: Scientific issues are best resolved by joint industry/government working groups dedicated to obtaining good quality data and analyses.

Difficult technical/scientific issues (e.g., oil spills, drilling muds) are best resolved by joint industry/government working groups. One key component is the desire and resources to obtain quality scientific evidence. Another key component appears to be the establishment of good communication channels leading to eventual consensus. Resolution based on trust and consensus is vulnerable to changes in people involved in the regulatory and negotiation process.

Currently, there are many barriers to the mobilization of information between government and industry scientists. First, industry often has business reasons for not sharing information. Second, most government research laboratories orient their staff towards publication and academic survival which makes them highly protective of their data until it has been published in a respected journal. Although not a problem in principle, it is a major issue because of the time required to take a study from experiment to publication (on the order of 2 to 3 years). This feature of government laboratories is a major impediment to government and industry making joint progress.

A notable exception to this issue in the case study was the resolution of the potential impacts of drilling fluids on the environment. Through the use of regular workshops and joint reports, government and industry were able to arrive at an acceptable conclusion. The trust and consensus established went a long way toward ensuring that limited research funds were not wasted and that development could proceed given certain caveats.

RECOMMENDATION 5: Government and industry should work together on resolving scientific questions.

Joint industry/government working groups should be accepted as a recognized institutional arrangement for resolving environmental issues. To some, this is stating the obvious; to others, it seems dangerous for it may compromise the government regulators during the approval process. However, for scientific issues, the increased understanding far outweighs this concern.

CONCLUSION 7: The EARP process serves to spotlight the current evolution of environmental issues.

Many environmental assessment issues have a long history within the existing regulatory process. Unfortunately, there is a tendency for those involved in more formal procedures (e.g., EARP) to believe that they are dealing with a brand new issue. This has the effect of frustrating those who have worked through the problems over a number of years. It is unlikely this problem will be resolved until those involved in the formal regulatory process are well educated on the current resolution of the issues.

The EARP process should take into account that the regulatory process has proven formal and informal arrangements for resolving environmental issues. This does not mean that there is not a place for the larger processes like EARP. The internalized impact assessment process that one finds in the regulatory process often works, but is not open to the public (e.g., the joint government/industry working groups dealing with drilling fluids were organized within a regulatory framework). A process like EARP provides for a broader consolidation of concerns and ideas, a crucial characteristic when dealing with the overall concern of environmental assessment. Also, EARP provides formal recommendations on broader questions of conditions under which development can proceed.

Further Research

At present, there are few agreed upon methodologies for conducting research on environmental assessment. Because of this, the issue-oriented approach taken in this study was, of necessity, experimental. The experience with the approach suggests that policy research could benefit considerably if researchers begin to look more closely at the workings of an environmental regulatory process rather than its outputs (e.g., environmental impact statements, environmental operating conditions). Research that follows up on environmental assessments has only begun in the last few years. In most cases, this research has focussed on evaluating the accuracy of impact predictions in environmental impact statements (cf. Tomlinson and Bissett, 1982). Evaluating predictions is an important research question, but it is a small part of the environmental assessment process. As seen through the lens of this analysis, impact statements are a snapshot in a much longer ongoing process of issue resolution. The predictions and information in an impact statement represent only the current state of resolution of issues and may not provide any of the history associated with the issue.

Thus, there is a need to look at environmental assessment in a broader context. There is a need to explore the formal and informal workings of the day-to-day regulatory process. Only then will progress be made towards a better understanding of how to improve the practice of environmental assessment. However, there is much to be learned about what the appropriate methods are for doing such research.

During the course of this study, a number of promising directions for additional research presented themselves. Some grew out of the inability of this study to pursue all of its intended directions. For example, this study was unable to obtain quantitative information on the efficiency (time and money) aspects of environmental assessment. Also, it was realized that the study had insufficient resources to evaluate the applicability of new approaches to environmental assessment by analyzing how things might have been improved given the procedures had been in place at the time the assessment took place.

The shortcomings of this study and many stimulating discussions led to the formation of the following research questions.

1. What is the cost in time and money of resolving environmental issues that arise during the lifetime of a project? Are there ways of shortening the time or reducing the costs?

This study suggests, but does not have quantitative evidence to support, the conclusion that it takes about five years for the resolution of a major issue.

2. Would new approaches to environmental assessment have been more effective in resolving the environmental issues?

It is not clear that they would have been; however, further work is required to address this question.

3. What learning has taken place within the government and industry over the past fifteen years of practice? For example, what knowledge of the environmental assessment of exploratory drilling was transferred to the west

coast as a result of the Beaufort experience, the East Coast experience, or the North Sea experience?

4. How can the EARP process be made more aware of the current state of resolution of a given issue? Must panels continually take a fresh look at issues that have been satisfactorily resolved?

There is a growing frustration among seasoned practitioners that there is little transfer of knowledge from one formal assessment to the next. If this is true, why is transfer not occurring, and what can be done about it?

5. Is it still standard practice to approve a development provided adequate research and monitoring is done with little regard to whether or not the project will have demonstrable effects?

The answer to this question will get at the real motivations for performing environmental assessment. How much research has been done to satisfy capricious interest as opposed to a realistic assessment of potential impacts?

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ENVIRONMENTAL COMPLIANCE AND EFFECTS MONITORING AT THE HINDS LAKE, UPPER SALMON AND CAT ARM HYDROELECTRIC DEVELOPMENTS IN NEWFOUNDLAND, CANADA

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Introduction

During the hectic period of resource development in Canada in the late 1970's, proponents prepared environmental impact statements (EIS) guided by a defined theoretical framework, but by little practical experience. Critics in the early 1980's (Rosenberg et al, 1981; Beanlands and Duinker, 1983) evaluated the strengths and weaknesses of these early efforts and made recommendations for improvements of future EIA. They suggested that better monitoring during construction and operation of an undertaking was needed. Environmental compliance monitoring would identify unexpected impacts which might require mitigation. Environmental effects monitoring programs would validate impact predictions and provide an inventory of experience for future EIA.

Although environmental practitioners have accepted these recommendations, the administrative and scientific frameworks for environmental compliance and effects monitoring are still being formulated. The first step toward developing such frameworks is to examine cases where compliance and effects monitoring have occurred. This paper summarizes the experiences of Newfoundland and Labrador Hydro (Hydro) with environmental compliance and effects monitoring over the past decade at three successively planned and developed hydroelectric projects: Hinds Lake, Upper Salmon and Cat Arm. Details of these and other aspects of the three projects appear in a previous report (Kiell, Barnes and Hill, 1985).

Background

Table 1 summarizes the physical features of the three hydro projects. Detailed descriptions of the three projects are available elsewhere (Connor and Kwan, 1980; Sturge and McKechnie, 1981; Jerseh and Helwig, 1984). The Hinds Lake and Cat Arm projects are typical hydroelectric schemes: dams and dykes impound water in a reservoir in order to allow controlled release through a powerhouse

TABLE 1 FEATURES OF THE HINDS LAKE, UPPER SALMON AND CAT ARM HYDROELECTRIC DEVELOPMENTS

Feature	Hinds Lake	Upper Salmon	Cat Arm
Turbines			
- Type	Francis	Francis	Pelton
- Number	1	1	2
- Total Installed Capacity (MW)	75	84	127
- Average Annual Energy (GW)	345	555	676
- Rated Flow (m^3/s)	40	190	21
Head (m)	217	51	387
Drainage Area (km^2)	651	4,119	651
Reservoir			
Number	2	2	2
Full Supply Level (m a.s.l.)	310.9	241.5	393.2
Maximum Drawdown (m)	4.9	1.0	7.3
Total Surface Area (km^2)	57	120	55
Total Area Flooded (km^2)	18	30	50
Capacity of Camp (No. of People)	250	300	800
Length of Access Road			
Permanent (km)	20	65	43
Temporary (km)	39	15	22
Length of Transmission Line (km)	15	51	177
Length of Penstock (m)	1,400	447	425
Length of Tunnel (m)	-	-	2,474
Length of Power Canal (m)	6,320	3,500	3,300
Number of Dams and Dykes			
Major	3	2	2
Minor	3	0	8

downstream. The seasonal fluctuation in water supply to the reservoirs leads to a fairly dramatic seasonal drawdown in both. The heads at the Hinds Lake (217 m) and Cat Arm (387 m) projects are relatively high.

The relationship between the head and water management is different at the Upper Salmon project. The head (51 m) is relatively low, but the project is located downstream of the main storage reservoir (Meelpaeg) for the much larger Bay D' Espoir hydroelectric development (Table 1). Drawdown in the Upper Salmon reservoirs is relatively small.

The lengths of permanent and temporary access roads are approximately equal at the three projects. The length of transmission line required to interconnect Cat Arm to the provincial grid (177 km) was much greater than at Upper Salmon (51 km) and Hinds Lake (15 km).

History of Environmental Involvement

Engineering and environmental assessment of the Hinds Lake project began in early 1977. In October 1977, the provincial government allowed construction of the access road and clearing of the transmission line right-of-way prior to completion of the EIA. This decision was made out of sequence because of the flexibility in the still evolving EIA process. The EIS was submitted to government in the summer of 1978 by Newfoundland and Labrador Hydro (1978) and construction of the main civil works was undertaken in 1979 and 1980.

A preliminary environmental assessment of the Upper Salmon and Cat Arm projects (Airphoto Analysis Associates and Beak Consultants, 1976), undertaken in 1975 and 1976, indicated that Upper Salmon was less sensitive environmentally than Cat Arm. However, because of the emergence of Hinds Lake as the most attractive available generation option, a formal EIA of Upper Salmon and Cat Arm was delayed. In 1978, engineering and environmental studies were again initiated for Upper Salmon. The construction schedule indicated that the access road would have to be started in the spring of 1979 to allow construction of the main civil works in the spring of 1980. Approval to initiate construction of the access road on schedule was given by the provincial government contingent on the submission of an EIS. The EIS was submitted in April, 1980 (Newfoundland and Labrador Hydro, 1980). The main civil works were constructed between 1980 and 1982.

In late 1978, the projected growth in energy requirements dictated that an additional source of generation would be needed by the end of 1984. The next most attractive on-island source was Cat Arm. Although some preliminary studies had been completed, the formal EIA was initiated in early 1979. The EIS was submitted to government in December 1980 and an addendum clarifying selected issues followed in April, 1981 (Newfoundland and Labrador Hydro, 1980; 1981). Construction commenced in June, 1981 and was completed in the fall of 1984.

Comparative Environmental Impacts

The magnitude and importance of the environmental impact of a project must be evaluated in the context of the site specific environment and its unique engineering requirements.

The Upper Salmon project was environmentally the most sensitive. The power canal and penstock are perpendicular to the spring and fall migration route of the large Grey River caribou herd (approximately 5,000 animals). The post-calving, rutting, and to a lesser extent, calving areas of the herd are also located near the development. Furthermore, one of the affected rivers contained important salmonid spawning and rearing habitat, and provincially rare wildlife habitat in a downstream delta. The potential recreational and aesthetic values also add to the richness of the area.

The magnitude and importance of environmental sensitivities at Hinds Lake and Cat Arm were less than at Upper Salmon, but relatively equal to each other. The long transmission line at Cat Arm made it more susceptible to conflict with other resource issues such as wildlife, forestry and aesthetics. The main civil works are on the periphery of the range of the Northern Peninsula caribou herd (approximately 500 animals), the reservoir flooded naturally acidic lakes with limited fish populations. Potential impacts on a small amount of habitat for anadromous fish stocks in the lower Cat Arm River, and merchantable, but not salvageable timber in the reservoir flood zone were issues of concern.

The short transmission line and access road at Hinds Lake restricted the impact of the project to a relatively small area around the main civil works. However, within that area were a number of environmental concerns. There were locally significant populations of sport-size salmonids in the reservoir supported by spawning and rearing habitat in tributary streams. Spawning and rearing habitat in one of the dewatered streams was judged to be important to salmonid populations in downstream lakes. Timber in the reservoir flood zone was merchantable and because of increased access and the proximity of a pulp mill, was potentially an important factor had flooding occurred unrestricted.

Environmental Compliance Monitoring (ECM)

Initiation of ECM and Development of Communication Channels

Prior to commencement of construction at the Hinds Lake project, Hydro emphasized the need for a preventative rather than a restorative approach to environmental protection. Wide ranging environmental protection clauses were proposed in the EIS for inclusion in all contracts. These provided details and guidelines on Hydro's environmental protection policy, contractors' environmental responsibilities and technical aspects of environmental protection (e.g., handling of fuels and oils, protection of fish habitat and protection of archaeological and historic findings). More importantly, Hydro proposed to employ an environmental monitor on site to ensure adherence to environmental specifications. It was these self-regulatory commitments which marked the initiation of ECM in Newfoundland.

In May, 1978, Hydro placed an environmental monitor at Hinds Lake. The monitor reported to Hydro's Environmental Services Department in St. John's. However, environmental concerns were addressed in the field by direct consultation with supervisory staff of the project management consultant, ShawMont-Lavalin.

It was not until January 1979 that government endorsed ECM and began to formally participate in its development when the Minister of Environment requested in his letter of approval for the project that:

> "All necessary measures must be enforced for the whole period of construction to prevent pollution caused by labour force equipment, construction operations, operation and maintenance of camp facilities, vehicle servicing, solid waste disposal, stream crossing by vehicles and any other pollution causing activity associated with this project."

Despite this endorsement, direct involvement by government agencies remained limited for the duration of construction.

Hydro also placed an environmental monitor at Upper Salmon. Because of the environmental sensitivities of the project, the provincial government also decided to employ their own monitor (later called the environmental surveillance officer). This officer was intended to have authority similar to that of other resource protection officers of the Crown and was to report to government through an environmental surveillance committee of wildlife, environmental, and other officials who were responsible for enforcing compliance with environmental laws and regulations.

Initially, there was uncertainty about reporting procedures for the environmental surveillance officer on the construction site. On-site authority for all aspects of construction is concentrated with the project manager. At Upper Salmon, as at Hinds Lake, the environmental monitor was delegated the responsibility for daily environmental matters. Hydro suggested, therefore, that the provincial surveillance officer communicate to the project manager through the environmental monitor. It was also understood that environmental problems that could not be resolved on-site would be referred to the environmental surveillance committee and Hydro's Environmental Services Department for resolution. Although this was the general communication channel adopted, government insisted on and obtained the right to approach directly the project manager and contractors if circumstances dictated. Figure 1 summarizes the channels of communications for ECM.

To facilitate communication, bi-weekly meetings were held throughout construction between the project manager, environmental surveillance officer and environmental monitor. These meetings encouraged proactive rather than a reactive solution to environmental problems and served to improve the quality of environmental protection at Upper Salmon.

ECM was again implemented at the Cat Arm project by both Hydro and government. The communication channels were the same as described in Figure 1. During the final year of construction, there was an increasing level of cooperation in the daily activities of the surveillance officer and the monitor. While the duties of the surveillance officer were restricted to that of surveillance, the environmental monitor would frequently request the officer's opinion and advice. This was particularly useful in situations not strictly governed by laws, regulations, permits or EIS commitments.

In May 1983, with the commencement of construction of the 177 km transmission line, Hydro appointed a second monitor leaving the original monitor free to concentrate on the main civil works. Shortly thereafter, government was also assigned a second monitor to this task.

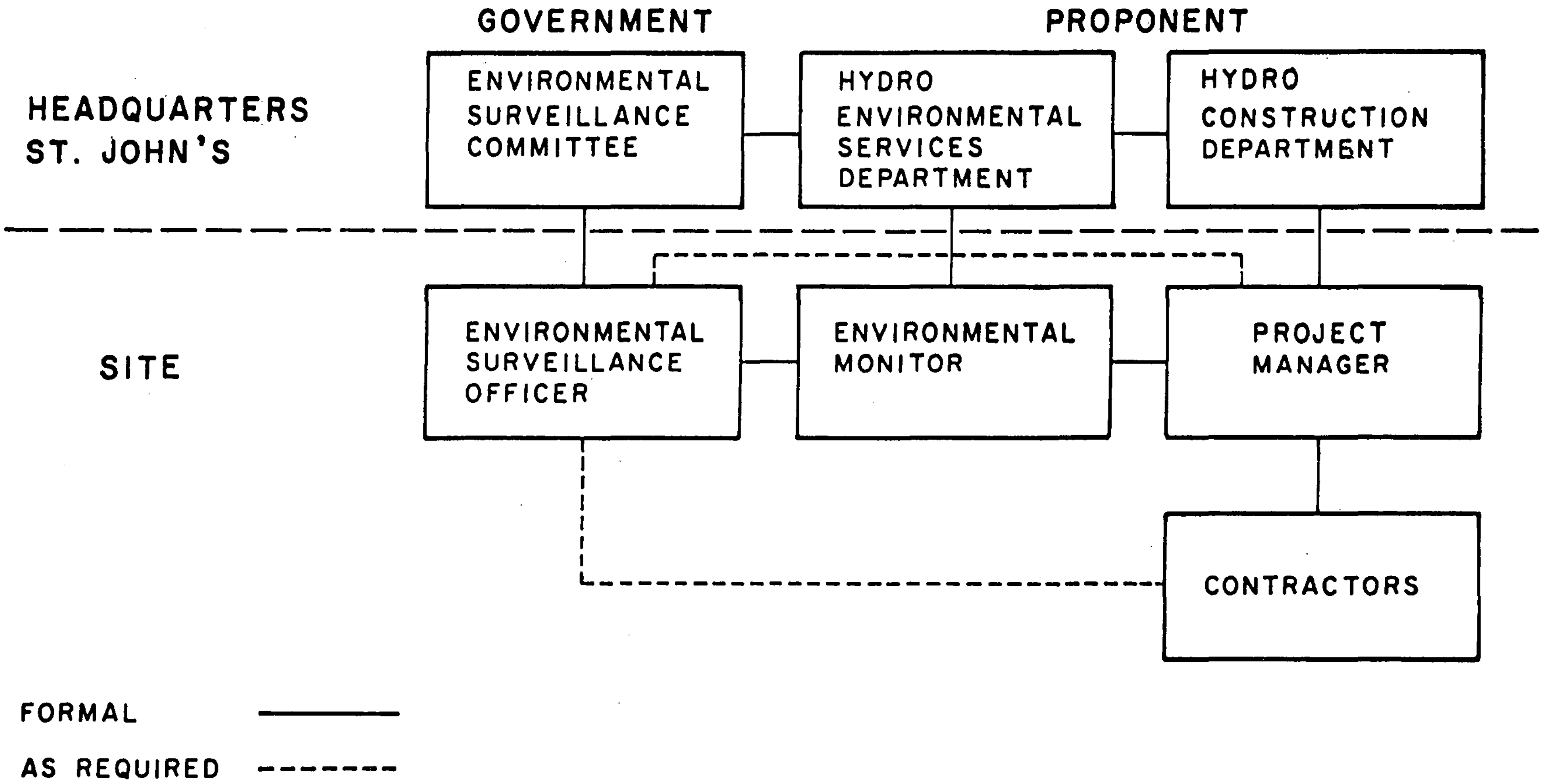

FIGURE 1 CHANNELS OF COMMUNICATION FOR ECM

Regulatory vs Self-Regulatory ECM

ECM at the three projects consisted of two distinct but basic components: regulatory environmental surveillance and self-regulatory ECM. The former is government's tool to ensure compliance with environmental laws, regulations, guidelines, permit conditions and EIS commitments. The latter, however, is a broader process wherein the proponent monitors its own activities against internal and external environmental standards. This necessarily implies that the proponent supports through policy and action the need for environmental protection. The distinction between regulatory and self-regulatory aspects of ECM, and the need for environmental protection has been identified by others, although different terminology has been employed. The ECM component carried out by regulatory agencies has been termed "surveillance" (Hoglund, 1985) (Mutrie, 1984) and the proponent sponsored coordination of environmental matters has been called "supervision" (Hoglund, 1985) and "environmental inspection" (Mutrie, 1984). Hydro chose to adopt new terminology which clearly describes the purpose (regulation) and responsibility (proponent or government) for the components of ECM.

Regulatory environmental surveillance relies on specific environmental laws, regulations, guidelines and permit conditions, such as the regulations for solid waste disposal to define acceptable practice. Because of the ease of identifying violations and the enforceability of regulations, the surveillance officers at Upper Salmon and Cat Arm emphasized matters governed by regulation, such as solid waste management. Hydro's environmental monitors spent an average of 5% of their time at these two projects on solid waste management issues, up from 1.7% at Hinds Lake (Kiell, Barnes, Hill, 1985). Even though it is appropriate to carefully manage solid waste disposal it is possible that inordinate concentration on a relatively straightforward issue may have reduced the amount of effort expended on more critical but essentially unregulated issues such as caribou/project interactions at Upper Salmon. On the other hand, without the presence of a regulatory environmental surveillance process, Hydro's environmental monitor might have overemphasized what were perceived to be critical or interesting issues at the expense of more mundane responsibilities.

Government requirements are often vague and do not provide adequate guidance for environmental surveillance officers or environmental monitors. Furthermore, there are many environmental problems on large construction sites for which no government regulations or guidelines exist. For example, at Upper Salmon construction was to occur mainly during the spring and summer months when large numbers of caribou were located in the vicinity of the project. In order to properly protect caribou without unnecessarily restricting construction activities, Hydro developed specific decision-making criteria based on caribou like history stages, location and numbers of animals in the project area, and the construction activity being undertaken. These criteria were ratified by provincial wildlife authorities and implemented by the environmental monitor and environmental surveillance officer. Although it is relatively unusual for a proponent to develop its own environmental restrictions, Hydro thought it would be better to operate with rules, rather than with the uncertainty of an unregulated, but real environmental problem. The description, implementation and effectiveness of the criteria are discussed elsewhere (Newfoundland and Labrador Hydro, 1981; Kiell, Hill and Mahoney, in press).

It is apparent that regulatory environmental surveillance and self-regulatory ECM are needed for the overall success of an ECM program. Government needs a representative on-site to ensure compliance with specific regulators, guidelines and special stipulations. There are also many difficult decisions to be made when no regulations exist. When balancing environmental and engineering problems, a regulatory and scientific interpretation of the problem is required. Under the pressures of a construction schedule, these decisions are best made in the field by designates of government and the proponent.

The Need for Environmental Protection Plans

Important aspects of environmental protection at the three hydroelectric projects were outlined in various documents. There were environmental commitments made in the EIS, conditions and guidelines in contract documents and stipulations in government permits. The reporting procedures and responsibility of all those involved in ECM were not initially articulated clearly in one accessible document, and the goals and objectives of environmental protection were not adequately explained to all project employees. These weaknesses could have been alleviated by the preparation of an environmental protection plan prior to construction. This document would focus all those concerned with environmental protection and greatly enhance the effectiveness of an ECM program.

This approach to implementation of environmentally acceptable construction practices has been recommended previously (Mutrie, 1986) and used successfully by

Interprovincial Pipe Line (NW) Ltd. during the construction of the Norman Wells to Zama pipeline (Hardy Associates Ltd., 1983). Essential elements of an environmental protection plan would include but would not be limited to:

(1) a summary of all environmental regulations, permits and commitments;
(2) environmental contingency plans for emergencies such as an oil spill;
(3) guidelines and procedures for environmentally acceptable construction practices;
(4) a list of priority environmental issues and sensitive areas; and
(5) a clear identification of the responsibilities of key personnel involved in ECM and flowchart to facilitate unforeseen environmental decision-making requirements.

Specific elements of the environmental protection plan would be cross-referenced to affected clauses in contract documents. This would simplify the bidding process and later enhance the implementation of acceptable construction practices by contractors.

Environmental Effects Monitoring (EEM)

EIA is essentially a predictive tool that identifies potential impacts of a proposed development and suggests measures to mitigate or compensate for those impacts. This information is utilized in deciding whether, and in what form, a project should proceed. Intuitively, it is obvious that if EA is to improve, it will be necessary to determine the accuracy of impact predictions and the effectiveness of ameliorative measures. This is the role of EEM.

EEM has been defined as "repetitive measurement of environmental variables to detect changes caused by external influences" (Duinker, 1985). It is an aspect of EA that has received little attention in the past, but is now gaining prominence as an essential component of the process. In Canada, it has been suggested that EIA usually suffers from a lack of "good science" which threatens to undermine the entire process (Beanlands and Duinker, 1983). As one of the means of improving EIA, it has been suggested that well designed monitoring studies be incorporated in an EIS.

Hinds Lake, Upper Salmon and Cat Arm all underwent EIA and were constructed over the 10-year period between 1975 and 1985. However, the EISs for these projects were submitted within a shorter time period, 1978 to 1980. Those for

Upper Salmon and Cat Arm were written almost concurrently. As a result, there was little time for review of experience between projects and few changes in the assessment process were implemented. This is reflected in their similarity. They are relatively simple, descriptive documents with little attempt made to quantify predictive impacts. The proposed monitoring programs are vague and emphasize ECM rather than EEM. An exception is the Cat Arm EIS Addendum (Newfoundland and Labrador Hydro, 1981) in which a more detailed discussion of monitoring activities was required.

EEM studies were conducted at all three projects, but varied greatly in scope, level of effort and method of management. At each project, certain studies can be considered to have made a positive contribution to the art and science of EEM. Some of these studies developed through logical planning while others evolved fortuitously. In order for an EEM program to be effective, three components are required: good science; clear definitions of goals and objectives; and sound administration. The following examples from Hinds Lake, Upper Salmon and Cat Arm illustrate Hydro's experiences with these three requirements.

Mercury Study at Hinds Lake

Hydro initiated a small scale, low budget EEM study at Hinds Lake to examine the concentration of mercury in fish and sediments. Each year, about 30 fish of each of the two salmonid species in the reservoir and a control pond are collected and samples of the flesh are analyzed for mercury. Sediment and water samples are also collected and analyzed. Initially samples were collected by Hydro and analyzed by consultants. Now the study has become a cooperative effort with Hydro collecting the samples and the federal Department of Fisheries and Oceans (DFO) providing the analytical service.

This study contains the following components critical in EEM:

(1) a testable hypothesis; i.e., mercury levels in fish and sediments will not increase as a result of flooding;

(2) temporal control; i.e., data collected during the EA were supplemented by sampling during flooding and operation until any changes stabilize;

(3) spatial control; i.e., sediment and fish samples were taken from an unaffected pond; and

(4) statistically adequate sample sizes.

The study has been expanded to examine mercury accumulation in the Upper Salmon, Cat Arm and Bay D'Espoir reservoirs.

Fish Passage Program at Upper Salmon

One of the major mitigative measures instituted at Upper Salmon was the release of water to maintain fish habitat in the West Salmon River. In order for this mitigation to be effective it is necessary that fish be able to reach that stretch of river to spawn. During the EA, it was recognized that increased flows resulting from plan operation might create downstream velocity barriers which would prevent fish from migrating to upstream spawning habitat.

Hydro undertook a series of EEM studies to evaluate the question of fish passage. Details of this program are available elsewhere (Barnes, Peters and Grant, 1985). The first step in solving the problem was to determine whether there actually was a velocity barrier after commissioning. A computer model of the critical area suggested that fish should be able to swim upstream through this area.

The second aspect of the program was to show that fish were able to migrate through the critical area. A two-way counting fence and tagging study was designed to accomplish this. A number of hypothetical outcomes based on numbers of fish caught in the counting fences, and the proportion of tagged fish were postulated prior to initiation of the study. It was agreed with DFO that certain results would indicate that velocity barriers were not adversely affecting upstream migration and that no further mitigation would be required. The results of this study indicated that a large number of adult fish reached the spawning habitat protected by water release. The numbers were not large enough to eliminate the possibility of a partial barrier, but were sufficient to indicate that mitigation was not required.

A third component of the study involved the post-construction estimation of the standing stock of fry and juvenile fish in the protected part of the river. This study was to confirm that the river continued to be productive in spite of the potential partial velocity barrier and that water release as a mitigation is fulfilling its original purpose. This study is currently in progress and results are unavailable at this time.

There are at least four important points to be derived from this example:

(1) EEM programs often are best conceived of and undertaken in manageable portions each focussed around a testable hypothesis;

(2) there should be decision points throughout the program to account for the results of early studies in the conceptualization of later ones;

(3) EEM programs should be oriented toward solutions with results that can be employed at the current or future projects; and

(4) EEM programs may be beneficial to the proponent in terms of cost savings, knowledge that mitigation is working and confidence in future predictive capability.

Reservoir Enhancement Program at Cat Arm

The lakes of the Cat Arm River system contain brook trout (Salvelinus fontinalis) and Arctic char (Salvelinus alpinus). Littoral benthic invertebrates are the primary prey for these salmonids as there are no forage species such as sticklebacks (Gasteroideae) in the system.

As a result of the increase in habitat due to flooding, it was predicted that the potential yield of the reservoir to a sport fishery would be approximately twice that of the original lakes (Beak Consultants Ltd., 1980). It was also suggested that the size and longevity of the fish would increase. However, these positive impacts would probably be offset to some degree by a number of negative impacts. The major food supply of the salmonids, littoral benthos, would be negatively affected to an unknown extent by reservoir drawdown. It was predicted that dissolved oxygen deficits could occur in the reservoir during the first five years after flooding (MacLaren Atlantic Ltd., 1981). There was also a concern that flooding of the tributary streams would reduce recruitment rates to the reservoir with the result that the potential yield would not be realized.

In the Addendum to the EIS, Newfoundland and Labrador Hydro (1981) agreed to a number of actions, which became known as the reservoir enhancement program, to mitigate the impacts of construction on fish populations and to monitor the effects of reservoir creation. These actions included:

(1) monitoring the mercury content of the fish flesh, sediments and water; sampling would be undertaken prior to flooding to obtain baseline data and for at least five years after flooding;

(2) monitoring the book trout population at various stages in the life of the reservoir in order to detect negative changes for which mitigative strategies could be applied;

(3) provision of alternative spawning habitat by removing barriers on streams or creating spawning beds if the monitoring program showed that recruitment was falling; if these methods failed to correct the situation, a compensatory stocking program would be considered;

(4) monitoring development of the littoral zone and the establishment of littoral zoobenthos; if, as a result of poor littoral zone development, fish populations were limited by the food supply, then the introduction of forage fish would be considered; it was recognized that such an introduction would be experimental;

(5) monitoring primary production in the reservoir to determine whether the predicted increase would occur; and

(6) monitoring a number of limnological parameters to document long-term changes in the reservoir.

The objective of the reservoir enhancement program was to develop a sport fishery in the reservoir to compensate for negative impacts on fish populations resulting from the development. The foundation of this compensation scheme was the prediction that the annual yield of the reservoir would exceed that of the existing lakes and that increased access to the area could encourage sportsmen to utilize the fish resource. However, other predictions (reduced littoral benthic populations due to drawdown and insufficient recruitment due to flooding of streams) indicated that the potential yield of the reservoir would not be realized. It would be necessary to monitor and quantify limiting factors before implementing appropriate mitigative measures to maximize productivity.

Because of the magnitude of the proposed program and the diversity of expertise needed, Hydro appointed a Reservoir Enhancement Program Advisory Committee. The Advisory Committee included scientists in biology and physical geography from Memorial University of Newfoundland and representatives from DFO, the Newfoundland Department of Environment, and Hydro. The mandate of the Advisory Committee was to suggest study priorities and design, and to review terms of reference and reports. Hydro chaired the meetings and any recommendations were ratified by the company.

A Fisheries Sub-Committee was formed after the first plenary meeting. This sub-committee suggested that three studies should be undertaken:

(1) detailed population studies of brook trout in Cat Arm Lake including estimates of standing stock and potential yield using population data and two empirical methods;

(2) estimation of primary productivity in Cat Arm Lake and collection of related limnological data; and

(3) an intensive benthic invertebrate study.

The Advisory Committee approved these studies. They also agreed that the suspected dissolved oxygen deficit in the reservoir would not materialize and that developing a pH model for the reservoir was not a priority item.

The fish studies were initiated immediately and a proposal for primary productivity studies was developed by a Memorial University team. A Memorial University specialist on benthic invertebrates, after a trip to the site, suggested that the benthic invertebrate study was not feasible. This specific study was cancelled.

The final report on the fish in the reservoir (DeGraaf, 1983) was reviewed by the Fisheries Sub-Committee and circulated to the whole Advisory Committee. The study indicated that salmonids were abundant in Cat Arm Lake, but that they had a slow growth rate and were stunted in size. As a result, it was concluded that the fish resource, although of academic interest, had limited present or future economic or sport value.

Because of the findings of the fish study, the rationale for the Reservoir Enhancement Program was re-evaluated. It was decided that the original goal of developing a sport fishery in the reservoir was impractical, but that important data could be obtained on reservoir evolution. Hydro agreed to fund the long-term primary production study proposed by the Memorial University team, to continue to monitor fish populations in the reservoir, and to include the Cat Arm reservoir in the ongoing mercury monitoring program initiated at Hinds Lake.

There were benefits of adopting the Advisory Committee approach to managing the Reservoir Enhancement Program. The Program tended to maintain a broad perspective because of the multidisciplinary composition of the Committee. Study priorities were identified quickly, and infeasible and unnecessary studies were eliminated from further consideration. It is also suggested that the calming influence of the committee approach served to focus issues and promote consensus, thereby increasing cost-effectiveness while maintaining the scientific integrity of the Program.

Discussion and Recommendations

When undertaking an EIA, practitioners often find it easier to embrace specific recommendations rather than a lengthy discussion based on the opinion of the authors supported by published literature. Rather than list recommendations at the end of the paper, we have elected to initiate the discussion and formulate specific recommendations as the discussion unfolds.

It has been suggested previously that there is too pronounced a conceptual break between the assessment and construction phases of large projects and that there is too much emphasis placed on the EIS as a focus for decision making (Kiell, 1984). In fact, the EIS may be the cause of slow integration of monitoring in EIA. The EIS represents the culmination of years of study intended to predict the potential impacts of a proposed undertaking, identify mitigation which will eliminate or reduce these impacts, and to determine whether the project should be constructed. There is, therefore, little incentive during an EIA to plan for activities to be undertaken during construction and operation of the facility.

The experiences of Hydro over the past decade indicate that environmental compliance and effects monitoring are useful endeavors. Even though they are discussed under separate headings, ECM and EEM are components of the large EIA process. The challenge to practitioners is to integrate monitoring into EIA and bridge that conceptual gap between assessment and construction, and operation.

> RECOMMENDATION 1. Include environmental compliance and effects monitoring as an integral part of EIA and do not defer monitoring considerations until project approval has been obtained.

It is standard EA practice to focus an assessment by quickly identifying the important issues. These issues might involve foreclosure on other resource uses in the area, significant social and economic hardship for people in the vicinity of the project, or negative impacts on valued ecosystem components. Such issues are likely to require particular attention during the assessment, and may require special monitoring during construction and operation of the project.

RECOMMENDATION 2. Use the important issues identified during scoping of the EIA to suggest that EEM studies or specific ECM measures may be required.

For large projects there are usually many government regulations and guidelines which apply to construction activities. Often these regulations and guidelines are vague or site specific conditions make them inappropriate. Furthermore, government regulations and guidelines do not always adequately address all environmental concerns. Therefore, it is necessary to plan the ECM program during the assessment. An environmental protection plan focusses this planning and is the field document which will facilitate implementation of environmental protection measures during construction.

RECOMMENDATION 3. Begin preparation of an environmental protection plan during the EIA in anticipation of project approval. The environmental protection plan should be included as a part of the EIS.

In our experience, a proponent is well advised to consider developing decision-making criteria and environmental protection standards for important issues when government regulations and guidelines fail to provide them. This self-regulation reduces confusion and exposure to unreasonable standards that may be improvised and imposed by government under the stress of an impending crisis. These decision-making criteria and environmental standards must be a part of the environmental protection plan and will, therefore, be approved by government during the review of the EIS.

RECOMMENDATION 4. The proponent should develop environmental decision-making criteria and protection standards when government regulations are inadequate or when they are too broad or vague. This is particularly effective when important environmental issues are involved.

All environmental eventualities at a large construction project cannot be foreseen. There are problems that can arise on-site which require innovative and immediate solutions. Therefore, it is important that the environmental protection plan describe the reporting procedure and responsibilities for making decisions in the field. This will facilitate decision making and avoid the frustration caused by not knowing who can solve the problem.

> RECOMMENDATION 5. Clearly define in the environmental protection plan the communication and decision-making channels so that unforeseen problems can be handled expeditiously in the field.

EEM can be very useful in evaluating the accuracy of impact prediction and the effectiveness of mitigation. These studies, however, are different from those studies which describe the environmental setting. Therefore, when an EEM study is anticipated, one must ensure that the pre-development environmental data are adequate. In order to accomplish this, the study must possess a clear objective, and be technically feasible, defined in terms of a series of related hypotheses, and designed with adequate temporal and spatial controls. These must be included in the EIS.

> RECOMMENDATION 6. Carefully select EEM programs and be very conscious of the reason for and benefit of the study, and ensure that the program is scientifically practicable.
>
> RECOMMENDATION 7. EEM studies should be identified and designed early in the EIA process, preferably during scoping. However the EA process should also be sufficiently flexible to accommodate EEM studies that are identified later in the EIA.
>
> RECOMMENDATION 8. EEM studies should be designed and conducted as scientific studies; they require clear objectives and hypotheses, temporal and spatial controls, an adequate duration, practical methodologies, and sufficient funding.

The proponent is usually considered responsible for monitoring undertakings. However, EEM studies often provide valuable management data to resource agencies. There have been a number of instances in Newfoundland, when regulatory agencies participated in the management and funding of EEM studies and the experience has been generally positive. Regulatory agencies have accepted that the proponent is not always the sole beneficiary of the data generated from an EEM study.

RECOMMENDATION 9. Determine who will benefit from the study and consider joint funding projects between various parties.

Large scale EEM programs can be technically complex and involve a number of scientific disciplines. These programs often cannot be effectively managed by one person working for either the proponent or government agencies. During the Cat Arm reservoir enhancement program, the establishment of a multi-disciplinary, inter-agency advisory committee was beneficial in focussing issues and ensuring the availability of appropriate scientific expertise. The participation of university scientists added significantly to the balanced deliberation of the Advisory Committee.

RECOMMENDATION 10. An advisory committee comprised of impartial experts and representatives of the proponent, and regulations should be implemented for large, complex or costly EEM programs.

The above discussion and recommendations will enhance preparedness and improve decision making during the assessment, construction and operation of undertakings. As long as the proponent demonstrates a serious attitude toward environmental protection and government agencies recognize that environmental assessment attempts to optimize the use of resources in a given area, the effectiveness of EIA will improve and provide valuable service to all parties concerned.

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FOLLOW-UP ECOLOGICAL STUDIES AT THE WRECK COVE HYDROELECTRIC DEVELOPMENT, NOVA SCOTIA

C.P. Ruggles

Introduction

The consideration of environmental impacts associated with hydroelectric development has become a routine part of feasibility studies. However, follow-up analysis to determine the accuracy of the environmental predictions and the effectiveness of the mitigative measures is rare. Post-development monitoring and analysis were identified by Rosenberg et al. (1981) as the most frequent deficiencies of the six necessary components of an "ideal" scientific impact assessment. One opportunity to partly redress this deficiency is the case of the Wreck Cove Hydroelectric Project in Nova Scotia, Canada.

The Province of Nova Scotia decided to proceed with this project in 1974. Under guidelines developed by a technical group composed of federal and provincial officials, a multidisciplinary environmental impact assessment was conducted during the late design and early construction stages of the hydroelectric project. The Wreck Cove Environmental Assessment (Beak Consultants 1977) addressed a number of impacts, including aquatic, terrestrial, and socio-economic. It also identified management strategies for optimizing reservoir operation so as to minimize the impact of the project on the environment.

In this paper, the objective is to examine selected environmental predictions and mitigative measures identified for the Wreck Cove Hydroelectric Project. A great deal of the environmental concern focussed on the impact of reduced flows on the salmon resource of the Cheticamp River. A portion of the Cheticamp drainage was diverted through the Wreck Cove Lakes to provide the necessary volume of water to produce hydroelectric power in a powerhouse near Wreck Cove on Cape Breton Island.

One of the most important, difficult and controversial aspects of stream flow regulation below diversion dams is the determination of instream flow needs of aquatic biota (primary fishes). In the case of the Cheticamp River, instream flows for the maintenance of Atlantic salmon were considered to be a particularly important requirement because the species represented a valuable resource feature of the Cape Breton Highlands National Park.

A policy was devised that provided a base flow that would not go below the historical one-year-in-four mean July low flow (Beak Consultants 1977). Thus, in extremely dry years, riparian releases from Cheticamp Reservoir would maintain flows in the lower Cheticamp River at higher levels than would exist naturally. It was predicted that this would offset the negative effects which lower average flows, at other times, might have on salmon production.

A follow-up study of the Wreck Cove Hydroelectric Project provides the opportunity to follow changes in water quality over a ten-year period in storage reservoirs and to assess the accuracy of a number of water quality predictions. Water sampling had been conducted in the Wreck Cove Lakes from 1975 to 1977 (Kelly et al. 1980). The Nova Scotia Power Corporation commenced water samplings in the reservoirs in March 1979, and has continued up to the present. Thus, changes in water quality can be followed from pre-impoundment through a seven-year post-impoundment period.

The Wreck Cove Hydroelectric Development

The Wreck Cove Hydroelectric Project is located on the northeast side of Nova Scotia's Cape Breton Island, and utilizes 364 metres of head to generate up to 220 MW of peaking power at a capacity factor of 15%. Water for the project is stored in four reservoirs, which have a total volume of 1.55×10^8 m^3. In order to provide the necessary volume of water to realize 220 MW generating capacity, 218 km^2 of drainage from several streams located on the highland plateau is diverted through turbines located in a subterranean powerhouse near Wreck Cove. In all, the drainage system intercepts flows from 32% of the combined watersheds of East Indian, West Indian, McMillan, Wreck Cove and McLeod Brooks, and Cheticamp and Ingonish Rivers (Fig. 1).

Clearing and construction activity began during the spring and summer of 1975. The first 100 MW unit was commissioned on March 27, 1978, followed by the second unit a month later. A total of 19 dykes and dams, 5 canals and 5 major tunnels was constructed to control and redirect the flow from the various drainage basins. Wreck Cove, Gisborne and Cheticamp Reservoirs were formed by impounding existing lakes. McMillan Reservoir occupies a former steep-sided river valley. Approximately 18% of the Cheticamp drainage area is diverted by means of a dam at the outlet of Cheticamp Lake. Water storage began in Wreck Cove, Gisborne and the McMillan Reservoirs in the fall of 1977, and in Cheticamp

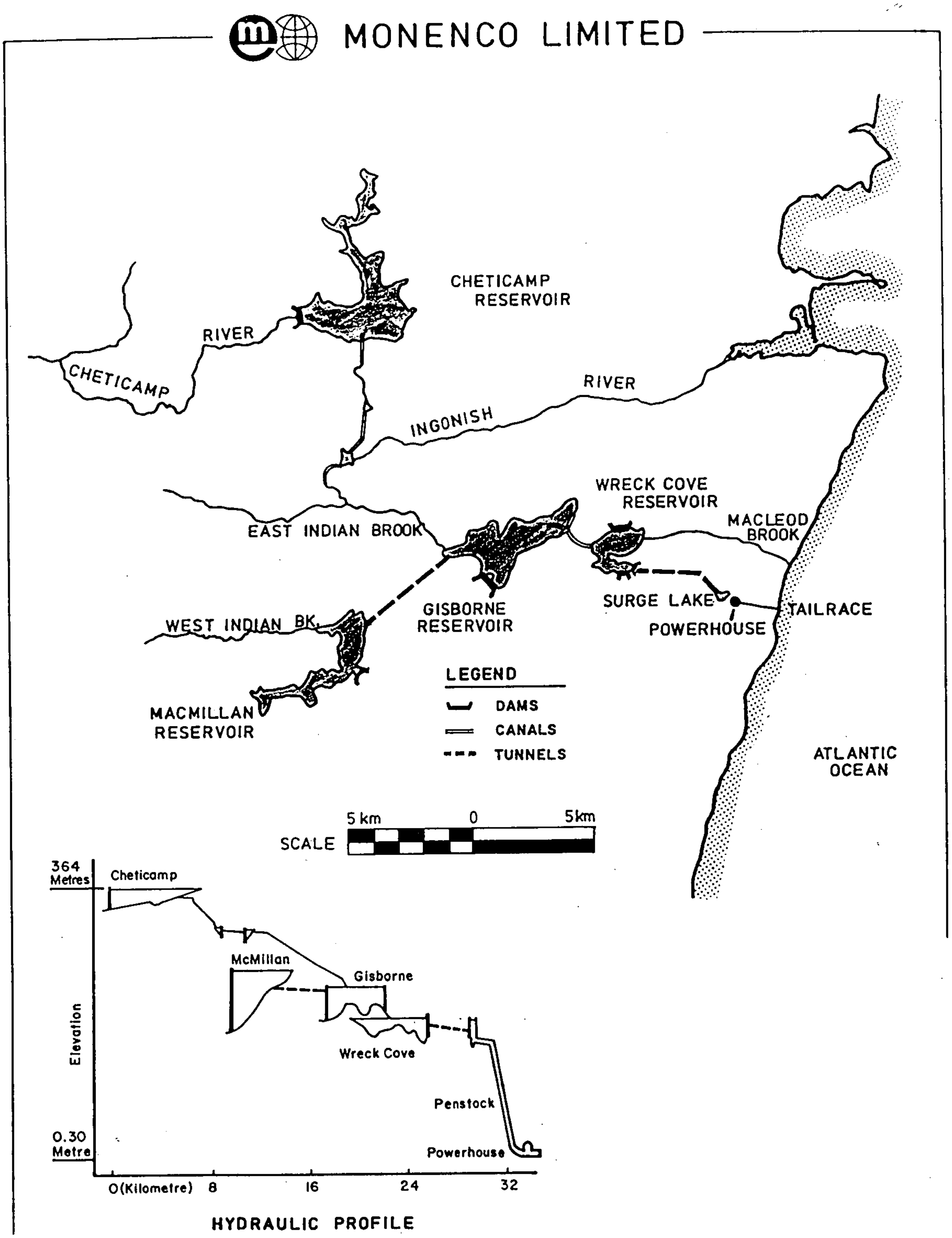


FIGURE 1 THE RESERVOIRS OF THE WRECK COVE HYDROELECTRIC PROJECT AND THEIR HYDRAULIC PROFILES

Reservoir in the summer of 1978. The mean annual flow for the entire project drainage area is 10.5 m^3/sec.

Methods

Using a similar strategy as Hecky et al. 1984, the diversion and resultant changes to the hydrologic regime in the Cheticamp River and the Wreck Cove Lakes is treated as a large-scale "experiment", conducted to test the predicted impacts and the success of a riparian flow strategy that were both developed prior to dam construction. The study, therefore, is composed of two separate segments - the first dealing with the impact of altered flow in the Cheticamp River on the salmon resource, and the second dealing with water quality changes in the Wreck Cove reservoirs.

Cheticamp Salmon

Juvenile Atlantic salmon densities were estimated in selected sites in the Cheticamp River in 1974 and 1975 (Sweeney 1978, Amiro 1982). A total of six samples from juvenile salmon habitat collected prior to the Wreck Cove development is available for analysis. Post-development juvenile salmon sampling in the Cheticamp was conducted in 1982 and 1983 (Parks Canada 1984). During the present study, juvenile salmon abundance was estimated in 1984 at several of the sampling sites previously sampled. Eleven post-development estimates of juvenile salmon abundance are available. The methods used for deriving these are described in Ruggles (1985) and need not be repeated here.

To examine the impact of the Wreck Cove hydroelectric development on Atlantic salmon angling success in the Cheticamp, the annual catch of salmon from the Cheticamp River for the period 1960 to 1984 was examined (Smith 1981, Swetnam and O'Neil 1984). The annual proportion that the Cheticamp catch made relative to the total angling catch from all remaining rivers on Cape Breton Island was also calculated for the period 1960-1984. The assumption is that this proportion would decrease, along with average catch, if the hydroelectric development had adversely affected salmon angling in the Cheticamp.

To compare pre- and post-development flows in the Cheticamp River in reaches supporting Atlantic salmon, the mean monthly flows before and after development were examined. Flow data from an adjacent watershed, the Northeast Margaree River, were used to construct a model to predict flows that could be expected in the Cheticamp during the post-construction period, had the Wreck Cove development not taken place. The model was calibrated for the period 1964-1977 by calculating the mean monthly flows in both the Cheticamp and Northeast Margaree. The data was normalized before averaging by reducing the flows to a common unit drainage area. The average differences between the mean monthly flows in the Cheticamp, as compared to the Northeast Margaree, during the pre-development period were then used to predict post-development flows in the Cheticamp from actual post-development flows in the Margaree. Predicted and actual flows in the Cheticamp for the post-development period 1978-1983, inclusive, are compared and discussed in the light of flow augmentation from the Cheticamp Reservoir.

Reservoir Water Quality

Water storage began in Wreck Cove, Gisborne and the McMillan Reservoirs in the fall of 1977, and in Cheticamp Reservoir in the summer of 1978. Prior to impoundment, the water quality of the existing lakes was sampled on a monthly basis from February 1975 to July 1977 (Kelly et al. 1980). Construction activities began during the pre-impoundment phase, but the 1975 data appear not to have been influenced by the hydroelectric development activity. Besides impounding existing lakes, one reservoir (McMillan) was created by impounding a steep-sided river valley. The Nova Scotia Power Corporation initiated reservoir water quality sampling in March 1979, and the reservoirs have been sampled at least two times per year up to the present time.

Samples were collected at the surface and about 0.5 m above the bottom at the deepest point in each reservoir or lake. All samples were appropriately field-fixed, then shipped for analysis to the Environmental Chemistry Division of Clinical Chemistry, Nova Scotia Department of Health. Analytical procedures are described by Kelly (1978). Results for the following parameters are discussed in the present study: total dissolved solids, suspended solids, colour, pH, total organic carbon, dissolved oxygen, total phosphorus, total nitrogen and chlorophyll a.

In 1979, seven sampling visits were made to the reservoirs between March 22 and November 7. From 1980 to 1982, three sampling visits were made during each of the three years, once in the winter, and once in early and late summer. In 1983 and 1984, only two sampling visits were made to each reservoir, once in the summer, and once in the winter. Whole-lake means were not calculated volumetrically, since neither the lakes or reservoirs showed significant stratification. Yearly means were calculated for each parameter.

Results

Juvenile Salmon Abundance in the Cheticamp River

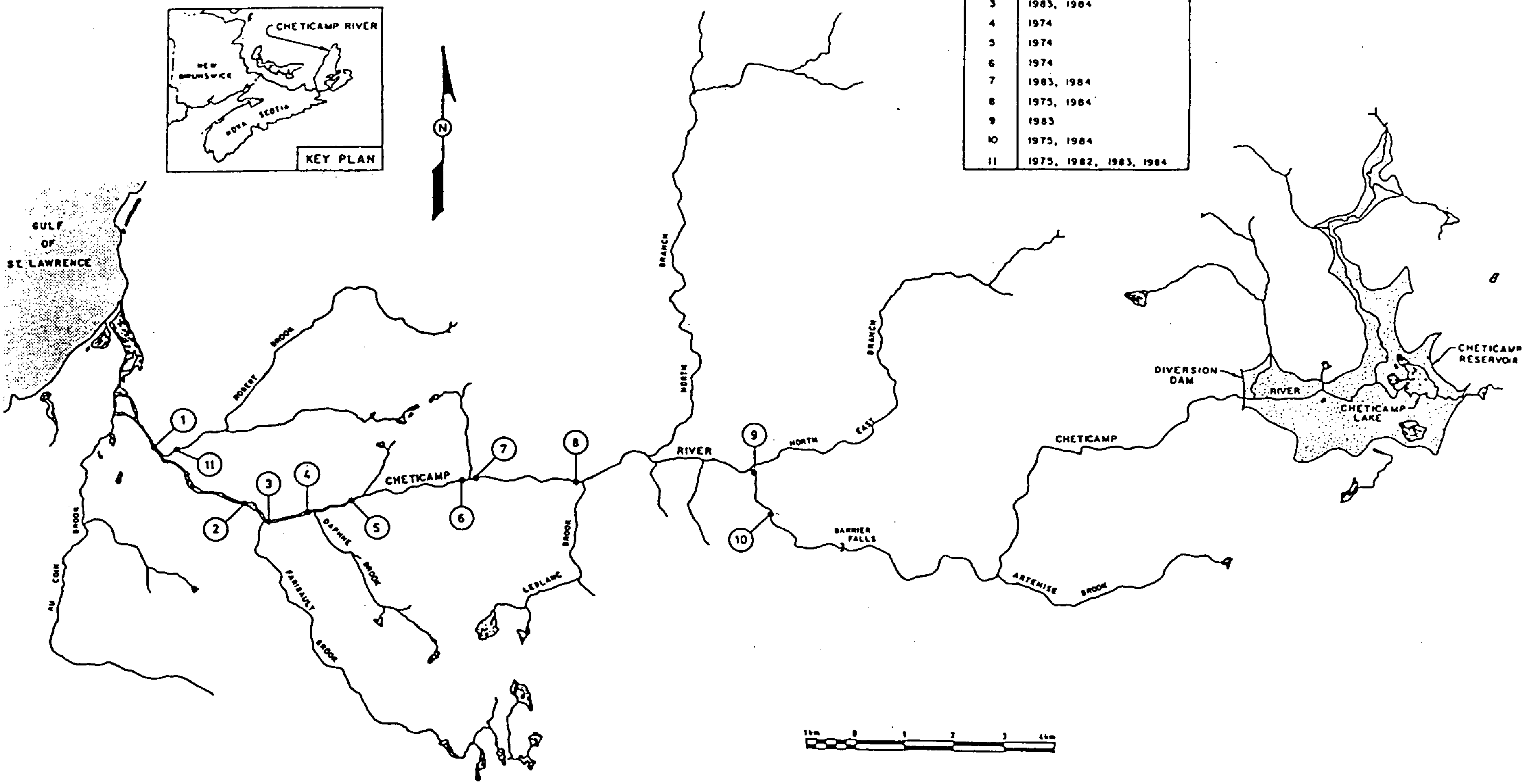
A total of ten sites on the main stem of the Cheticamp, and one site on Robert Brook, was sampled by electrofishing between 1974 and 1984, inclusive. The juvenile Atlantic salmon sampling sites were distributed in the lower 16 km of the river, below an impassable falls that prevents Atlantic salmon access to the river above (Fig. 2). In all, six pre-development and eleven post-development juvenile salmon abundance estimates have been made on the main stem of the Cheticamp. An additional four estimates (one pre- and 3 post-development) have been made on Robert Brook, a lower tributary to the Cheticamp unaffected by the hydro development. Estimates of fry and parr abundance are presented in Table 1 and Figure 3.

During pre-development sampling, the average juvenile abundance (fry + parr) was about 15 fish/100 m^2. After diversion of a portion of the Cheticamp flow, the average juvenile Atlantic salmon abundance has increased to about 30 fish/100 m^2. Normal (relative to other Maritimes salmon rivers in northern Nova Scotia and New Brunswick) densities are about 20-30 fish/100 m^2 (Watt et al. 1983). In the case of the Robert Brook sampling site, 67 juvenile salmon (one sample) were present prior to the Wreck Cove development and an average of 62 juvenile salmon (three samples) was present after the development. Juvenile salmon densities in Robert Brook, however, would not have been affected by the altered flow regime in the main stem of the Cheticamp River. None of the "before" and "after" differences in either fry or parr densities in either the Cheticamp River or Robert Brook is significantly different ($p => .05$).

Cheticamp River Angling Catch

The annual Atlantic salmon angling catch in the Cheticamp River has fluctuated between 8 and 118 fish during the period 1960 to 1984 (Fig. 4). Although the catch has fluctuated markedly, there has been a trend of increasing catches over the 24-year period, with the highest catches appearing during the last four years.

Also depicted in Fig. 4 is the proportion that the Cheticamp angling catch represents of the remaining total Cape Breton Island angling catch. The proportion



SITE	YEAR SAMPLED
1	1982, 1983, 1984
2	1975, 1984
3	1983, 1984
4	1974
5	1974
6	1974
7	1983, 1984
8	1975, 1984
9	1983
10	1975, 1984
11	1975, 1982, 1983, 1984

FIGURE 2 THE CHETICAMP RIVER JUVENILE SALMON SAMPLING LOCATIONS AND THE YEARS THAT POPULATION ESTIMATES WERE MADE

TABLE 1 NUMBERS OF ATLANTIC SALMON FRY AND PARR/100 M^2 AT SELECTED SAMPLING SITES IN THE CHETICAMP RIVER AND ROBERT BROOK PRIOR TO AND AFTER THE WRECK COVE HYDROELECTRIC DEVELOPMENT. THE SITE NUMBERS REFER TO THE SAMPLING LOCATIONS ON THE CHETICAMP RIVER. ONLY ONE SITE WAS SAMPLED ON ROBERT BROOK (SEE FIGURE 2).

		Cheticamp River		Robert Brook		
Years	Site	Fry	Parr	Fry	Parr	Source
Pre-Development						
1974	4	6.1	7.6			Sweeney 1975
1974	5	1.9[1]	1.4			Sweeney 1975
1974	6	4.3	7.7			Sweeney 1975
1975	2	0.0	4.4	45.0	22.0	Amiro 1982
1975	8	30.0	20.0			Amiro 1982
1975	10	0.0	4.9			Amiro 1982
Means		7.1	7.7	45.0	22.0	
Standard Deviation		11.5	6.5	--	--	
Number of Samples		6	6	1	1	
Post-Development						
1982	1	0.41	12.0	0.0	35.0[1]	Parks Canada 1984
1983	1	0.33	21.0[1]			Parks Canada 1984
1983	3	0.0	14.0[1]	11.0	43.0	Parks Canada 1984
1983	7	0.0	15.0			Parks Canada 1984
1983	9	12.0[1]	13.0[1]			Parks Canada 1984
1984	1	6.0	48.0[1]			Parks Canada 1984
1984	3	0.0	14.0			Parks Canada 1984
1984	7	14.0	27.0			Parks Canada 1984
1984	2	7.2	9.0	58.0	38.0	This Study
1984	8	47.0[1]	22.0[1]			This Study
1984	10	28.0	15.0			This Study
Means		11.0	19.0	23.0	39.0	
Standard Deviation		15.0	11.0	31.0	4.0	
Number of Samples		11	11	3	3	

1. Calculated from total catch.

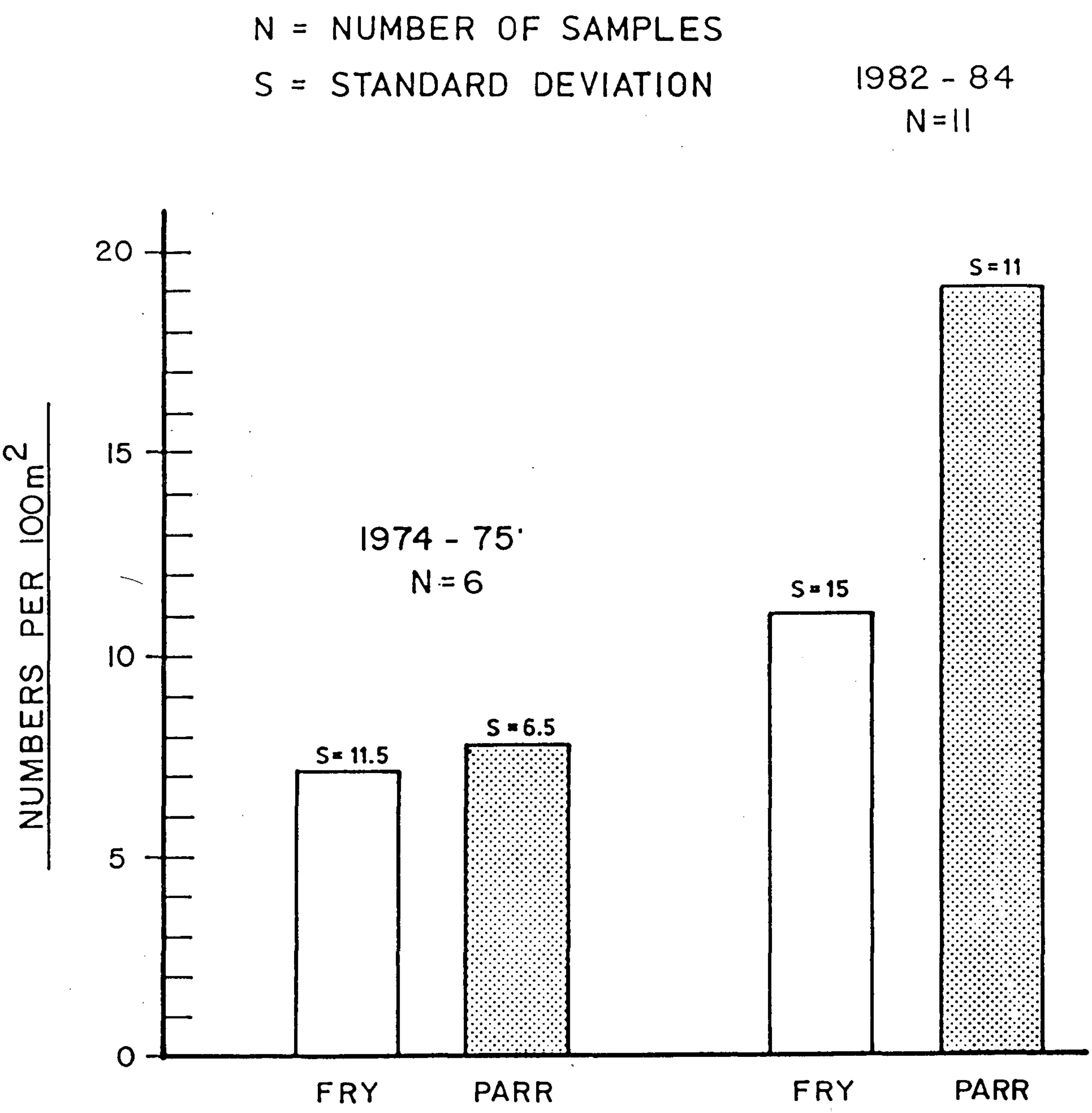


FIGURE 3 MEAN NUMBER OF ATLANTIC SALMON FRY AND PARR IN 1974-1975 (PRIOR TO DEVELOPMENT) AND IN 1982-1984 (AFTER DEVELOPMENT) IN SALMON REARING HABITAT IN THE CHETICAMP RIVER

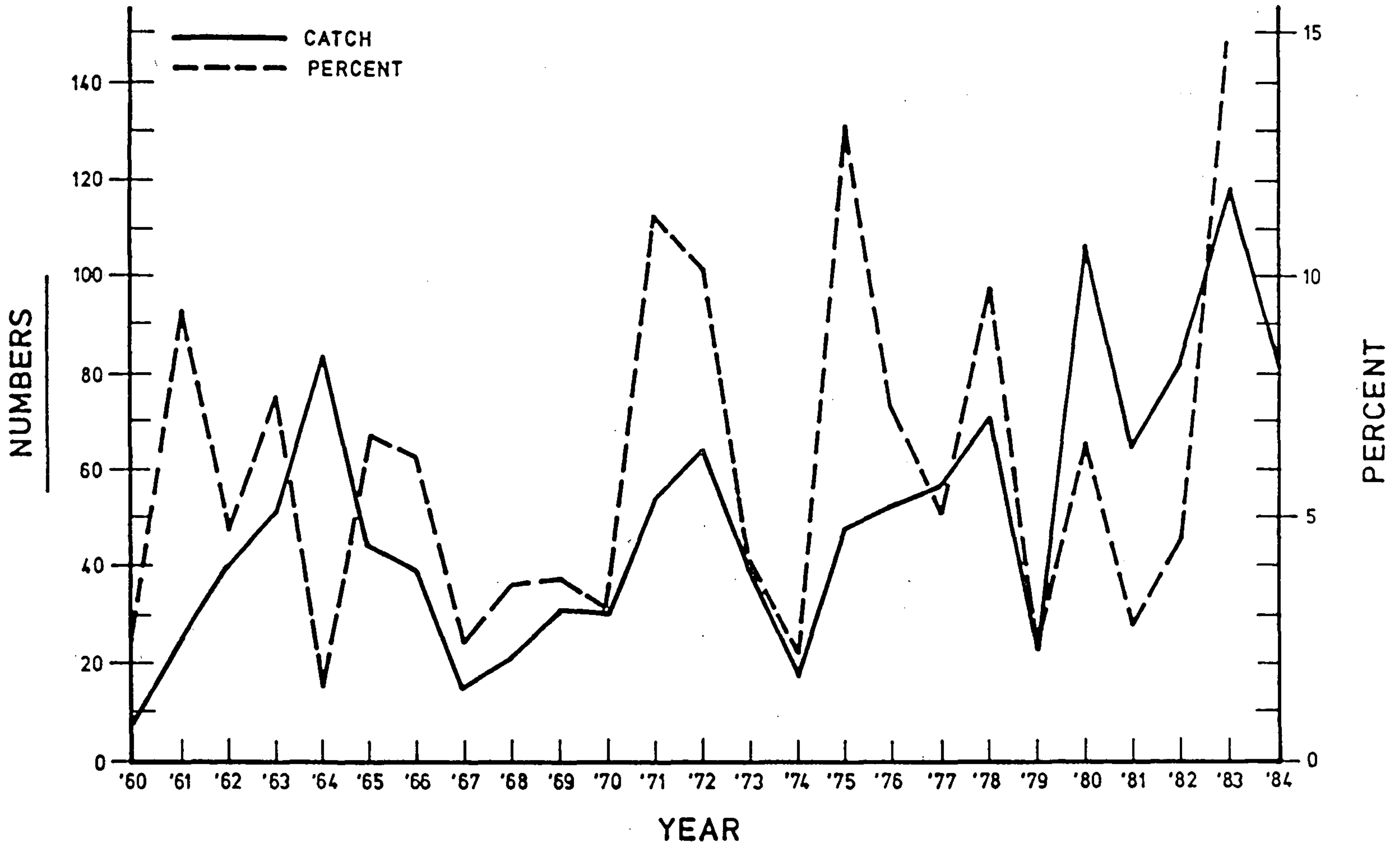


FIGURE 4 ANNUAL ATLANTIC SALMON ANGLING CATCH AND THE PERCENT THAT IT REPRESENTS OF THE REMAINING CAPE BRETON ISLAND SALMON ANGLING CATCH FROM 1960 TO 1984

has varied between a low of 1.3% in 1964, to a high of 14.8% in 1983. For the period 1960 to 1977, the Cheticamp proportion averaged 5.8%, while the proportion increased to 6.8% for the period 1978 to 1984. Although these data show an increase in the average Cheticamp angling catch relative to the total angling catch of other Cape Breton Island salmon rivers since flows were altered in the Cheticamp, the difference is not significant ($p > .05$).

Flows in the Cheticamp River

Mean monthly flows per unit drainage area for the Cheticamp River and for the Northeast Margaree River (an adjacent watershed) were similar for the pre-development period 1964-1977 (Fig. 5). The relationship of the monthly flows in these two drainages over this pre-development period was used to predict mean monthly Cheticamp flows from flows in the Northeast Margaree River under pre-development conditions. The predicted and actual mean monthly flows in the Cheticamp River were similar for the post-development period 1978-1983 (Fig. 6). In general, actual flows were slightly lower than predicted during high flow periods (April-May and September-October), and either equal to or higher during summer and winter low flow periods. The mean annual flow in the Cheticamp, since the hydroelectric development began to divert flow from the upper drainage area, was about 95% of that predicted by the model. Most of the storage appears to occur during the fall high flow period (September, October, November). The higher-than-predicted flow in December is probably due to spillage from the Cheticamp diversion dam.

During the summer period (June to September, inclusive) low flows in the Cheticamp River are augmented by releases from the Cheticamp Reservoir by means of an adjustable gate in the diversion dam. A gauging station was established on the Upper Cheticamp in the spring of 1978, below Artemise Brook, to monitor open-water low flows from the upper drainage area.

Summer flows recorded at the lower gauging station, located just above Robert Brook, the upper station, located below Artemise Brook, and the outlet from Cheticamp Lake, are present in Table 2 for the years 1978-1983, inclusive. On average, about 35% of the total summer flow (July-August) in the Cheticamp River above Robert Brook since development originates from the Cheticamp Reservoir and Artemise Brook. Beak Consultants (1977) estimated that pre-development summer

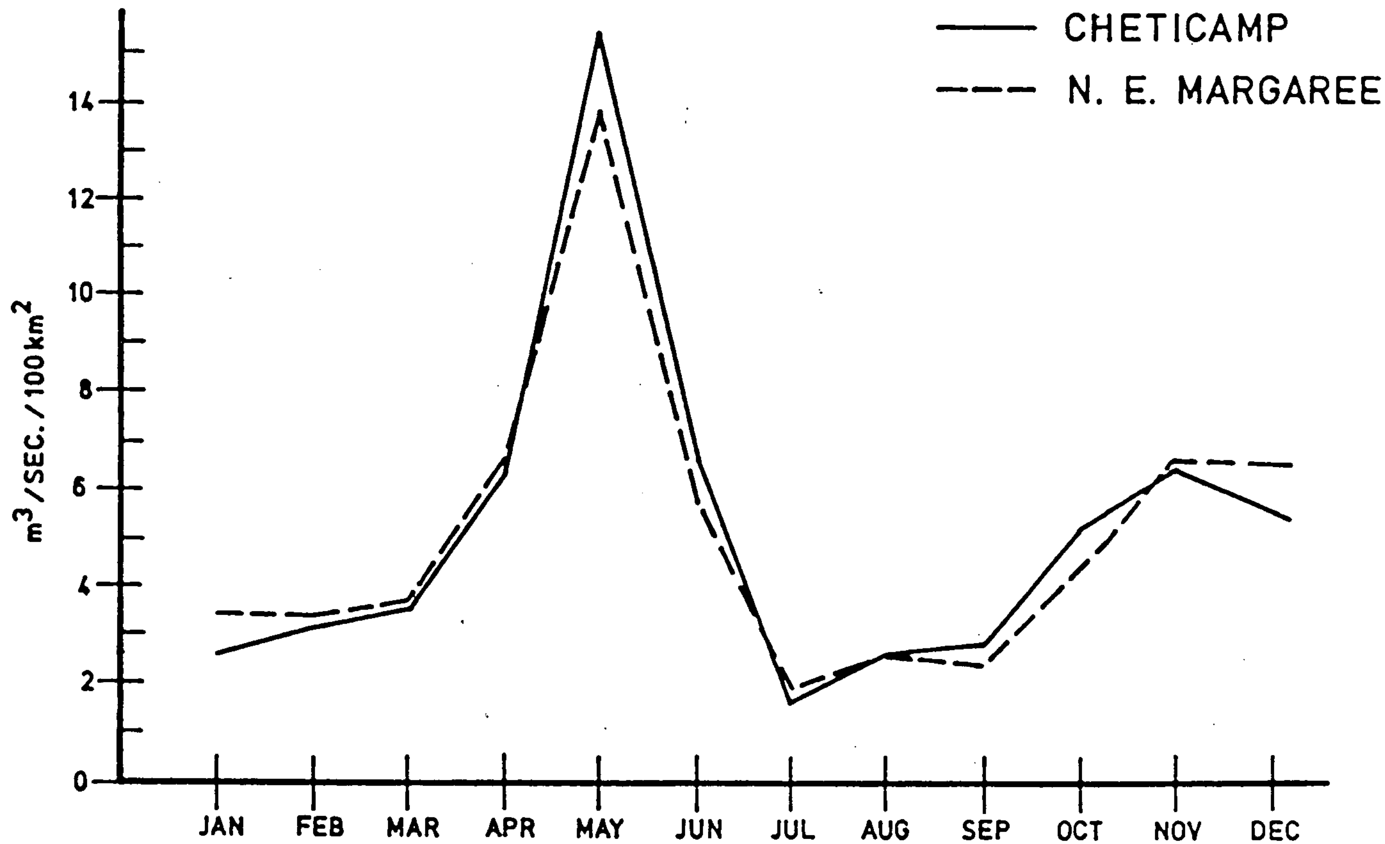


FIGURE 5 MEAN MONTHLY FLOWS PER 100 KM^2 IN THE CHETICAMP AND NORTHEAST MARGAREE RIVERS FOR THE PRE-DEVELOPMENT PERIOD 1964-1977

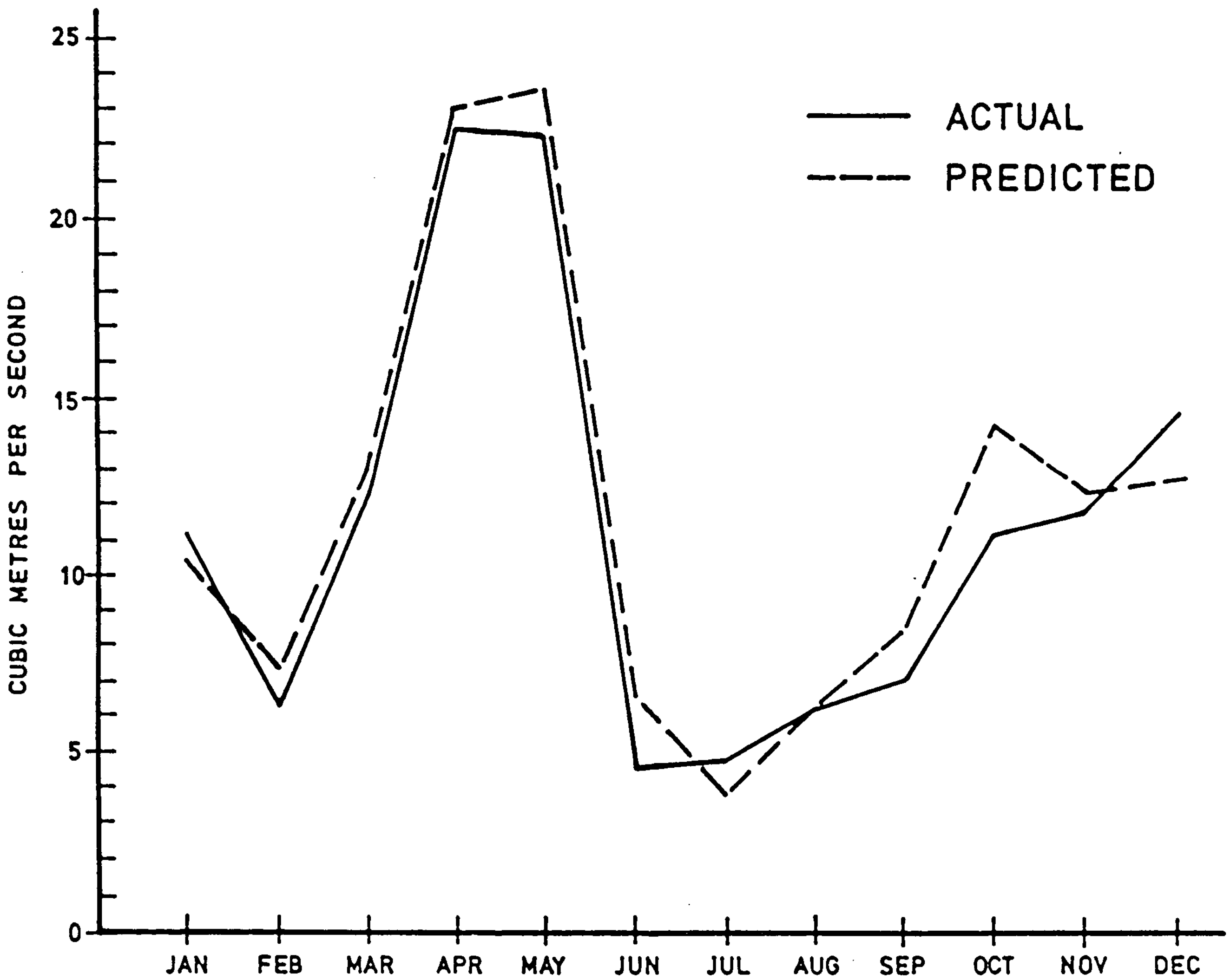


FIGURE 6 PREDICTED AND ACTUAL MEAN MONTHLY FLOWS IN THE CHETICAMP RIVER FOR THE POST-DEVELOPMENT PERIOD 1978-1983

TABLE 2 MEAN MONTHLY SUMMER FLOWS IN M^3/SEC AT THE TWO CHETICAMP RIVER GAUGING STATIONS AND THE RELEASE FLOW FROM CHETICAMP LAKE. THE LOWER STATION IS LOCATED JUST ABOVE ROBERT BROOK AND THE UPPER STATION IS JUST BELOW ARTEMISE BROOK AND ABOUT 3.5 KM UPSTREAM OF THE BARRIER FALLS (FIGURE 2)

	JUNE			JULY			AUGUST			SEPTEMBER		
Year	Lower Cheticamp	Upper Cheticamp	Release Flow	Lower Cheticamp	Upper Cheticamp	Release Flow	Lower Cheticamp	Upper Cheticamp	Release Flow	Lower Cheticamp	Upper Cheticamp	Release Flow
1978	5.25			3.09			2.05	1.03	0.74	6.06	1.47	0.28
1979	4.94		0.85	6.41	1.45	0.91	6.77	1.64	0.43	8.87	1.48	0.23
1980	5.13		0.79	5.85	1.49	0.71	6.65	1.56	0.74	7.17	1.60	0.17
1981	3.85		0.79	6.20	1.16	0.17	4.61	1.12	0.34	4.33		0.45
1982	4.25		0.23	3.35		0.77	3.15		0.91	7.27		1.16
1984	3.83	1.49	0.65	3.64	1.95	1.16	13.90	2.63	1.76	8.64	1.88	0.57
Mean	4.54	1.49	0.66	4.76	1.51	0.80	4.10	1.59	0.85	8.70	1.61	0.58

flows from the same watershed area reflects flow augmentation from the Cheticamp Reservoir during periods of low summer flow.

Reservoir Water Quality Changes

Since the area, shape and depth of lakes and reservoirs may have a profound influence on their physico-chemical conditions and productive capacities, a brief description of the morphometry of the lakes and reservoirs is presented. The surface area and volumes of the Wreck Cove Lakes and Reservoirs, before and after impoundment, were compiled by Kelly (1978). Some of these morphometric parameters are reproduced here in Table 3. The Cheticamp impoundment increased the existing surface area and volume by a factor of 24 and 119, respectively. Similar figures for Gisborne are 11 and 39, and for the Wreck Cove Lakes 3 and 10. Although the mean depth and flushing time increased after impoundment for both Cheticamp and Gisborne Reservoirs, both these parameters decreased in the Wreck Cove Reservoir. One important result is that the Wreck Cove Reservoir now has a complete water exchange (based on its volume and mean annual flow) in only 29 days. In contrast, the Cheticamp Reservoir has a theoretical flushing time of 304 days. Thus water is exchanged over ten times as fast in the Wreck Cove Reservoir as it is in the Cheticamp Reservoir.

In the following sections, brief descriptions of changes in certain reservoir constituents are presented. The years 1975-1977, inclusive, represent conditions in the reservoirs. In 1978, the reservoirs were in the process of being filled.

Phosphorus and Nitrogen

The year following reservoir filling, both phosphorus and nitrogen levels rose dramatically in all reservoirs (Fig. 7). The phosphorus and nitrogen levels in McMillan Reservoir, the reservoir created by the flooding of a river valley, were similar to those in the other three reservoirs, created by impounding existing lakes. Phosphorus levels showed a classical "trophic upsurge" (Baranov 1961) in the year following impoundment, followed by a rapid reduction to mean levels approaching those recorded for the pre-impoundment lakes. Phosphorus levels were higher in the Cheticamp Reservoir than in McMillan, Gisborne and Wreck Cove Reservoirs. The increases in the nitrogen levels were greater than for phosphorus, and they did not show any reduction over the six years since impoundment.

TABLE 3 MORPHOMETRY OF THE LAKES AND RESERVOIRS OF THE WRECK COVE HYDROELECTRIC DEVELOPMENT

	Area	Max. Depth	Mean Depth	Volume	Flushing Time
	(ha)	(m)	(m)	($10^5 m^3$)	(days)
Cheticamp Lake	44	3.0	0.9	5	15
Reservoir	1050	19.5	5.9	616	304
Gisborne Lake	52	10.7	2.7	12	16
Reservoir	591	24.0	8.1	478	57
Wreck Cove Lakes[1]	116	9.1	2.2	28	80
Reservoir	355	19.2	0.4	263	29
McMillan Reservoir	463	48.0	10.9	503	144

[1] Composite figures for Big and Long lakes.

Chlorophyll a

There has been a large increase in the annual mean concentrations of chlorophyll (a measure of phytoplankton biomass) in all reservoirs since the year of impoundment (Fig. 8). Large increases in phytoplankton biomass in Cheticamp and Gisborne Reservoirs did not occur until the third year after impoundment. Chlorophyll concentration in McMillan Reservoir increased over a four-year period and reached levels similar to those recorded for Gisborne and Wreck Cove Reservoirs by 1982. The phytoplankton biomass in the Cheticamp Reservoir is about three times as great as for the other three reservoirs.

Total Organic Carbon and Colour

There has been a large increase in total organic carbon and colour during the first two years after impoundment in all reservoirs (Figs. 9 and 10). There is a strong correlation between total organic carbon and colour in Cheticamp, Gisborne and Wreck Cove Reservoirs. After the initial two-year upsurge, total organic carbon levels decreased to values similar to those existing in the pre-impoundment lakes. Colour returned to values slightly higher than those existing during pre-impoundment years. Cheticamp Reservoir was slightly more highly coloured than the other reservoirs prior to, and after, impoundment.

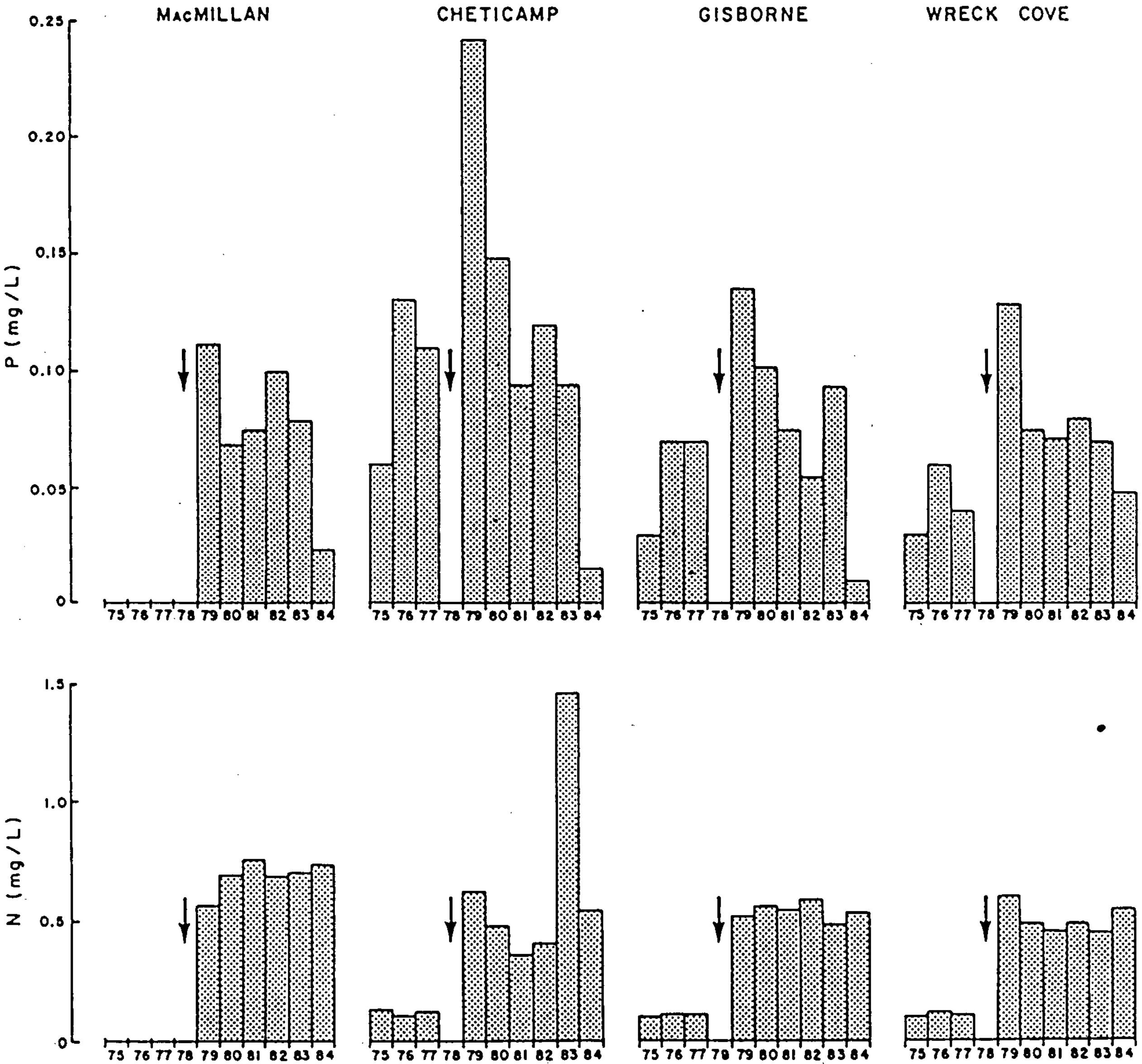


FIGURE 7 YEARLY MEAN CONCENTRATIONS OF TOTAL PHOSPHORUS AND TOTAL NITROGEN IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

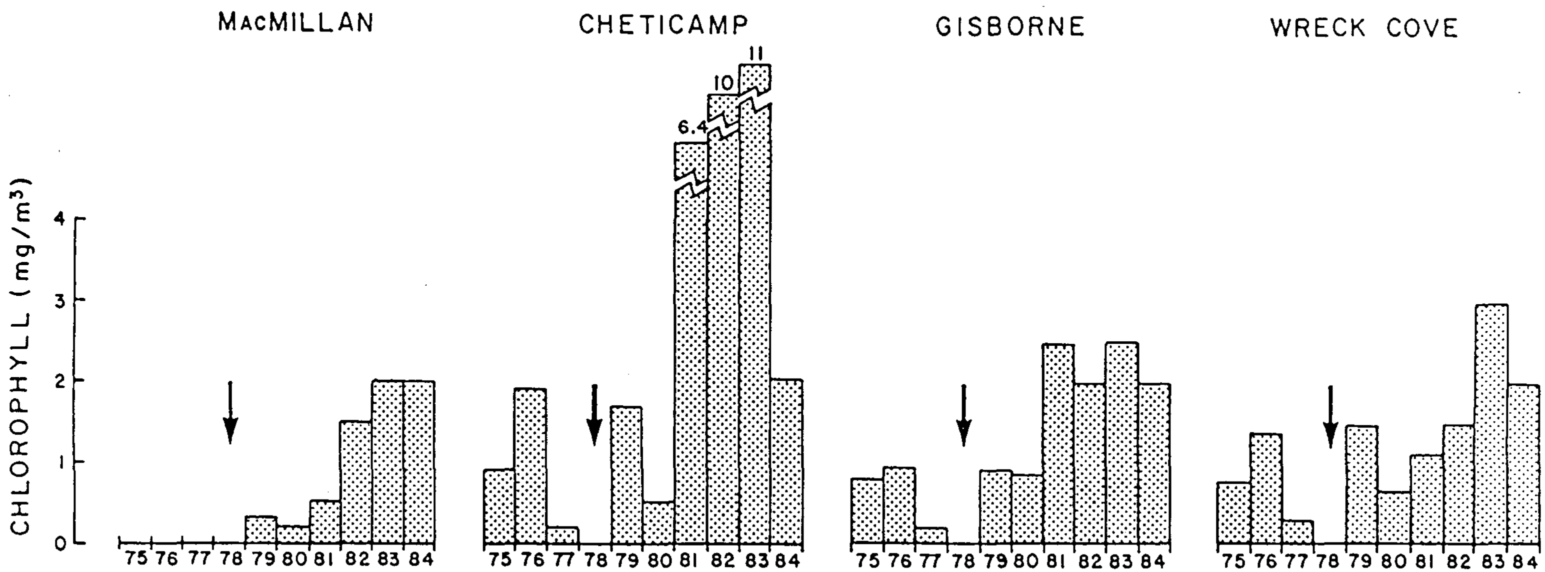


FIGURE 8 YEARLY MEAN CONCENTRATIONS OF CHLOROPHYLL A IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

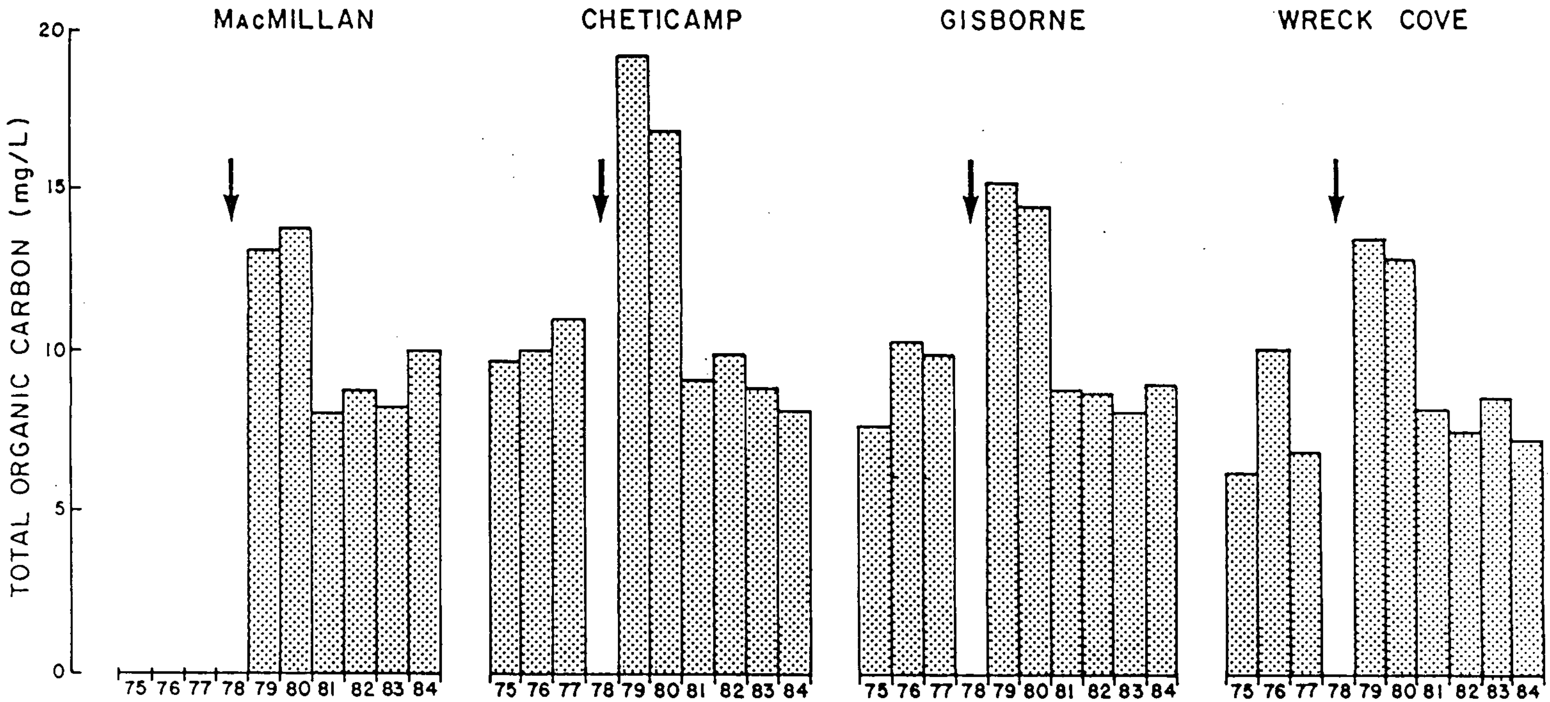


FIGURE 9 YEARLY MEAN CONCENTRATIONS OF TOTAL ORGANIC CARBON IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

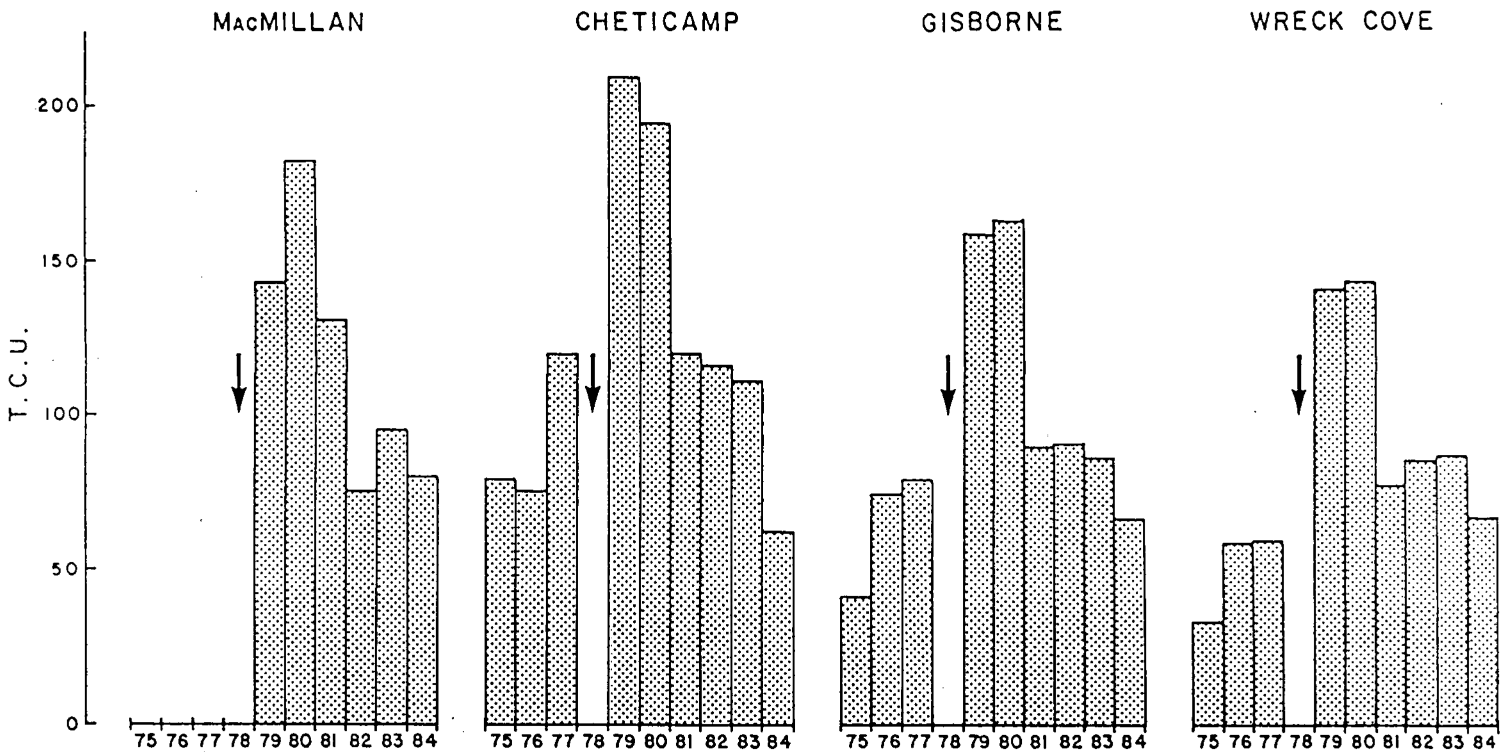


FIGURE 10 YEARLY MEAN CONCENTRATIONS OF COLOUR IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

Suspended Solids

Quantities of suspended solids increased noticeably in Cheticamp and Gisborne Reservoirs for about a three-year period after impoundment (Fig. 11). Increases in suspended solids in Wreck Cove Reservoir were moderate, when compared to the already high levels present prior to impoundment. The yearly pattern of increase was different for each of the four reservoirs but, within four to six years, suspended solids decreased to levels below those measured in the pre-impoundment lakes. In Gisborne and Wreck Cove Reservoirs, the decrease in suspended solids occurred in the fourth year after impoundment, while in Cheticamp Reservoir the decrease to below pre-impoundment levels did not occur until the sixth year after impoundment. There is no evident difference in the concentration of suspended solids in any of the four reservoirs. Prior to reservoir filling, Cheticamp and Gisborne Lakes showed a very similar pattern of increasing suspended solids over the 1975-77 period. By 1984, levels had dropped to below pre-impoundment levels.

Total Dissolved Solids

The concentration of total dissolved solids increased slightly since impoundment (Fig. 12). The yearly means of total dissolved solids for all four reservoirs are similar. Year-to-year fluctuations in total dissolved solids have not been extensive, ranging from a low of 25 in the Cheticamp Reservoir, to a high of 46, which occurred in the Wreck Cove Lakes in 1975.

Dissolved Oxygen

There has been a reduction in mean annual dissolved oxygen levels for the first three years after impoundment (Fig. 13). The decrease however has not been great, and mean annual dissolved oxygen levels remained above 8 mg/L in Cheticamp, Gisborne and Wreck Cove Reservoirs. After the initial three-year period, dissolved oxygen concentrations returned to levels equal to or greater than existed in the pre-development lakes.

pH

There has been no change in the pH level since the impoundment of Cheticamp Reservoir (Fig. 14). In Gisborne and Wreck Cove Reservoirs, the mean annual pH levels are slightly lower than existed in the pre-impoundment Wreck Cove Lakes. The pH in Cheticamp Lake and Reservoir is much less than in the remaining

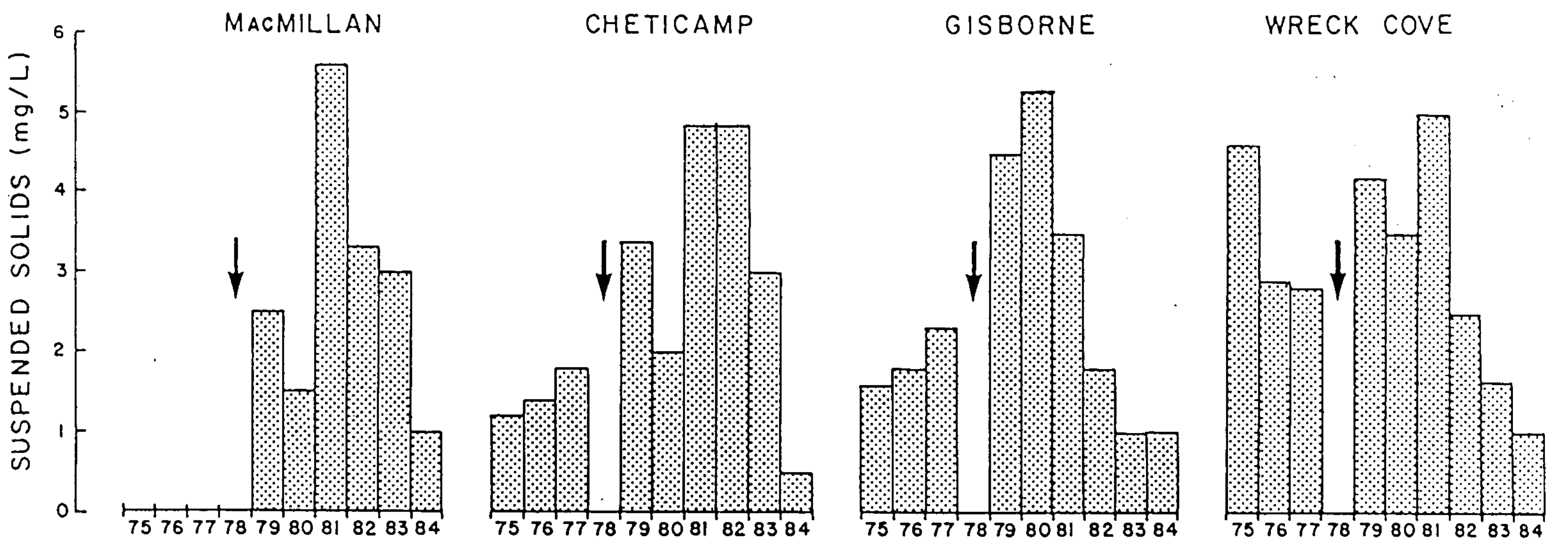


FIGURE 11 YEARLY MEAN CONCENTRATIONS OF SUSPENDED SOLIDS IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

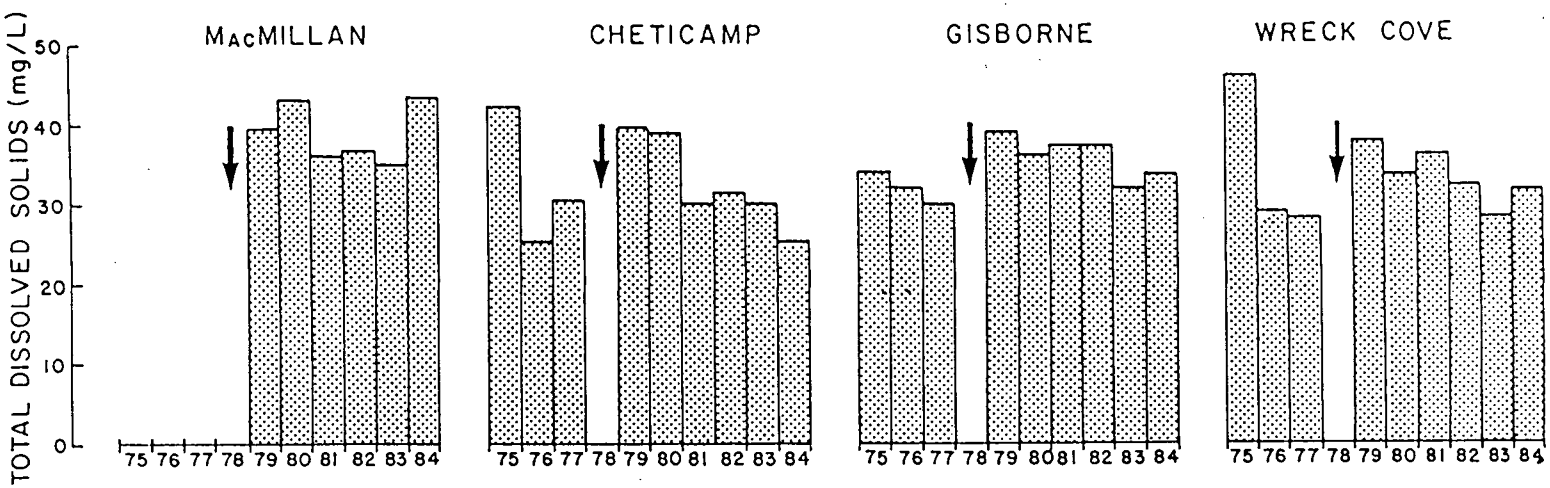


FIGURE 12 YEARLY MEAN CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

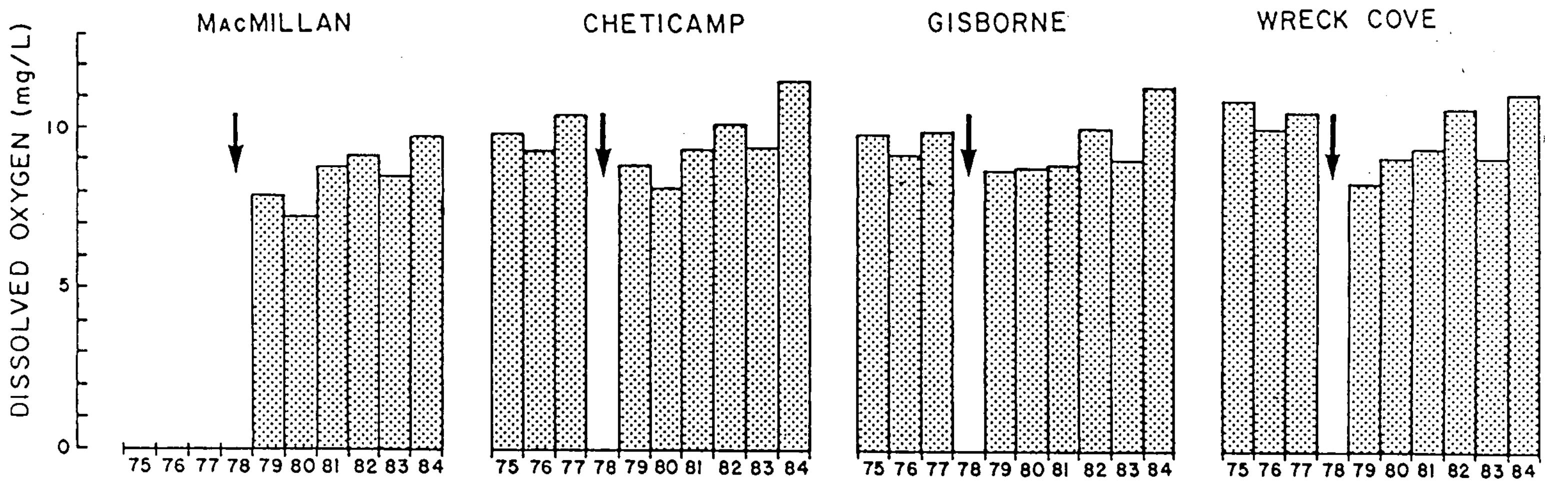


FIGURE 13 YEARLY MEAN CONCENTRATIONS OF DISSOLVED OXYGEN IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

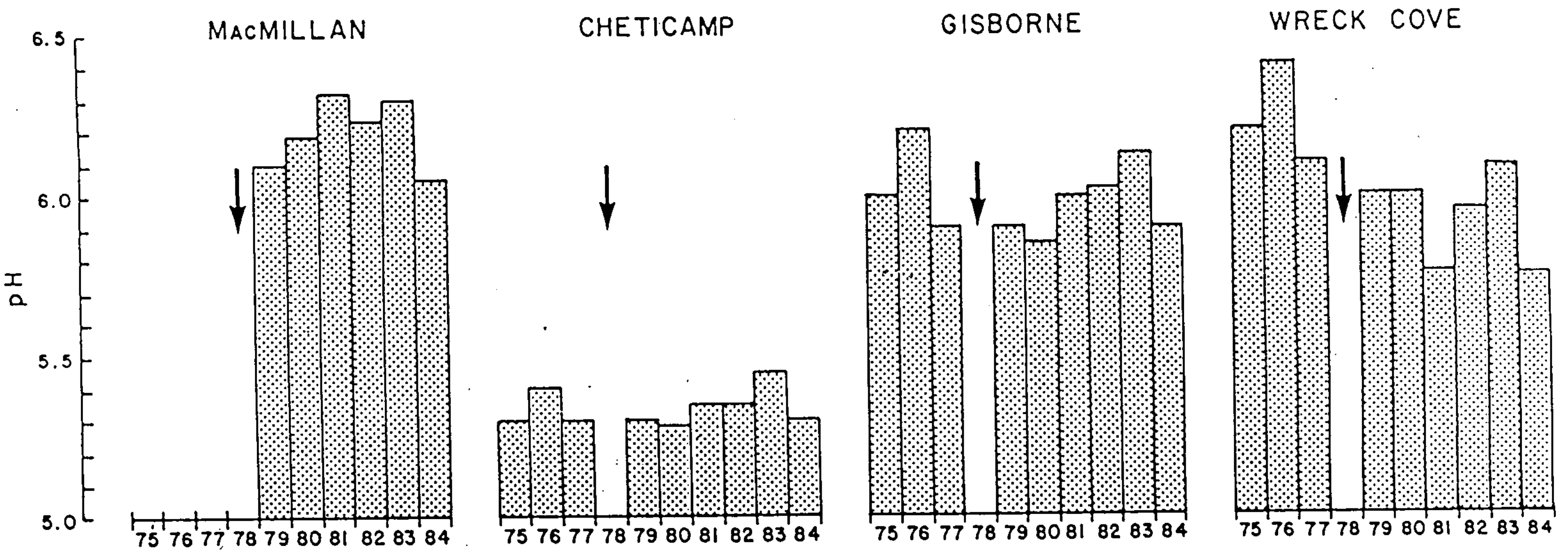


FIGURE 14 YEARLY MEAN pH'S IN THE LAKES (1975-1977) AND RESERVOIRS (1979-1984). THE ARROWS DENOTE THE YEAR OF RESERVOIR FILLING

reservoirs. Prior to impoundment, Cheticamp, Gisborne and the Wreck Cove Lakes showed similar annual changes in pH. The pH is highest in McMillan Reservoir.

Discussion

The increase in juvenile salmon abundance in the Cheticamp River during the post-development period demonstrates the effectiveness of the minimum flow provision developed during the pre-development environmental assessment and confirms the prediction that the salmon resource would not suffer as a result of the hydroelectric development. Although the increase is not significant at a probability of error of 5%, the doubling of parr abundance is suggestive of what is likely happening to juvenile salmon populations in the lower Cheticamp River. In any case, it can be concluded that juvenile salmon abundance in the Cheticamp has not declined since the construction of the Wreck Cove hydroelectric project. Hence, the riparian flow has been adequate to maintain juvenile salmon abundance at or above pre-development levels. The fact that only 18% of the drainage area of the Cheticamp was diverted has meant that the natural hydrologic regime in the Cheticamp has been more or less maintained, while summer low flows have been augmented by releases from the Cheticamp Reservoir. It is not surprising, therefore, that juvenile salmon populations are maintaining their pre-development levels of abundance.

An important lesson from the lack of precision in measuring changes in juvenile abundance is the necessity of adequate "before" and "after" sampling to establish suitable data for comparison. The variability of population estimates derived from removal methods must be taken into account when designing a juvenile salmon survey. Moran (1951) presents the following conditions that are required to derive valid population estimates from the quantitative depletion sampling:

(1) The population must be isolated, i.e. the influence of migration, losses caused by natural mortality and recruitment must be significant during the sampling period.

(2) The catch per unit effort must significantly reduce the population size.

(3) The probability of capture remains constant throughout the entire sampling period, i.e. no change in effort between sampling is acceptable.

(4) The probability of capture is the same for all individuals in the population.

(5) The population must not be so large that the catching of one member interferes with the capture of another.

In the case of the present study, the first two conditions were reasonably met. However, it is unlikely that the probability of capture of juvenile salmon remained constant (the third condition). Both Libosvarsky (1967) and Mahon (1980) showed that the vulnerability of fish to capture by electrofishing declined in successive fishings due to the inactivity of previously stunned, but uncaught fish.

The probability of capture being the same for all individuals in the population (the fourth condition) was violated due to size selectivity in electrofishing (Vibert 1967). The splitting of the sample into fry and parr, and estimating abundance for each of these life history stages separately, overcomes this problem to some degree. The fact that salmon fry, as opposed to parr, are more difficult to capture by electrofishing, results in higher sample variability in the estimates of fry abundance than in similar estimates for parr.

It is unlikely that there was any large error introduced due to interference although there may have been an unconscious bias towards selecting the larger stunned fish because of their greater visibility (condition five).

It is particularly unfortunate that more juvenile salmon abundance estimates are not available for the period before hydroelectric development. No amount of post-development sampling can make up for the lack of a suitably precise pre-development estimate of juvenile salmon abundance. The inherent variability of the population estimates, based on the quantitative depletion method, suggests that at least 10 samples should be obtained to derive useful estimates of juvenile Atlantic salmon abundance under conditions found in the Cheticamp River.

Although the use of catch statistics as a proxy for overall fish abundance is notoriously unreliable, it does provide a record of how the resource is utilized. The fact that the average Cheticamp River angling catch, as well as the proportion this represents of the remaining salmon angling catch for Cape Breton Island, has not declined since the Wreck Cove development, demonstrates that diversion of the headwaters has not had an adverse impact on salmon angling. This conclusion is consistent with the results of the juvenile salmon sampling and suggests that the Cheticamp salmon resource, and its major use by man, has not been adversely affected by the Wreck Cove hydroelectric development. Thus, the prediction that the hydroelectric development would not adversely impact the Cheticamp salmon resource was correct.

The derivation of a suitable flow release strategy from the Cheticamp Reservoir to protect the salmon resource in the Cheticamp River was an important objective of the environmental assessment. The consultants reasoned that due to the freshwater life history of Cheticamp salmon, any year class of salmon in the river would, on average, be exposed to the equivalent of a one-in-four-year minimum summer flow. The assumption was made that juvenile salmon were adapted to low flow stresses of this magnitude because the freshwater stage lasted an average of four years. On this basis, flow releases from the Cheticamp Reservoir were derived to guarantee a minimum flow at the barrier falls of 0.9 m^3/sec. This criteria for the guaranteed flow is the average July low flow which occurs historically one year in four. This summer minimum flow was subsequently increased through negotiations between federal fishery officials and the Nova Scotia Power Corporation to 1.2 m^3/sec., the estimated historic mean July flow at the barrier falls. On average, it was estimated that a flow of about 0.3 m^3/sec. would be required to be released from the Cheticamp Reservoir in order to provide the minimum flow required at the barrier falls. The July-August releases have averaged over 0.8 m^3/sec. from the reservoir.

The summer minimum flow at the barrier falls site has been met or exceeded in four of the six years for which records are available. In neither of the two years when upper Cheticamp flows were below the minimum, did recorded flows go below 1.03 m^3/sec. The impact of diverting a portion of the Cheticamp drainage on the natural hydrologic regime of the river has been minimal and may have benefitted salmon production by stabilizing and improving flows during the summer low flow period. A number of other workers have noted improved conditions for anadromous fish below dams through improved and stabilized flows (Moffet 1949, Neave 1958, Lister and Walter 1966, Mundie 1979). In general, the flow release strategy appears to have been successful in protecting the salmon resource in the Cheticamp River and the predictions of how the resource would respond to the altered hydrologic regime were accurate.

Nutrients, primarily phosphorus and nitrogen, exhibit periods of rapid inputs from flooded soils and vegetation after reservoir creation. Ostrofsky (1978) showed that the vegetation covering the area flooded by the Smallwood Reservoir readily released it phosphorus and nitrogen when submerged. Crawford and Rosenberg (1984) showed that black spruce (Picea mariana) needles were quickly colonized and broken down, mainly by chironomids, in the Southern Indian Lake impoundment.

Baranov (1961) describes the general process as bacterial decomposition of submerged vegetation releasing inorganic phosphorus and ammonia nitrogen (which is transformed into nitrate nitrogen). The release of these and other nutrients causes a subsequent raising of the trophic level. Baranov felt that the trophic upsurge could last as long as six years. In the case of the reservoirs associated with the Wreck Cove hydroelectric development, elevated nutrient levels are in evidence six years after impoundment.

The impoundments associated with the Wreck Cove development altered the morphometry of the existing lakes in different ways that may have influenced the rates of sedimentation in each reservoir. Changes in volume and flushing rates in McMillan, Cheticamp and Gisborne Reservoirs make these reservoirs better sediment traps after impoundment, as has occurred in many other reservoirs (Baxter and Glaude 1980). However, the morphometric changes in the Wreck Cove Reservoir probably have had a different effect on sediment transport and deposition. The increase in flushing rate after the impoundment of the Wreck Cove Lakes will decrease the rate of sedimentation in the Wreck Cove Reservoir.

The trophic upsurge in all the reservoirs was followed two years later by higher concentrations of chlorophyll. Since chlorophyll is a measure of phytoplankton biomass, phytoplankton populations remained depressed, even when nutrient levels were high, during the first two years of impoundment. It is probable that high colour, which was characteristic for the two years following impoundment, reduced light availability for photosynthesis. Hutchinson (1957) suggests that organic compounds originating from soils or peaty material produce highly coloured water which impedes light penetration and photosynthesis.

The higher phytoplankton biomass in Cheticamp Reservoir compared to the other three reservoirs probably reflects the much longer flushing time in this reservoir (Table 3). Thus, phytoplankton populations have a more stable lake-like environment to develop in and are not flushed out of the reservoir by a rapid exchange of water. In addition, phosphorus levels (often a limiting nutrient for phytoplankton growth) are higher in Cheticamp Reservoir than in the other three reservoirs.

Larkin (1984) stresses the value of using experimentation and computer simulations for deriving some of the answers to questions about how the aquatic environment may change due to hydroelectric development. He also notes the lack of these techniques in most environmental impact assessments for large projects affecting lakes and streams in Canada. The Wreck Cove environmental study utilized both experimentation and computer simulations to predict impacts on the reservoirs and to derive an operating schedule that would maintain suitable water quality. Laboratory simulation experiments to study peat decomposition and mathematical modelling studies of the temperature and oxygen regimes in the reservoirs were conducted. A complete description of the derivation of the models and the results of the peat decomposition experiments is given by Snodgrass and Holloran (1978).

Based largely on the results of these models and peat decomposition experiments, predictions were made concerning conditions to be encountered in the four reservoirs under different reservoir operating schemes. It was determined that the two lower reservoirs (Wreck Cove and Gisborne) had the greatest potential for fish production and recreational use if water levels in these reservoirs were closely managed, and the two upper reservoirs (Cheticamp and McMillan) could be drawn down to supply the power generation needs. Results of the reservoir simulations were used to devise a reservoir operating scheme that maximized environmental benefits, while not seriously reducing power production. One important result has been the maintenance of oxygen in all the reservoirs at levels suitable for fish production. In general, predictions on oxygen levels have been confirmed.

The Wreck Cove environmental assessment also made a number of specific predictions concerning water quality and primary production in the four reservoirs. These are summarized in Table 4, along with observations from this study. In general, the impact study failed to accurately predict changes in colour, pH, nutrients and primary production that occurred due to impoundment.

The lack of accuracy in all these predictions seems to have originated in underestimating the increases of allochthonous material derived from soils, vegetation and peaty material flooded by rising water levels. The impact study predicted that much of the nutrients added, by way of flooding and leaching, would be removed by sedimentation and flushing before contributing to biotic cycles in the reservoirs. There may also have been an underestimation of the contribution of eroding shorelines as a source of organic matter (mostly humic materials) and nutrients.

Because the amount of humic material eventually reaching the reservoirs was also incorrectly predicted, an increase in pH after impoundment was underestimated. The reason why a reduction in humic material was predicted was the belief that it would decrease in the reservoirs due to UV radiation and to physical and

TABLE 4 PRE-IMPOUNDMENT PREDICTIONS AND POST-IMPOUNDMENT OBSERVED CHANGES IN COLOUR, pH, NUTRIENTS (PHOSPHORUS AND NITROGEN) AND PRIMARY PRODUCTION IN THE WRECK COVE RESERVOIRS

	McMillan	Cheticamp	Gisborne	Wreck Cove
- Predicted impact on colour	lower (50-80)	lower (100)	lower (50)	lower (50)
Observed impact on colour	higher (75-180)	higher (60-120)	higher (70-165)	higher (65-145)
- Predicted impact on pH		increase (above 6)	increase (6.5)	increase (6.5-7.5)
Observed impact on pH		no change (5.5)	no change (6.0)	decrease (5.8-6.1)
- Predicted impact on nutrients	a noticeable increase	slight increase	slight increase	slight increase
Observed impact on nutrients	large increase	large increase	large increase	large increase
- Predicted impact on primary production	trophic surge greatest	very slight increase in 1st year	very slight increase in 1st year	very slight increase 1st year
Observed impact on primary production	trophic surge similar	very large increase in 3rd, 4th and 5th yrs.	large increase in 3rd to 6th years	increase in 1st to 6th years

- In relation to other reservoirs.

microbial adsorptive processes. Along with this reduction of humic materials, it was felt that there would be an increase in pH due to less organic acid reaching the reservoirs per unit drainage area than had previously reached the lakes. The reverse has occurred in Gisborne and Wreck Cove Reservoirs due to the inflow from the more acidic Cheticamp Reservoir, with resultant reductions in pH since impoundment. The low pH, both before and after impoundment, in the Cheticamp Lake and Reservoir reflects the effect of acid bog drainage.

CONCLUSION

The conduct of this follow-up study allows some general conclusions to be made concerning the effectiveness with which certain environmental factors were taken into account in the planning of the Wreck Cove hydroelectric development. Although the environmental impact assessment process carried out on this hydroelectric project suffered from many defects (Cunningham 1983), it appears to have been successful in protecting the Cheticamp salmon resource and in minimizing water quality deterioration in the reservoirs.

It should be noted, however, that the original flow release strategy proposed in the Environmental Assessment Report was altered through negotiations with federal fishery officials, so that the final minimum flow at the upstream limit of salmon distribution in the Cheticamp River was increased by about 33% over that recommended. In any case, instream flows in the Cheticamp since hydroelectric development have been similar to those prior to development. In fact, the new flow regime may represent an improvement for fish production over the natural flow regime, since peak flows in the spring and fall are moderated and summer low flows are augmented by releases from the Cheticamp Reservoir. It is unclear whether the original flow release strategy proposed in the Beak study would have been successful in maintaining Cheticamp Atlantic salmon at pre-development population levels.

The use of laboratory simulation experiments to study peat decomposition and mathematical modelling studies to predict temperature and oxygen regimes in the reservoirs was a laudable example of the use of these scientific methods that are often under-utilized in environmental impact assessments. Their use enabled a reservoir operating scheme that preserved oxygen levels in all reservoirs suitable for fish production and maximized trout habitat in Wreck Cove and Gisborne Reservoirs.

Another strength of the Wreck Cove environmental assessment was the planning of before-and-after water quality studies of the affected lakes and resultant reservoirs. Unfortunately, no one (for instance a government department or university) has followed up on the unique opportunity to document the aquatic changes resulting from the Wreck Cove development. The present study examines only gross water quality changes in the reservoirs and the work by Kelly (1978) was terminated prior to impoundment. There appears to have been a lack of follow-through by government to utilize this water quality information, even though they continue to request its collection. One explanation may be the change of government personnel with the resultant loss of continuity, personal knowledge, commitment and understanding of the hydroelectric project. The result is that scientific and technical interest has not been sustained over the life of the project.

The lack of adequate baseline data on Cheticamp juvenile salmon abundance is an example of a common shortcoming of many environmental impact assessments. The baseline data on fish abundance was not collected in a satisfactory manner to allow for a valid comparison with future data collection. This is a serious problem that is easily solved during the planning stages of an EIA, but cannot be resolved after the project has been completed.

The lack of accuracy in a number of specific predictions concerning colour, pH, nutrients and primary production may have been partly the result of not interpreting existing scientific information correctly on the development sequence of reservoirs. None of the relevant literature that forms the current "reservoir paradigm" (e.g. Baranov 1961; Frey 1967; Lowe-McConnel 1973; Baxter 1977) was referenced in the impact study. Perhaps because of the unfamiliarity with this literature, there was an underestimation of the amount of allochthonous material derived from soils, vegetation and peaty material that eventually reached the reservoirs and, subsequently, altered the colour, pH, nutrient levels and primary production of the original Wreck Cove Lakes.

The Wreck Cove environmental study was meant to maximize environmental benefits by incorporating appropriate mitigative measures into the hydroelectric project design, rather than assess whether the project was environmentally acceptable. Insofar as protecting the Cheticamp salmon and maintaining reservoir water quality, the environmental protection process seems to have worked. A combination of the efforts by the environmental consultants, the Nova Scotia Power Corporation and the regulatory agencies has resulted in a reservoir management policy that provides suitable riparian flows in the Cheticamp River, minimum water quality deterioration in the reservoirs, and maximum power production. In view of the litany of defects of the Wreck Cove EIA process (Cunningham 1983), it is important to note the effectiveness with which these environmental factors were considered in the final planning and operation of the Wreck Cove hydroelectric development.

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FOLLOW-UP REVIEW OF IMPACT ASSESSMENTS WITHIN THE COQUIHALLA VALLEY, BRITISH COLUMBIA

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Introduction

Environmental Impact Assessment (EIA) has become an integral part of almost every development proposal having some regional significance. However, despite the widespread incorporation of EIA documents into regulatory processes, their predictive capability is usually extremely limited. In addition, there has been almost no attempt to follow up developments with monitoring programs capable of evaluating the accuracy of impact predictions or the effectiveness of mitigative measures employed (Beanlands and Duinker 1983; Larkin 1984).

This study is intended to aid in the refinement of the EIA process, by examining technical aspects of several developments where some formal assessment was undertaken and at least some follow-up review was completed. This retrospective examination was expected to provide some of the essential information necessary to improve both the procedural/administrative and technical aspects of EIA, thereby increasing its effectiveness in early project planning and decision making.

After examining a number of potential areas, the Coquihalla Valley in southwestern British Columbia (Figure 1) was selected as the study area. It is a multi-use transportation corridor where several linear and non-linear developments (pipelines, roads, mines, logging) have been constructed. The Coquihalla River supports an important fish resource, summer run steelhead trout, which have been a major focus of environmental concern related to developments in the corridor.

The study focuses on the three linear developments within the valley corridor shown in Table 1. Although other linear developments have occurred in this region, they were completed prior to 1960 when the assessment process for these activities was not well documented. These and other ancillary non-linear developments were not reviewed in the same detail as the three case studies, but were considered peripherally to provide a more complete understanding of environmental issues in

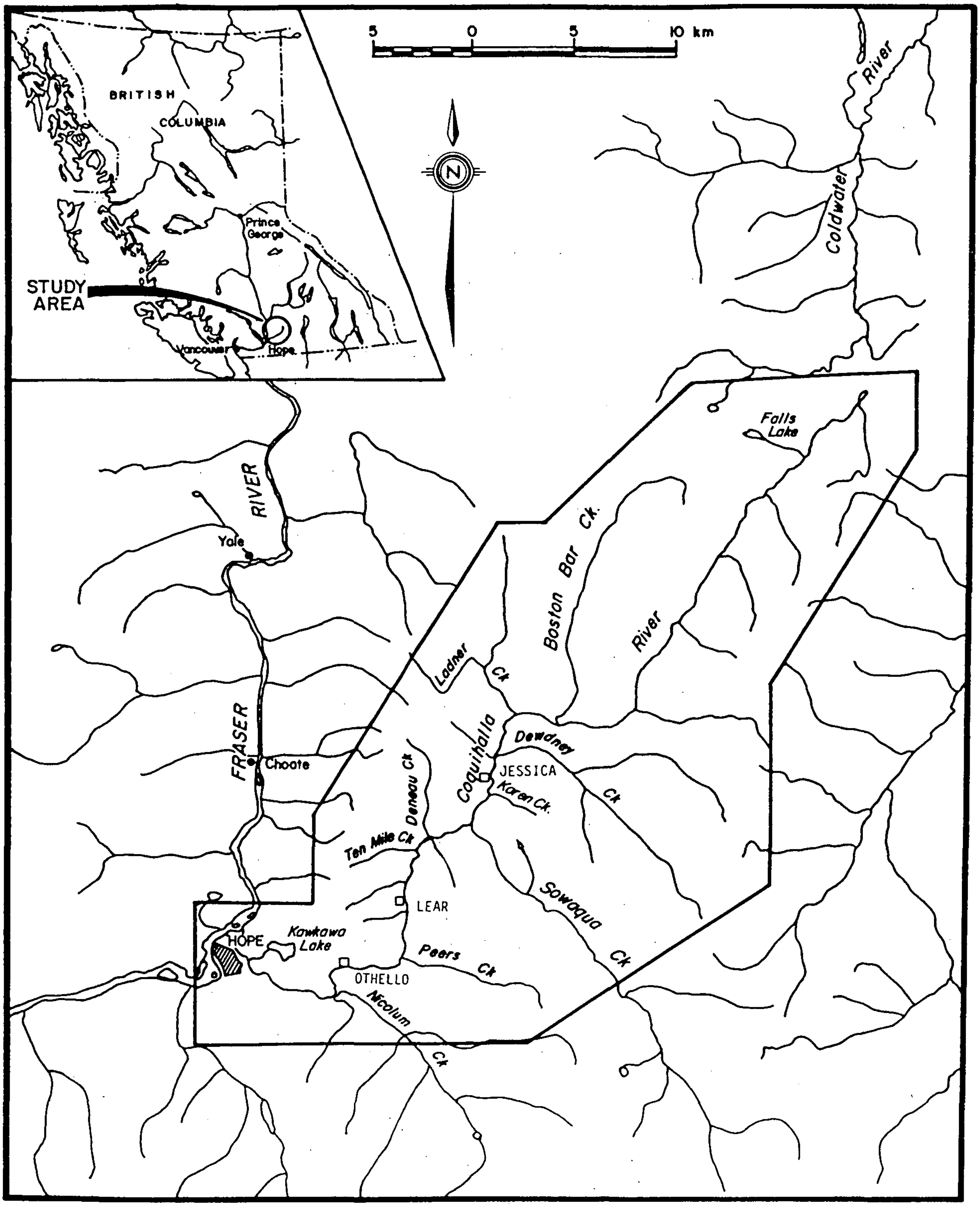

FIGURE 1 STUDY AREA FOR THE COQUIHALLA FOLLOW-UP REVIEW

TABLE 1 CASE STUDY DEVELOPMENTS

Proponent	Development	Environmental Submission	Status
Trans Mountain Pipe Line Co. Ltd.	762 mm oil pipeline	NEB Application/Environmental Assessment submitted	Reviewed at NEB hearings in 1979; not constructed
Westcoast Transmission Co. Ltd.	914 mm natural gas pipeline	NEB Application/Environmental Assessment submitted	Construction completed in 1979
B.C. Ministry of Transportation and Highways (MOTH)	Major 4 lane highway from Hope to Merritt	• Preliminary Assessment (1978) • Detailed Assessment (1979) • Referral process	Initial segment (Nicolum Ck to Peers Ck) constructed in 1980

the region (Table 2). The locations of all developments over several time periods are shown in Figure 2.

This paper presents the main results of the investigations reported by Zallen et al. (1985). Some detail is also provided on the methods employed to provide comparison with other studies.

Study Approach

The study was restricted to impact considerations with respect to the summer steelhead population. Other resources such as vegetation or wildlife were not investigated. The study emphasizes technical aspects of the assessments, but also examines certain procedural or administrative processes, such as responsibilities for monitoring, supervision, and surveillance, or specific terms and conditions applied to project development.

The follow-up study involved the participation of individuals representing both government and industry (Figure 3); acquisition of information related to environmental impact assessments conducted for the major developments in the Coquihalla corridor; and the evaluation of each case on the basis of a series of technical questions related to the EIA process.

The specific questions that were addressed by the study team were:

A. What were the key issues related to residual impacts in project EIA?

TABLE 2 OTHER CORRIDOR DEVELOPMENTS REVIEWED IN LESS DETAIL

Proponent	Development	Environmental Submission	Status
Kettle Valley Railway	Railway Line	None	Constructed 1916; abandoned 1961
Forestry	Logging and road system	None	1950 - present
Trans Mountain Pipeline Co. Ltd.	610 mm oil pipeline	None	Installed 1953
Westcoast Transmission Co. Ltd.	760 mm gas pipeline	None	Installed 1956/57
Carolin Mines Limited	Underground gold mine above Ladner Creek	B.C. Stage I/ Addendum to Stage I	Constructed 1979/80; closed 1984

B. What were the approaches, methods and criteria used to complete EIA?

C. How did EIA describe the potential impact magnitude?

D. What was the degree of cumulative impact assessment?

E. How were environmental planning and project planning integrated?

F. What environmental terms and conditions were attached to project approval?

G. What mitigative measures were proposed and actually employed?

H. *What monitoring, surveillance and supervision programs were employed?

I. What was the degree of residual impact that occurred?

J. What unanticipated impacts occurred (not documented in the EIA)?

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* For the purpose of this study, monitoring was defined as any program which provided data for determining residual impacts of developments or evaluating mitigative structures or techniques. Surveillance refers to various inspection activities by regulatory agencies related to overseeing actual construction activities, supervision refers to inspection activities undertaken by the developer.

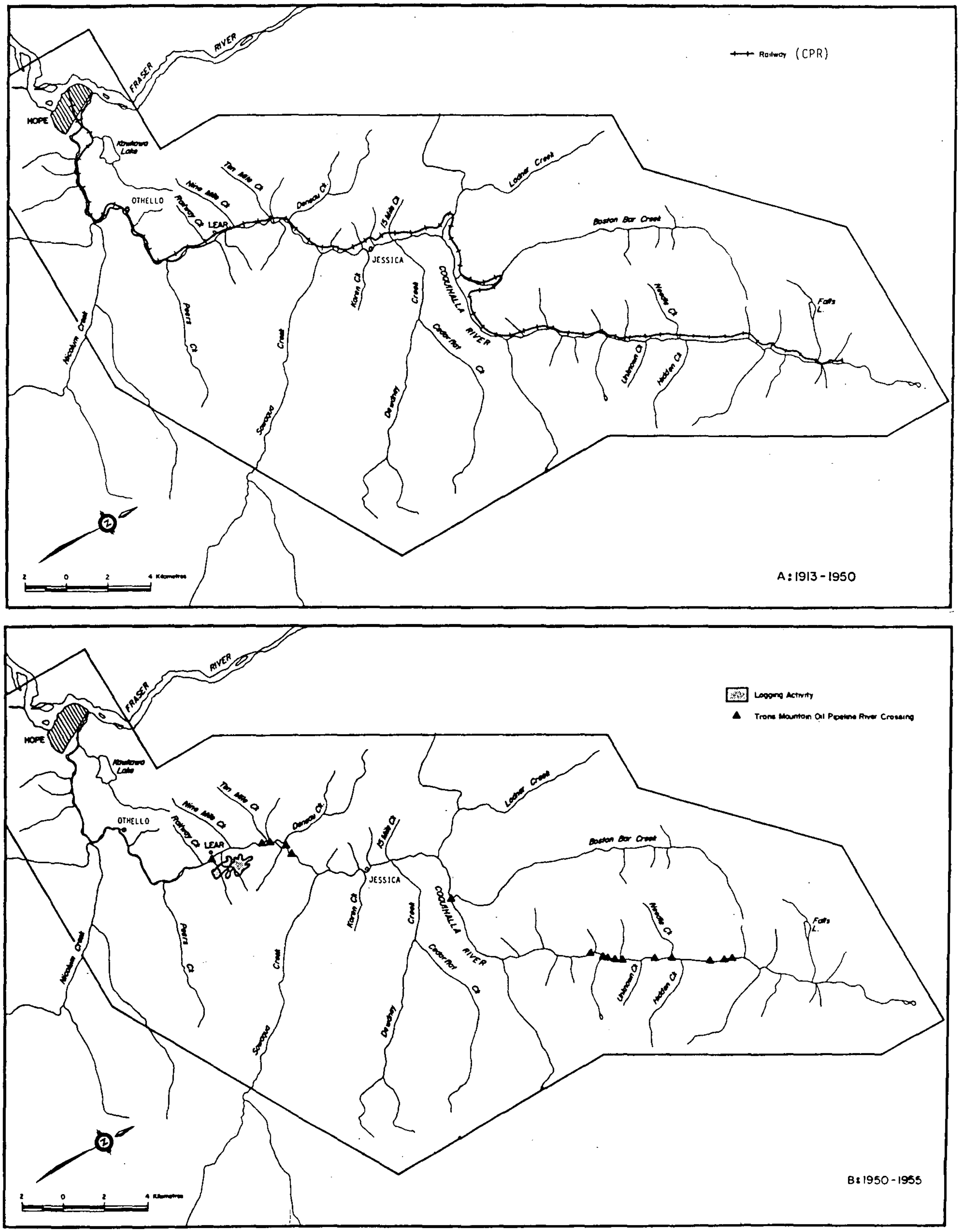

FIGURE 2 LOCATIONS OF MAJOR DEVELOPMENTS IN THE COQUIHALLA VALLEY DURING VARIOUS TIME PERIODS BETWEEN 1900-1984

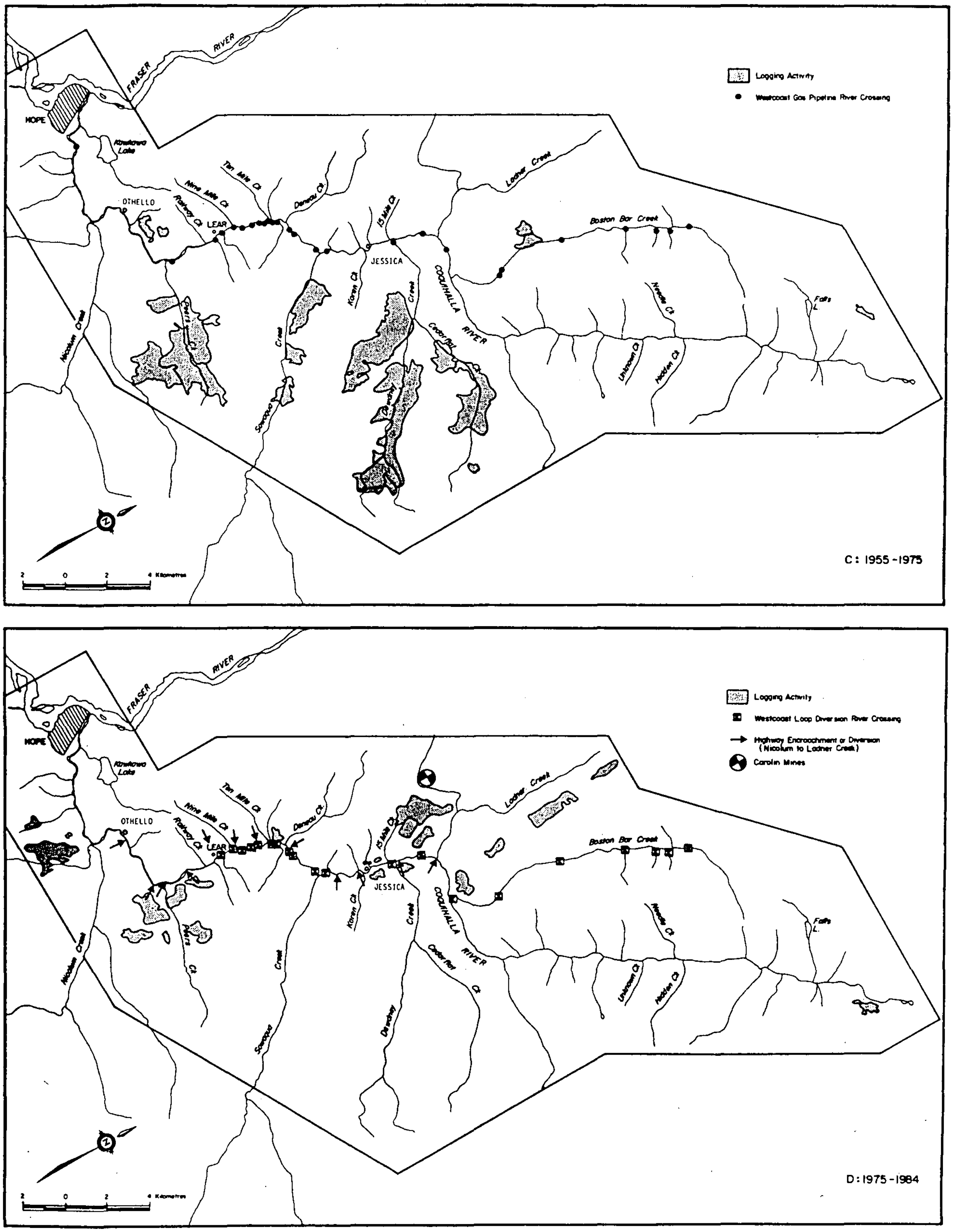

FIGURE 2 LOCATIONS OF MAJOR DEVELOPMENTS IN THE COQUIHALLA VALLEY DURING VARIOUS TIME PERIODS BETWEEN 1900-1984 (Continued)

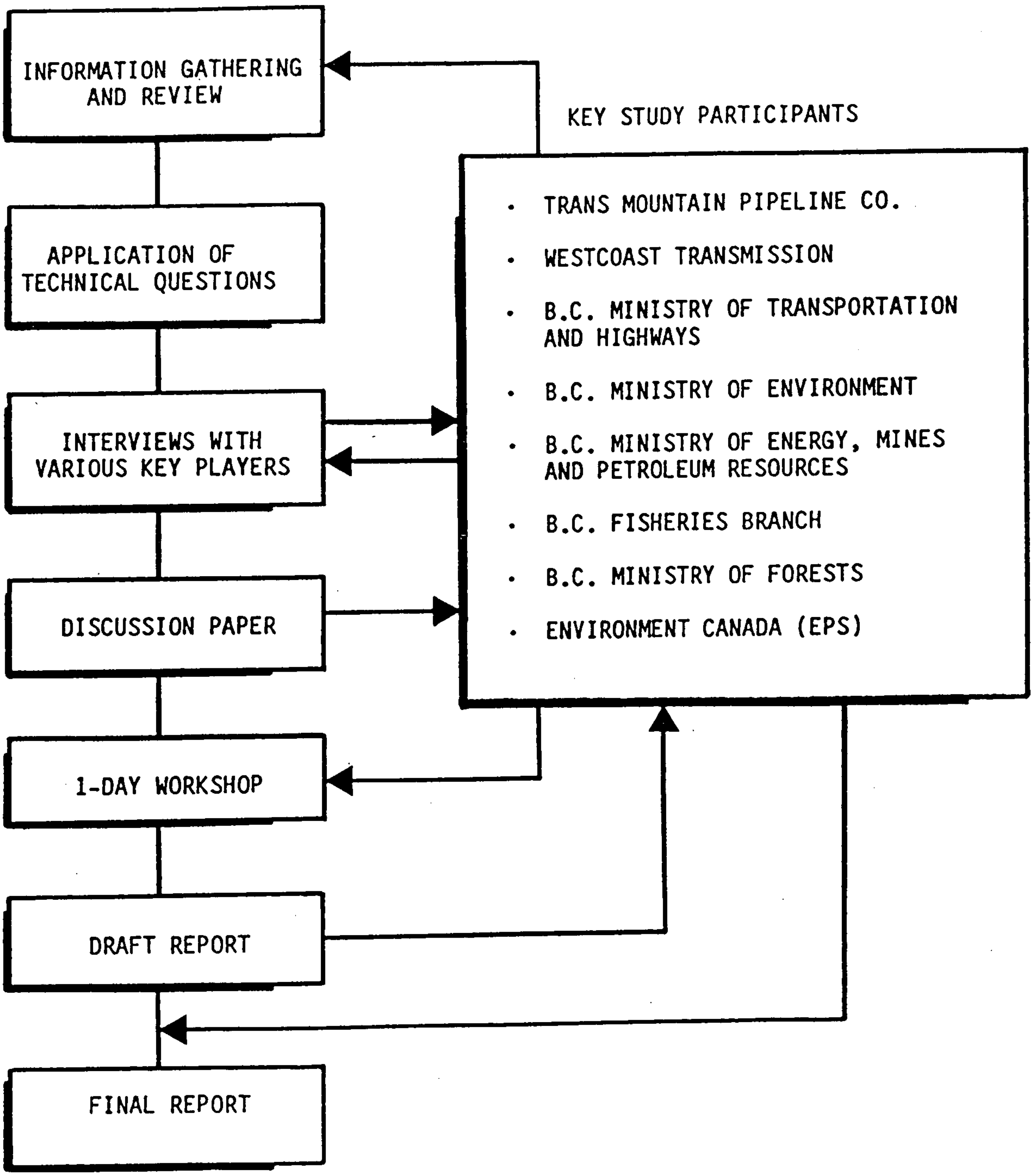

FIGURE 3 STUDY APPROACH FOR FOLLOW-UP REVIEW IN THE COQUIHALLA VALLEY

Following the review, a discussion paper was prepared to outline the results of the case history review, and the study team's major conclusions and recommendations on the technical aspects of the EIA process. This document provided the focus for a 1-day workshop for the various industry and government personnel participating in the study to review the findings, and refine specific conclusions and recommendations to be included in the final report. A draft report was then circulated to selected participants for comment. While the contents of the final report remained the responsibility of the study team, the conclusions and recommendations in the report were intended to reflect the collective opinion of the workshop participants.

Study Findings

The following sections outline the results and major conclusions of the study. Discussion is organized under the following headings which were emphasized throughout the investigation: (1) impact assessment characteristics; (2) cumulative impacts; (3) monitoring/surveillance/supervision; (4) mitigation; and (5) accuracy of impact predictions.

Impact Assessment Characteristics

There was a wide discrepancy in the level of environmental review that different projects in the Coquihalla Valley were required to undergo. The year that the development was proposed was obviously a major determinant of the necessary environmental review process, particularly for projects prior to the mid- to late-1960's when EIA was in its infancy.

Despite progressive improvements, the level of assessment undertaken for recent projects has not been consistent due to the different review processes employed for each development. The Westcoast gas pipeline looping project and the Trans Mountain oil pipeline application were subjected to federal National Energy Board (NEB) review processes, where the assessment reports were descriptive and preliminary in nature. No detailed phase of assessment was required for the approval of Westcoast's gas pipeline project, although a public hearing was conducted for an earlier application, and a review of crossing plans and sensitive areas was undertaken internally by Westcoast in conjunction with regulatory personnel. There was no specific indication of the types or magnitude of impacts anticipated in the Westcoast Transmission assessments. The Trans Mountain oil pipeline application provided specific information on the types of impacts which could occur. Although public hearings were completed for this project, there were no detailed or site specific assessments prepared.

The Ministry of Transportation and Highways (MOTH) assessments for the Coquihalla highway project were prepared within a referral type of review process, and involved the proponent and representatives of both federal and provincial agencies. The assessment documents included both a preliminary overview and a subsequent detailed analysis of impacts which was performed by consultants outside of the review process. The detailed assessment incorporated a multidisciplinary review of specific encroachments and diversions of the river and resulted in site-specific recommendations for mitigative design. The multidisciplinary approach provided cross-checks on the feasibility of designs for habitat preservation, since biologists and engineers were simultaneously involved in the review process and prepared report sections in a cooperative manner.

For other developments in the valley, not reviewed in detail during this study, only forestry activities and the Carolin Mine developments occurred in a period during which environmental assessments existed. The Carolin mining project was subjected to a separate provincial review, for which only a Stage I (preliminary) report was prepared. No further detailed assessment was required, although further examination of some concerns with respect to the tailing pond design was conducted. In contrast, there has been no formal or rigorous environmental review of logging activities in the Coquihalla Valley despite consistent observations of past and potential impacts on fish and aquatic habitats in the valley as a result of these activities.

In all of the assessment documents reviewed, there was a consistent lack of systematic definitions for terms used to describe impacts, such as "minimal", "high", or "severe". The documents prepared in relation to the Coquihalla highway project did provide some indication of impact magnitude by specifying the amounts of aquatic habitat that would potentially be lost. However, there was no attempt to delineate a range of potential effects in the assessments and thereby place some bounds in impact magnitude. For example, given an estimated quantity of released sediment from pipeline trenching, it should have been possible to provide an estimate of the rate of flushing of sediments from the system and their zone of influence based on hydraulic considerations and background suspended sediment levels. This information could then be used to provide an estimate of impact magnitude to aid in the evaluation of appropriate mitigative strategies or provide a basis for follow-up comparison of predicted versus actual impacts.

Cumulative Impacts

The potential for cumulative impacts received little attention in the assessments reviewed within the Coquihalla Valley, despite the multi-use nature of the corridor. Cumulative impacts on fish were not addressed in either of the two pipeline assessments. However, both the MOTH and Carolin Mines assessments indicated that forestry activities represented an additional significant source of impact on fish populations in the Coquihalla River, particularly by the creation of unstable side slopes and potential debris torrent sites, and by contributing large amounts of sediment and debris which can accumulate in the river channels.

Potential cumulative impacts resulting from the increasing amounts of river training works along the Coquihalla riverbanks also appeared to be significant, and were addressed in the MOTH assessment. These various bank alterations consist of rip-rap structures installed to protect pipeline crossings, access roads, and the new Coquihalla highway. MOTH indicated that these cumulative alterations could significantly reduce fish habitat by reducing lateral channel mobility. In that assessment, it was estimated that a relatively large linear distance of river would be affected by all of the developments in the valley (approximately 30 percent of the riverbanks within the areas most heavily utilized by steelhead).

Monitoring/Surveillance/Supervision

Monitoring

There were no monitoring programs established for the developments under review (gas pipeline loop, highway). Furthermore, the NEB appeared to be inconsistent in their requirement for monitoring of the Westcoast Transmission gas pipeline loop. For example, in a 1978 review of this project, the Board indicated that monitoring programs should be implemented for the Coquihalla Valley; yet in 1979, when project approval was granted, they did not incorporate any requirement for monitoring in the final order.

Similarly, a monitoring program was not employed or required during the initial phase of highway construction. However, a formal post-hoc monitoring program is presently being developed by MOTH and various regulatory agencies.

Surveillance

The lack of documented results of surveillance activities on the part of regulatory agencies stood out as an obvious problem in successfully undertaking the follow-up reviews. Surveillance of the gas pipeline loop was undertaken by a B.C. Fisheries Branch Conservation Officer stationed near Hope and a District Fisheries Officer from the federal Department of Fisheries and Oceans (DFO). However, formal reports regarding surveillance activities could not be properly evaluated. Westcoast Transmission also indicated that representatives from NEB had inspected the project, but no written report was ever forwarded to the company.

Surveillance of the initial phase of the Coquihalla highway project was also conducted by B.C. Fisheries Branch Conservation Officers and DFO District Fisheries Officers. Some internal files were available for review, but generally, records of surveillance during highway construction were not summarized or formally reported.

Supervision

The results of supervisory programs conducted on behalf of the project proponents were better documented, compared to those from surveillance activities. Although there were no requirements for supervisory programs attached to project approvals for the gas pipeline loop, Westcoast Transmission did employ an environmental inspector to oversee the construction contractor and provide the necessary contact with regulatory authorities. Supervisory reports were filed as internal weekly reports, which were available for review during the follow-up investigation.

Similarly, MOTH hired a supervisor to oversee construction of the initial Coquihalla highway segment. This inspector also reported on specific mitigative techniques employed during construction of the highway, and these observations were summarized in a separate report (Seremba 1980). That report was particularly useful for the purpose of this follow-up review, since it detailed specific problems associated with construction activities and discussed the success of various mitigative techniques employed in the field.

Mitigation

During construction of the gas pipeline loop by Westcoast Transmission, a series of mitigation techniques, identified in the EIA, were employed. These included timing considerations (in conjunction with regulatory authorities), specifications for construction techniques, and reclamation of disturbed stream banks. Many of these mitigation procedures were mandatory requirements written into the construction contract. In addition, some selective rock placement and re-channelization of the river for the purpose of fish habitat improvement was also completed at the request of regulatory agencies.

Construction proceeded on schedule, within specific construction windows. Various alternative trenching techniques were employed, but in the main stem of the river almost all crossings were completed using an open trench technique. In general, conflicting reports on the effectiveness of mitigation strategies stood out during the review of this case study. For example, observers from the B.C. Fisheries Branch indicated that site-specific strategies should have been adopted for each crossing site to minimize the degree of sedimentation. Another regulatory observer with the same Branch, however, indicated that the degree of disturbance that occurred during construction was largely unavoidable. The company supervisor cited only a few instances where he felt that sedimentation could have been reduced by modified construction designs. As a result, the degree to which sedimentation from pipeline trenching activities can be mitigated by site-specific crossing designs appeared to remain unsolved.

Specific mitigative measures were incorporated into the design of the initial segment of the Coquihalla Highway, and most procedures were adopted for the final construction segments. Mitigation included the designation of specific construction techniques, timing windows, and design configurations for specific highway encroachment and river diversion sites. Most of the mitigative design features described in the assessment documents were adhered to during the actual construction of this portion of the highway.

Written documentation of specific construction techniques employed for protection of river habitats was also provided by the on-site inspector for MOTH. This report indicated that the major mitigative strategies designed to minimize construction impacts on fish were employed. The supervisor suggested that the interactive and multidisciplinary approach utilized by MOTH for the assessment of the initial highway segment was successful in providing specific mitigative recommendations.

Some participants involved during the design and construction of the highway segment noted that the types of mitigative techniques required for the protection of the fish resources during and after construction appeared to be in direct conflict with standard engineering practices. For example, the strategic use of large boulders in one of the major highway diversion sites for the creation of scour pools and back eddies represented almost the opposite approach that standard engineering practices would dictate, namely the design of a stabilized fluming structure. In one instance, the construction engineers removed a large boulder from a channel which had been specifically incorporated to create a holding pool for fish.

Accuracy of Impact Assessments

Assessments of impacts following construction were available for two case studies, the Westcoast Transmission gas pipeline loop and the initial segment of the Coquihalla highway project, and for one of the corridor developments (Carolin Mines), which did not receive a detailed review.

Gas Pipeline Loop

Major issues identified for the gas pipeline project were related to the steelhead which spawn and rear in the areas where most of the river crossings were located. No specific types of impact or causes were cited, but the assessment documents indicated that direct interference with steelhead spawning or migration and downstream sedimentation from riverbed disturbance were the major sources of potential impact.

There was no clear statement of the potential magnitude of impact. A 1979 NEB application indicated some inevitable impact to spawning and rearing habitats largely as a result of sedimentation downstream of the crossings. An earlier (1978) assessment had indicated "minimal" impact due to this effect if mitigation strategies were adopted. There was no indication of the degree of potential sedimentation from pipeline construction.

There were no monitoring programs specifically oriented towards assessing residual impacts of the gas pipeline project. However, information on fish populations in the river was collected by the B.C. Fisheries Branch, particularly with respect to the management and enhancement of summer steelhead populations (Ptolemy 1980, 1983). These programs have been largely oriented towards fisheries management objectives and included surveys of the number of adults returning to spawn, and population densities of fry and juveniles sampled at selected index sites along the river. Although information from both of these programs has been collected each year since 1977, it has been largely used internally and detailed results have not been available to industries with operations or facilities in the valley.

The amount of sedimentation resulting from pipeline construction was documented by routine visual observations of substrates at fish index sites and during snorkel surveys conducted by the B.C. Fisheries Branch. A post hoc sampling program designed to identify sediment changes that may have been caused by pipeline construction was initiated by the B.C. Fisheries Branch. This program involved the collection of gravel cores (using freeze-core techniques) from known steelhead spawning sites at selected locations upstream and downstream of the pipeline crossing sites. Surveys were conducted in October 1980 and April 1981, the results of the programs were summarized in unpublished draft reports by Harding (1981) and Ptolemy (1983).

Some indication of suspended sediment levels was available from opportunistic "grab" samples of water taken by the Westcoast environmental inspector at two crossing sites, and from additional water samples collected by B.C. Fisheries Branch personnel at various sites during and after construction. Collections of samples after construction were obtained at selected times the following winter, when rainstorms occurred in the valley. It is emphasized that these samples were not obtained as part of a pre-designed monitoring program, but rather were collected more or less due to specific interests of the individuals involved.

Since no formal monitoring programs were undertaken, the residual impacts of the pipeline installation could not be accurately identified. The provincial Fisheries Branch indicated that their results provided evidence of substantial increases in the amounts of sediment in the river. It also indicated that there was a substantial decline in the steelhead fry population immediately following the period of construction. This greatly reduced fry population in 1980 was attributed to the effects of sedimentation from pipeline construction on the spawning gravel. There were other sources of sedimentation during the same period in the form of runoff from logged slopes, road grading, and construction of the Carolin Mines development in one of the side valleys, although the extent of these disturbances was reported to be substantially less than those resulting from construction of the pipeline.

The results suggested that there were no further effects on egg to fry survival in subsequent years and there is no evidence that pipeline construction activities affected adult returns to the river in 1979 or the survival of juvenile fish during construction. However, the Fisheries Branch indicated that their results suggested that retention of fine sediments in habitats has reduced the rearing capacity at some locations.

The findings of the provincial Fisheries Branch have never been published or formally reviewd, and several participants in this study indicated that it is impossible to substantiate the accuracy of these impact conclusions without an independent review of their data and analytical techniques. If the information obtained by the Fisheries Branch is correct, it suggests that installation of the Westcoast Transmission pipeline loop caused a greater degree of sedimentation in the river than anticipated in the assessment process, and may have affected one year-class of steelhead through a reduction in egg to fry survival in 1980.

Coquihalla Highway (Initial Segment)

The potential sources of fisheries impacts identified for the Coquihalla highway were:

(1) the construction of encroachments and diversions that change the flow characteristics of the river, increase bank erosion and the levels of suspended sediments in the water;

(2) the building of encroachments into spawning or rearing areas which would reduce the total amount of productive fish habitat; and

(3) water quality degradation through increased suspended sediments and sedimentation, and contamination of the river as a result of toxic chemical spills during construction and from runoff or accidents along the highway during its operation.

None of the assessment documents evaluated the potential magnitude of impacts. The early reports provided estimates of fisheries habitat potentially affected, and the preliminary overview identified encroachment and diversion sites ranging from "minimal" to "severe", although these terms were not defined. The detailed assessment provided some justification for the degree of anticipated impact or concern, since the amounts of specific habitats that could be affected by the development were identified in the latter document. Potential "high" impact was predicted for a major diversion in the lower section of highway (Schoolhouse diversion), unless mitigation design features (mentioned earlier) were incorporated.

Evaluation of impacts for the construction of the initial highway segment consisted of: (1) inspections by an environmental supervisor for the B.C. Ministry of

Transportation and Highways (MOTH); (2) inspections by the B.C. Fisheries Branch; and (3) observations by environmental consultants to MOTH.

Following completion of the Schoolhouse diversion, it was observed that the new channel was functioning close to design expectations. The construction of the diversion was completed largely outside of the wetted channel, and the subsequent opening did not appear to contribute significant amounts of sediment to the river. The new channel was designed to create holding pools for adult fish as well as shallow rearing habitats along the river margins. However, the pools that developed were smaller than anticipated. Removal of the large natural boulder in the channel was expected to be the major reason the channel (mentioned earlier) did not possess the designed habitat characteristics.

There were numerous independent observations of fish use in the new channel created during construction of the initial section of the Coquihalla Highway. Adult fish were present in the channel following its completion, and juvenile fish were also present in numbers similar to other portions of the river. As a result, these preliminary observations suggested that no significant impacts were detectable as a result of the major diversion channel in the lower highway section.

Impacts resulting from sediment deposition were observed in a smaller tributary diversion (Peers Creek). Large quantities of sand and debris were deposited in the downstream portion of the channel, as well as in localized areas in the main stem of the river. However, logging activities upstream were believed to be the significant source of this sediment.

The initial section of the Coquihalla Highway between Nicolum Creek and Peers Creek did not appear to cause significant impacts on the steelhead population. However, the highway project is still under construction and the initial section is not as yet open to traffic. The potential for large scale impacts from continued construction and long-term use of the highway still exists. It was generally agreed at the review workshop that the large scale nature of the highway development represents the most significant source of potential long-term impact on the steelhead population in the river.

Other Corridor Developments

Apart from the case studies, information related to the Carolin Mines development also provided some assessment of the accuracy of impact predictions. Although logging activities were identified as a major source of impacts on fish in the corridor, there were no assessment documents related to forestry with which to evaluate their impacts. The major effects of logging cited by study participants were sedimentation due to slope instability on cleared slopes and access roads, and large quantities of debris in the river which diverted flow from fish bearing pools and channels and created obstructions to fish passage.

Major concerns identified in the Stage I assessment for the Carolin Mines development were the stability of the tailings dam and the potential for contamination from tailing fines and dissolved chemical components entering watercourses, since the mine was to utilize a cyanide process. The preliminary assessment also indicated that a plan for handling emergency spills or discharges should be developed in a detailed environmental assessment. The requirement for a Stage II (detailed) submission, however, was subsequently waived and the mine received approval to proceed after providing additional details on the tailings pond design.

Following operation of the mine some mortality of steelhead occurred as a result of an unauthorized discharge of contaminated tailings water in 1982. The extent of mortality was never clearly determined, but the effects of the toxic discharge were surmised to be most prevalent in Ladner Creek and portions of the Coquihalla River between the Ladner Creek and Sowaqua Creek confluences (Figure 2D). The inability of the plant to meet water quality expectations and the lack of suitable water testing procedures were the primary causes of the toxic discharge. The incident substantiated what the Stage I preliminary report had correctly identified as a significant potential impact related to the mine development, and raises questions related to the lack of formal Stage II assessment, which may have required that contingency plans recommended in the Stage I document be established prior to opening of the mill.

Recommendations

The following recommendations are provided in order to identify areas where various aspects of the EIA process might be improved. These recommendations are based on the review of case histories and conclusions, as well as the discussions with industry and government personnel during the workshop review session. The recommendations incorporated in the following section, however, do not necessarily reflect the opinions of all of the invited participants.

It is difficult to place any priorities on these recommendations, since they apply to many phases of the review and assessment process, and priorities may, in fact, differ among the various participants in any development. Instead, the recommendations are listed with respect to the normal chronological sequence for the assessment process, and they are meant to provoke thought and discussion on needed improvements.

Assessment requirements for various projects in the same corridor should be consistent. The wide discrepancy in the level of environmental assessment that recent developments and activities in the Coquihalla Valley have been required to undergo suggests the need for a systematic approach to the EIA process. Although there have been improvements in EIA standards over the years, the level of assessment required for each project has not been consistent even though these developments had the potential to affect similar resources. No detailed phase of environmental assessment was required for the Westcoast looping project, although a preliminary environmental overview and interdisciplinary assessment was provided in MOTH documents related to highway development. Despite observed effects of logging activities in the valley, no formal assessment has ever been prepared. The regional approach to assessment which is currently being followed for larger developments (e.g., Beaufort Sea - Mackenzie Delta hydrocarbon production and Fraser-Thompson transportation corridor reviews by the Federal Environmental Assessment and Review Office) may also be applicable to relatively small multi-use corridors, such as the Coquihalla.

Potential impact magnitude should be defined in the assessment documents and should be assessed in a systematic and interdisciplinary manner. A rigorous set of definitions for specifying levels of impact should be used to determine possible ranges in impact magnitude. In the absence of a systematic approach, terms such as "major", "minimal", or "long-term" have no usable meaning. A procedure for evaluating impacts could involve a modelling approach or adaptive management techniques (e.g., Larkin 1984) that would allow for more consistent and precise descriptions of projected impacts, as well as identification of impact hypotheses for subsequent follow-up monitoring programs.

Cumulative impacts should be addressed in all environmental assessments. In multi-use corridors such as the Coquihalla Valley, an evaluation of potential cumulative impacts should be completed. Obviously, the potential to forecast accurately all future developments which will affect a resource is impossible. Yet where existing interests are already present, cumulative impacts can be addressed.

These impact assessments should identify the source and magnitude of potential cumulative impacts, rather than simply identify their possibility. The MOTH environmental assessments addressed the potential cumulative impacts on fish resources in the Coquihalla River that could result from the proposed highway development in conjunction with forestry-related activities and various river training works required for pipelines and roads in the valley.

Site-specific mitigation plans should be developed during the assessment and review process. For pipelines, this would involve a multidisciplinary examination of each river crossing so that site-specific mitigative measures could be incorporated into the construction designs for each crossing. This interdisciplinary approach was utilized by MOTH for assessment of the initial highway section, and appeared to be successful in providing mitigative strategies that were incorporated into final construction plans and ensured that all aspects of mitigation were properly addressed.

Conflicting opinions regarding specific mitigation techniques applicable to pipeline construction should be resolved. There were differing opinions, even within the same regulatory agency, regarding the potential for minimizing sedimentation at river crossings during pipeline construction. An effort should be made during the assessment process to estimate potential disturbances associated with river crossing activities, and to review site-specific techniques for the mitigation of projected impacts.

Documentation of the use and effectiveness of mitigative measures employed during construction is required. Without accurate records of the mitigative techniques used during construction of a project, it is difficult to build upon previous experiences or apply this experience to future developments.

Specific monitoring, supervision, and surveillance programs should be outlined during the approval and design stages, and should be attached as conditions to project approval. Follow-up monitoring, supervision and surveillance programs need to be clearly specified during the final stages of a development. The nature of these requirements should be determined during the assessment process, since some projects may only require limited supervision, surveillance and monitoring. Monitoring programs that are directed at providing information on the magnitude and duration of impacts and the effectiveness of mitigative techniques or structures would undoubtedly aid in improvement of technical aspects of the EIA process.

Responsibility for supervision, surveillance and follow-up effects monitoring programs should be clearly specified. For the developments reviewed in this document, supervisory programs were undertaken by the proponents and periodic inspections were made by regulatory personnel. For large scale projects, it may be possible for such programs to be jointly conducted by the proponent and regulatory agencies. However, it is essential that an objective analysis of the program results is provided by whomever assumes responsibility. The responsibility for follow-up monitoring programs needs to be clearly defined to ensure that objective and detailed documentation of the use and effectiveness of mitigative measures employed is prepared.

Follow-up monitoring programs should be developed in a manner which allows them to be stated as testable hypotheses. Any monitoring programs implemented to examine the effectiveness of mitigative measures or residual impacts following construction of a project should incorporate appropriate experimental designs and data analysis procedures. These programs may be most successfully developed by a multidisciplinary team with specific and relevant expertise in impact assessment and environmental research and monitoring. Depending on the scale of monitoring, some external review of the program may also be appropriate.

The results of supervisory and surveillance activities should each be summarized within a relatively short period (1 year) following construction. Guidelines for these activities, specifying the type of information to be recorded, should be incorporated into the assessment and approval process. It should also be required that the monitoring reports be made available for critical review. This would ensure that the results undergo some external scrutiny and would also be available to improve the level of understanding of impact prediction and effectiveness of mitigative strategies.

Monitoring programs must be adaptive to the dynamic nature of the environment. In the Coquihalla Valley and other similar river systems subject to periodic major flood events, it is apparent that monitoring of impacts related to hydraulic features should be conducted over a period encompassing several flood events, rather than a fixed time period. On the basis of historical experience in the Coquihalla, this time period could be greater than 5 years. As a result, monitoring programs which simply involve collection of information over a fixed period following construction may not provide meaningful results. In addition, these programs should be designed to examine cumulative effects of activities or developments already present in the region.

Following project completion, "As Constructed" specifications should be considered a requirement to adequately address follow-up questions. The most effective way of determining how the final construction compared with the design specifications is to examine drawings or other documents that specify the project, as actually constructed.

ACKNOWLEDGEMENTS

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AN ENVIRONMENTAL PERFORMANCE AUDIT OF SELECTED PIPELINE PROJECTS IN SOUTHERN ONTARIO

Ian Moncrieff
Mary L. Shea
Lloyd W. Torrens

Introduction

This Environmental Performance Audit examined the treatment of environmental issues related to pipeline projects in southern Ontario over the past decade. The specific issues considered include route selection, environmental assessment (evaluation of baseline conditions and potential impacts), mitigation procedures and monitoring programs.

Among those planning and approving pipeline projects, it is generally assumed that there has been a gradual improvement in the treatment of environmental issues. The purpose of this study was to critically examine this hypothesis. For a comprehensive review of the southern Ontario situation, a series of typical pipeline projects spanning the last ten years was selected and evaluated (Figure 1). Many of the selected projects were conducted by Union Gas Ltd. but other pipeline company projects and research papers were also studied (Table 1).

As background, four 'component' papers on agricultural land, watercourse crossings, natural environment areas, and public/land owner involvement were prepared. Under each of these topics, the performance audit examined the route selection process, the detailed studies of the proposed route, the proposed mitigation techniques, the monitoring techniques, and the results and conclusions for each selected pipeline project.

To broaden the perspective, input was also obtained from the Ontario Energy Board (OEB) which is the regulatory body for pipeline projects subject to provincial jurisdiction. This involved an additional component paper concerning the development and application of OEB environmental guidelines. Input was also solicited from Pe Ben Pipelines (1979) Ltd., a major pipeline contractor involved in the actual construction of several of the pipeline projects evaluated. This involved a review of the component papers and the preparation of a "contractor's perspective" on environmental protection in the pipeline industry.

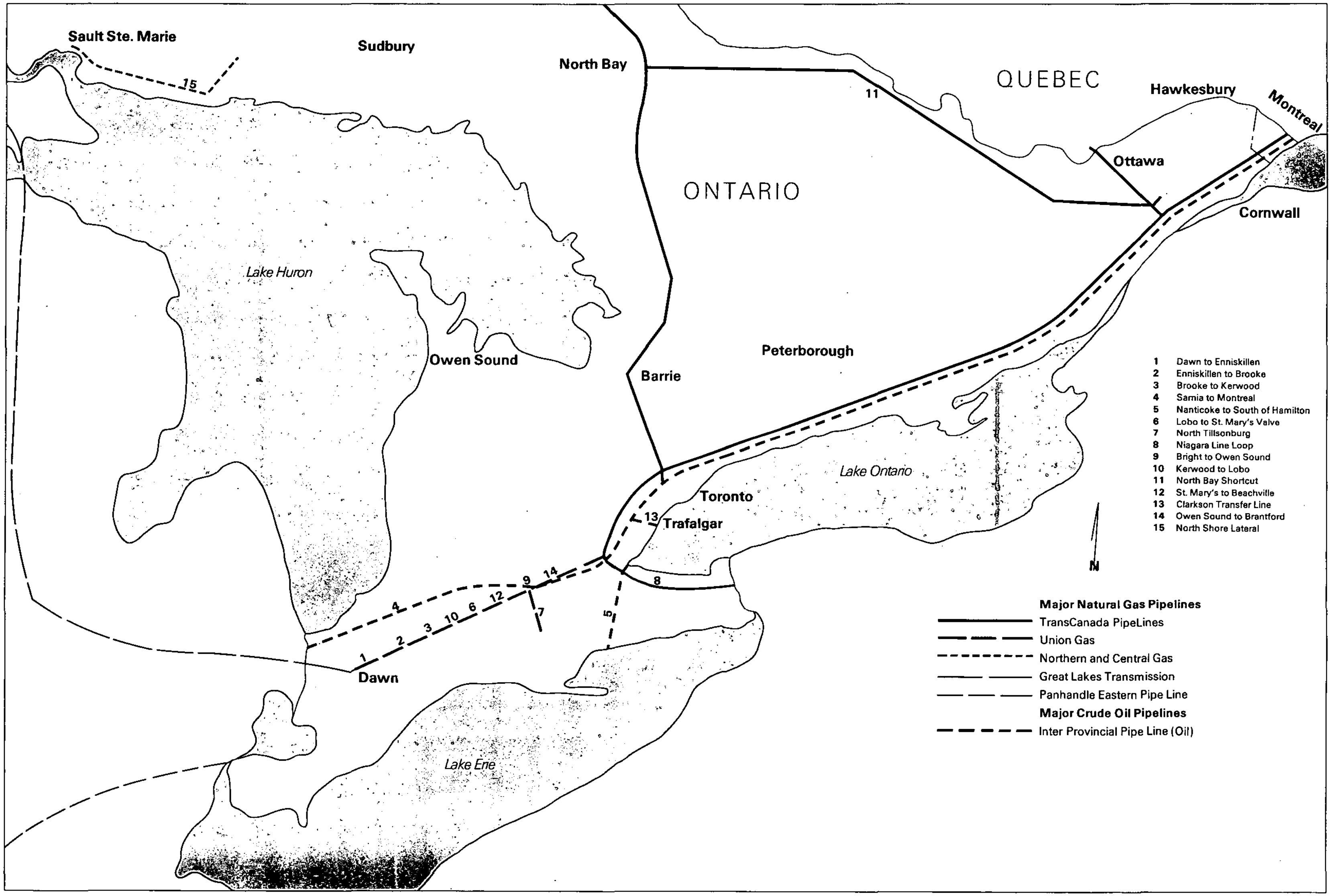

FIGURE 1 LOCATION OF REPRESENTATIVE PIPELINE PROJECTS

TABLE 1 REPRESENTATIVE PROJECTS

Construction Year	Project Title, Proponent and Related Reports	Construction Year	Project Title, Proponent and Related Reports	Construction Year	Project Title, Proponent and Related Reports
1974	Dawn Valve to Enniskillen Valve Union Gas Rehabilitation Study (Union Gas, 1983b)	1977-1981	Lobo Station to St. Mary's Valve Union Gas Environmental Assessment (D.H. Duncan Co., Ltd., 1977) Monitoring Study (Union Gas, 1982c)	1983	North Bay Shortcut TransCanada Pipelines Environmental Report (D.H. Duncan, 1980; TransCanada Pipelines, 1983) As-built Reports (Northland Engineering, D.H. Duncan, 1983a-c) Major River Crossing Report (IEC/Beak Consultants, 1983)
1975	Enniskillen Valve to Brooke Valve Union Gas Rehabilitation Study (Union Gas, 1983b)	1978	North Tillsonburg Union Gas Environmental Assessment (James F. MacLaren Ltd., 1977a)	1984	St. Mary's - Beachville Union Gas Environmental Assessment (MacLaren Plansearch, 1982c)
1975-1976	Sarnia to Montreal IPL Environmental Assessment (F.F. Slaney and Company Limited, 1974; Andre Marsan Associes Inc., 1974) Environmental Line Lists (Bechtel Canada Ltd., 1976) Monitoring and Evaluation Study (MOE, 1978) Agricultural Restoration (Dunsmore et al, 1976)	1981	Niagara Line Loop TransCanada Pipelines Environmental Assessment (Geo-Analysis, 1981a, b) As-built Report (MacLaren Plansearch, 1982a) Stream Monitoring (MacLaren Plansearch, 1982d) Restoration (MacLaren Plansearch, 1983)	1984	Clarkson Transfer Line IPL Environmental Assessment (MacLaren Plansearch, 1984a)
1976	Brooke Valve to Kerwood Valve Union Gas Environmental Assessment (Union Gas, 1976a) Rehabilitation Study (Union Gas, 1983b)	1982	Bright-Owen Sound Loop Union Gas Environmental Assessment (MacLaren Plansearch, 1981a, b) Monitoring Study (Union Gas, 1983a)	1985	Owen Sound to Brantford Union Gas Environmental Assessment (Ecological Services for Planning, 1983a, 1984)
1977	Nanticoke to South of Hamilton Trans-Northern Pipeline Co./IPL Environmental Assessment (Trans-Northern Pipeline, 1977a) As-built Report (Ecoplans, 1978a, b)	1982	Kerwood Station to Lobo Valve Union Gas Environmental Assessment (Ecoplans, 1981a, b) Monitoring Study (Union Gas, 1983a)	1985	North Shore Lateral Northern and Central Gas Corp., Ltd. Corridor Selection Study (Hunter, 1984) Environmental Protection Report (Ecologistics, 1984a-b)

Subsequent sections of this paper will set out the findings of the performance audit with respect to six issues:

- Route Selection
- Evaluation of Environmental Conditions and Impact Prediction
- Mitigation Procedures
- Monitoring
- Costs
- General Conclusions and Recommendations

Route Selection

The environmental information on route selection provided in the reports was very general. No distinction was made between route selection and detailed route assessment. This was a result of a combination of factors which included:

- The general nature of the 1976 OEB environmental guidelines left much open to interpretation and did not distinguish between route selection and detailed route assessment.
- The environmental mapping required in the 1976 guidelines was at a comparatively small scale of 1:50,000. This has proven to be too small to properly reflect the environmental concerns in the highly developed agricultural and urban environment of southern Ontario.
- Most pipeline projects undertaken during this time period were looping or twinnings of existing pipelines and consequently route selected was given a minor consideration. In fact, several projects were entitled route 'evaluation' rather than route 'selection' studies.
- The general value of environmental assessment to the overall regulatory approval process was not recognized by the pipeline companies.

By 1980, the issue of alternative routes was recognized by those involved in pipeline assessment as a key element of the environmental assessment process. This recognition arose through the evolution of general guidelines prepared under the regulations of the Environmental Assessment Act and through the planning of new pipeline projects that involved more than line loopings. The draft 1980 OEB guidelines contained general requirements for addressing alternative routes and the 1984 finalized guidelines provided detailed route selection requirements.

Of the projects reviewed, the Union Gas - North Tillsonburg report of 1977 was the first which documented a formal route selection procedure leading to a proposed route. Most of the subsequent projects, which were not pipeline looping projects, used a similar comparison table format for evaluating alternatives.

In addition to the formal requirements for route selection , the selection process itself has evolved. One particular aspect that has undergone considerable change deals with landowner involvement. In the early studies landowner involvement was not a significant consideration in route selection (Table 2). By the late 1970's, however, landowner involvement was initiated as an element of the selection process and has since become an extremely significant component of most subsequent studies.

As a general observation, it has become evident that the route selection component of the pipeline planning process has undergone increasing scrutiny as a result of growing public involvement in recent years. Organized interest groups have gained greater experience in environmental assessment studies and have become increasingly effective in their evaluation of planning procedures. The greater effectiveness of public participation is due in part to the role played by the public in various environmental assessments prepared under the Environmental Assessment Act in Ontario.

Evaluation of Environmental Conditions and Potential Impacts

The evaluation of environmental conditions and potential impacts have been documented in increasing detail in the environmental assessment reports over the past ten years. While this increase in detail has not been consistent from project to project and/or from year to year, most recent projects have provided a comparable level of information. There were, and still are, differences in the level of information provided in each environmental topic area (i.e., agricultural soils, geology, biology, land use, etc.). This disparity is due, to some extent, to the special concerns of the study area for each given project.

Base information sources (e.g., Canada Land Inventory) have been commonly available throughout the last decade but more detailed or comprehensive information in the form of published and unpublished reports has become available from public agencies (e.g., Ontario Ministry of Natural Resources, Ontario Ministry of the Environment, Ontario Ministry of Agriculture and Food, and Agriculture Canada).

TABLE 2 LANDOWNER PUBLIC INVOLVEMENT IN SELECTED PIPELINE PROJECTS

UNION GAS and Other Representative Pipeline Projects in Ontario 1974 - 1985		1. Environmental Assessment	2. Reviewed by O.P.C.C.	3. Landowner Contact Required in Guidelines	4. Contact made during Data Collection for Route Selection	5. Contact made during Environmental Assessment of Preferred Route	6. Public Involvement in Mitigation Design	7. Contact made during Review by O.P.C.C. or O.E.B.	8. Public Meetings	9. Negotiating Landowner Committee Formed	10. Public or Landowner Involvement in the Hearings	11. Length of Board Hearing	12. Cost of Board Hearing	13. Public Influence on Conditions of Approval	14. Pre-Construction Interview	15. Contact During Construction	16. Contact During Operations	17. Number of Property Owners	18. Number of Expropriations	19. Cost of Expropriations	20. Construction Delay due to Landowner Problems
1974 Dawn - Enniskillen	NPS 42	N	N	N	N	N	N	N	N	N	10	1 Day	2100	Y	Y	Y	Y	38	29	20,000+	N
1975 IPL, Sarnia Montreal (oil) (N.E.B.)	NPS 30	Y (N.E.B.)	O.E.B.	N	N	N	N	N	N	Y	1	8 Days	N/A	Y	Y	Y	Y	2500	51	N/A	3 weeks Y
1975 Enniskillen - Brooke	NPS 42	N	N	N	N	N	N	N	N	Y	5 O.F.A.	1 Day	2,930	Y	Y	Y	Y	57	15	20,000+	N
1976 Brooke - Kerwood	NPS 42	Y in-house	N (M.O.E.)	N	N	N	N	N	N	Y	3 O.F.A.	3 Days	3,625	Y	Y	Y	Y	24	17	20,000+	N
1977 Petrosar Line	NPS 10	Y	N (M.O.E.)	▲Y	N	N	N	Y	N	N	Y	1 Day	2,288	183	Y	Y	Y	9	0	0	N
1978 North Tillsonburg	NPS 10	Y	N (M.O.E.)	▲Y	N	N	N	Y	Y	Y	Y	2 Days	3,659	183	Y	Y	Y	37	1	15,000+	N
1979 Tillsonburg Loop	NPS 8	Y	Y	▲Y	N	N	N	Y	Y	Y	Y	2 Days	Hearing as above	Y	Y	Y	Y	12	4	20,000+	1 year Y
1979 Lobo - London	NPS 42	Y	Y	▲Y	Y	N	N	Y	N	Y	7 O.F.A.	3 Days	2,294	Y	Y	Y	Y	35	1	15,000+	1 year Y
1981 London - St. Mary's	NPS 42	Y	Y	▲Y	Y	Y	Y	Y	Y	Y	1 O.F.A.	2 Days	4,746	Y	Y	Y	Y	21	0	0	0
1982 TCPL North Bay Shortcut (N.E.B.)	NPS 36	Y	Y indirect	Y (N.E.B.)	Y	Y	Y	Y	Y	Y	6	5 Days	N/A	Y	Y	Y	Y	600	0	0	0
1982 Kerwood - Strathroy	NPS 42	Y	Y	▲Y	Y	Y	Y	Y	Y	Y	5	1 Day	2,093	Y	Y	Y	Y	25	0	0	0
1982 Bright - Owen Sound Valve	NPS 42	Y	Y	▲Y	N	N	Y	Y	Y	Y	0	1 Day	2,093	Y	Y	Y	Y	32	0	0	0
1984 St. Mary's - Beachville	NPS 42	Y	Y	●Y	Y	N	Y	Y	Y	Y	0	2 Days	N/A	N	Y	Y	Y	26	0	0	0
1985 Northern and Central Sault Ste. Marie - Elliot Lake	NPS 12-10	■ Y	Y	●Y	N	N	Y	partial	Y	N	Y	7 Days	N/A	Y	Y	Y	Y	220	43	-	2 weeks
1985 Owen Sound Valve - Brantford	NPS 42	Y	Y	●Y	Y	Y	Y	Y	Y	Y	2	1 Day	N/A	Y	Y	Y	Y	29	1	0	0

▲ *1976 O.E.B. Guidelines*
● *1984 O.E.B. Guidelines*
■ *Environmental Protection Report*
Y *Yes*
N *No*

The early studies relied heavily on limited published information sources for route selection and environmental assessment; subsequent projects from the mid-1970's onward supplemented this information with site-specific studies. Standard evaluation procedures for specific environmental topics (e.g., aquatic biology) were adopted by some pipeline companies.

During the 1960's and early 1970's, there was a growing public awareness of environmental issues and impacts on the environment. Although there were concerns regarding pipeline construction procedures before the mid-1970's, it was the Sarnia to Montreal oil pipeline in 1975 and 1976 which clearly demonstrated how pipeline construction could cause unnecessary damage to the environment and helped to promote the organization of specific interest groups.

Largely in response to the problems experienced with the project, the Ontario Energy Board produced their first environmental guidelines entitled Environmental, Agricultural and Resource Guidelines for Construction and Operation of Pipelines in the Province of Ontario (1976). All subsequent provincial provincially regulated pipeline projects required an environmental assessment (EA) as described in this document. These EA reports and the ensuing monitoring or as-built reports form the basis of reference material for this performance audit.

An increase in landowner involvement in pipeline projects over the study period is clearly evident in Table 2. Landowner participation in route selection, detailed assessment of the proposed route and development of mitigation procedures, has become standard practice. This exemplified the Union Gas projects. Public meetings and landowner negotiating committees have also become common in the environmental assessment process.

The potential impacts on the environment vary considerably depending on the topic area or issues (i.e., agricultural land, watercourse crossings, natural environment). As illustrated in the component paper on natural environment areas, the major impacts in this topic area are significant, long-term and extend beyond the limits of the pipeline right-of-way on a regional or even global scale. Conversely, impacts on agricultural land are usually site-specific, and may not pose substantial long-term impacts if the appropriate mitigation procedures are employed. It is also noteworthy that certain construction activities, such as stream crossings, appear to create a significant impact at the time of construction but monitoring studies generally indicate no long lasting environmental change.

Overall, potential environmental impacts have been addressed in greater depth in the environmental assessment reports as the assessment procedures have improved and the requirements for mitigation have increased.

Mitigation Procedures

Although many mitigation procedures were recommended in the Sarnia to Montreal project prior to construction, the comprehensive review by the Ontario Ministry of the Environment following construction identified many problems and made many recommendations, particularly relating to stream crossings. Many of the problems were associated with time constraints, inadequate planning and general inexperience in the application of mitigation techniques. A lack of communication between the contractor and the environmental inspection staff, in combination with poor weather conditions during construction, led to many problems which were not necessarily a result of the proposed mitigation techniques. Most subsequent projects proposed similar, but more detailed, mitigation requirements (for further explanation see Torrens, Shea and Moncrieff, 1985).

The success of mitigation procedures remains largely dependent on the attitude of the contractor towards the environment and their cooperation with the environmental inspection staff. The attitude towards mitigation is particularly important in the protection of the natural environment areas. In general, the effective implementation of proposed mitigation measures requires good judgement and environmental awareness by the contractor and environmental inspector. Many mitigation procedures are simple precautionary tasks (e.g., tree protection) and considered good construction practices, but they may be viewed by the contractor as an annoyance to implement. Also important is good construction planning and communication between supervisory staff and work crews. Although environmental attitude, planning and communication are the keys to successful mitigation, these issues are rarely addressed in monitoring reports. Failure to document these issues leads to difficulty in evaluating the success of mitigation.

The most effective means of mitigation is avoidance of sensitive features or areas through route selection. This is particularly important in natural areas because pipeline construction usually creates a major disturbance to the resource base (e.g., forest cutting along the easement), and alters it in relation to the surrounding natural systems. Currently there is no practical means of avoiding extensive vegetation removal within a construction easement. In southern Ontario many sensitive natural areas and stream sections can be avoided by environmental analysis and planning.

Similarly, impacts on agricultural land are often minimized by routing through low class agricultural soil areas; although in many situations in southern Ontario impacts on prime agricultural land are unavoidable. These impacts are usually associated with damage to drainage tile, mixing of the soil layers, increased stoniness, soil compaction and erosion, all of which lead to poorer crop yields. Mitigation procedures to reduce these impacts have developed considerably over the last decade. Many simple procedures, such as topsoil stripping, stone picking and tile drainage repairs, have substantially improved post-construction conditions. Specialized techniques, such as subsoiling, have also proven to be very effective in reducing losses in crop yield in areas of severe compaction.

Many of the problems associated with post construction agricultural soil conditions are attributable to construction during high soil moisture levels. Construction procedures such as 'wet weather shutdown' are effective in reducing many adverse impacts to the soil. Planning construction for periods when prolonged dry conditions are likely to occur (e.g., mid-summer) is also an important mitigation measure. Mid-summer construction can be costly, however, during a busy construction period.

The greatest potential impacts from stream crossings are usually associated with increased turbidity, downstream sedimentation and disruption of fish spawning runs. The mitigation techniqus chosen to reduce these impacts have largely been dependent on the sensitivity to increased sediment loadings. Although there have been a variety of specific procedures for sediment control proposed in the stream crossing methodologies, these are essentially fine tuning items. The most effective prevention of significant impacts remains:

1) the avoidance of sensitive stream sections;
2) seasonal timing of the crossing;
3) minimizing the duration of instream activities; and
4) proper construction planning and environmental awareness.

Some stream crossing methodologies (i.e., 'dry' crossings) can only reduce turbidity. However, these procedures may only have appreciable value in the most sensitive stream crossing situations. Similarly, site plan drawings which illustrate the crossing location, construction features and include detailed instruction to the contractors certainly aid in communicating mitigation requirements. These detailed measures, however, again are only necessary for sensitive stream crossing situations. The attention focussed on the stream crossings from site plans is probably of greatest benefit because it improves the 'awareness' of the contractor to environmental concerns during construction.

Instream crossing procedures have become increasingly detailed and, as experienced on the recent TransCanada Pipeline (TCPL) North Bay shortcut line, may be too restrictive. Flexibility in construction practices and on-site design of procedures to suit field conditions at the time of construction is an important aspect of environmental protection.

Monitoring

Monitoring reports have documented a wide range of impacts and construction procedures. Some recent reports have been quite comprehensive but there are inconsistencies in format or content between reports.

A number of recent comprehensive watercourse monitoring reports have provided interesting results, indicating there were no apparent long-lasting environmental impacts from these pipeline crossings. These are valuable findings since subsequent projects can use this information to refine procedures and predict impacts. Each subsequent monitoring project increases the data base and helps the assessment process.

Monitoring reports for the pipeline projects under study provided little information on the success of mitigation procedures related to the natural environment areas. We can only speculate that problems which occurred during the Sarnia to Montreal project have been largely avoided in subsequent projects. The development of monitoring programs would be useful to document problems and to determine the effectiveness of mitigation procedures.

Monitoring of agricultural soils and crop yields has developed substantially over the past ten years. Crop yield results are an effective means of evaluating various mitigation procedures. Monitoring results have illustrated the rate at which agricultural land has returned to high productivity and have been used to design more effective mitigation procedures.

Costs

In carrying out the performance audit of selected pipeline projects, the cost implications of applying mitigation procedures to reduce environmental impacts were reviewed. Although some studies have been conducted on the costs of specific procedures (e.g., stream crossings), statistics on construction costs were generally not available for a number of reasons:

- many mitigation techniques are concerned with construction planning and the procedural execution of the techniques; and consequently there are no specific costs (e.g., labour and materials);
- many of the mitigation procedures are no longer separate tasks and have been included in routine construction operations;
- mitigation procedures are often relatively inexpensive and represent an insignificant cost in pipeline construction. They are often adopted simply as good construction practices;
- mitigation procedures are often specific or unique tasks (e.g., protection of sensitive areas);
- pipeline companies have incurred some cost savings as a result of improved environmental procedures. In particular, increased public involvement has resulted in less expropriations and fewer costly construction delays.

Conclusions

With the development of environmental guidelines there has been a corresponding improvement in environmental assessment, mitigation and monitoring procedures. This improvement also includes social aspects such as the incorporation of landowner and interest group concerns.

It must be emphasized that the environmental requirements of the Ontario Energy Board and the changes in conditions of approval represent an evolutionary process. They reflect the nature of environmental concerns relative to pipeline projects based upon:

- the nature and extent of pipeline projects undertaken throughout the province under both federal and provincial jurisdiction;
- the role the Province of Ontario plays at the National Energy Board (NEB) level;

- the nature of environmental concerns expressed through interventions at pipeline "Leave to Construct Hearings" or during Expropriation Hearings; and
- the role played by the OEB in both construction and post construction monitoring.

In general, during the past ten years, environmental assessments of pipeline projects have become more detailed and have included more site-specific information. The detail given for proposed mitigation procedures has progressed substantially to a point where it may be too restrictive. Flexibility is needed to choose specific procedures appropriate to site conditions. There is little doubt that successful execution of mitigation procedures is still largely a function of good planning and cooperation between the construction supervisor, the inspection staff and the contractor.

One of the key planning issues is the selection of an appropriate construction season. Selecting a time period (i.e., mid-summer) when dry conditions are likely to be encountered is of prime importance. Many construction problems and associated environmental impacts are the result of wet conditions along the construction easement. It must be recognized also that selection of such a limited construction period may be more costly during periods of major activity.

Monitoring reports, particularly recent ones, have provided important feedback on construction activities. The ability to predict impacts and recommend appropriate mitigation procedures has probably been the most important advance for the assessment process.

As the information base generated through environmental monitoring expands, pipeline companies will be in a position to:

- review their environmental policies, practices and procedures;
- improve basic construction specifications for dealing with environmental concerns;
- improve their project or site-specific specifications to supplement the basic construction specifications.

Recommendations

Despite improvements in the environmental assessment process, there is a continuing need to monitor impacts and for a review of mitigation procedures. Monitoring is the important link in the assessment process which provides feedback on the success of mitigation procedures. The approach and format of monitoring reports should be standardized, as has been the case with environmental assessment reports.

Monitoring reports should evaluate each mitigation procedure. In some cases this will require detailed field sampling (e.g., stream sampling); in other cases documentation of observations made during construction is sufficient (e.g., woodland protection). A monitoring report should also consider the importance of planning, attitudes towards the environment and the cooperation between inspection staff and the contractor.

Each pipeline company should have:

- a clearly defined environmental policy, practices and procedures incorporating public input; and
- a basic set of standard environmental specifications which are supplemented by project or site-specific specifications as required. Standard environmental specifications should be sufficiently detailed to ensure a high degree of environmental protection but retain flexibility to address the project or site-specific concerns.

The information base developed from monitoring various projects should be used to improve environmental policy, practices and procedures, as well as standard and site- and project-specific specifications.

Flexibility should be built into the design of mitigation procedures thereby encouraging environmental inspection staff to use their discretion according to site conditions. Inspection staff must understand the environmental impacts and procedures in order to make fair evaluations during construction. Their understanding should incorporate findings from recent monitoring reports. Knowledgeable inspection staff should anticipate problem situations and provide the appropriate on-site planning to avoid difficult situations.

Public involvement should continue to be encouraged at the early stages of project planning and developed as a key element of the assessment and performance audit process. This will serve to streamline the overall planning and approvals process in a cost effective manner for all parties involved in pipeline projects.

The environmental assessment process for pipeline projects in southern Ontario has reached a level of proficiency where we can expect future pipeline projects will provide a good degree of environmental protection. The key to ensuring continued improvement lies in strengthening the monitoring procedures for feedback to the assessment process.

REFERENCES

The basic reference document for this study is:

Torrens, L.W., M.L. Shea and J. Moncrieff, 1985. Environmental Performance Audit Report of Selected Pipelines in Southern Ontario, prepared for Environment Canada, Hull. A consolidated list of reference material for the audit is appended to the report.

ENVIRONMENTAL MANAGEMENT STRUCTURE FOR THE BANFF HIGHWAY PROJECT

S.H. Janes
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Introduction

The objective of this audit has been to produce a critical evaluation of the Banff Highway Twinning project from the perspective, firstly, of predicted impacts and the proposed mitigation measures, and, secondly, the environmental management structure. Both these topics have been dealt with in a longer report produced for Environment Canada. The purpose of this paper is to focus on the effectiveness of the management structure, since it is the authors' belief that the experience warrants serious consideration in the development of other large-scale and complex projects.

In this audit, three important questions are addressed:

- Did the environmental management structure function effectively? (That is, did it achieve an environmentally suitable project?)
- Was the management structure suitable for those involved (Parks Canada, Public Works Canada)?
- Was it meaningful to the interested public?

The answers in our view will be particularly useful in assigning responsibility for environmental management in future projects.

Background to the Highway Project

A brief background to the project is in order. The concept of twinning the highway in Banff National Park has had a relatively long and somewhat turbulent history. Conceptual studies commenced as early as 1963. During the next eight years, proposals were made to twin the Trans-Canada Highway for a distance of 120 km through Banff and Yoho National Parks. These studies were done at a time when environmental considerations played a much smaller role than they do today, and it was not until the early 1970's that any environmental studies were carried out. At that time, Parks Canada conducted a public participation program on the proposal, and the twinning was strongly opposed by environmental groups.

In 1975, a decrease in traffic over 1974 occurred, mainly as a result of the worldwide concern over oil shortages. This combined with public opposition, caused Public Works Canada (PWC) to temporarily shelve its plans for highway twinning. After 1975 traffic growth resumed and PWC recommenced studies. By 1978 PWC completed an Initial Environmental Evaluation (IEE) from the park East Gate (km 0) to the Banff traffic circle (km 13) which provided information on various twinning alignment alternatives and their environmental effects. This led to the conclusion that comprehensive environmental assessments would have to be undertaken.

Subsequent to this decision, the environmental assessments and project designs prepared by PWC were separated into two phases. These were submitted and heard by a federal Environmental Assessment Panel in two separate sets of hearings:

Phase I km 0-13 - Panel decision published October 1979.
Phase II km 13-27 - Panel decision published April 1982.

The modifications now being undertaken by PWC to the Trans-Canada Highway in Banff National Park will result in twinning the highway between the park's East Gate and km 27 near the Sunshine Village ski area access.

Design and preliminary field studies are currently under way to extend the twinning west from the new interchange at the Sunshine interchange (Phase II) to the Lake Louise access point. Given the experience gained through the first two phases, this third phase may not be submitted for a full Panel review. It is quite likely, however, that an environmental assessment will have to be undertaken.

One of the major factors which influenced the last part of Phase I and all of Phase II was "fast tracking" or the planned acceleration of construction. The initial schedule proposed by PWC indicated completion by 1990. A revised schedule presented during the environmental review concluded that one year could be cut off the construction time. In addition, further "fast-tracking" of the project has occurred with the injection of special funding by PWC. This involves a very significant acceleration of all aspects of the twinning project, and Phase II is now expected to be completed by 1986.

Fast tracking is introduced at this point to acquaint the reader with one of the major causes of future environmental co-ordination and management problems.

Major Actors in the Banff Highway Project

The Banff Highway Project, because of its scale, a national park location and environmental consequences, assumed a level of importance unique in Canadian highway development. In carrying through the project, a number of significant participants were involved:

1. EARP Panel/FEARO. The initial Environmental Evaluation led to the referral of the project by PWC to the Federal Environmental Assessment Review Office (FEARO) in May 1978. A Panel was then appointed to conduct a formal, public review of the environmental consequences.

The important factor to recognize in respect of FEARO involvement is that the Panel Reports, with the Minister of the Environment's endorsement, stand out as the fundamental design and construction directives to PWC. In addition to numerous mitigation recommendations, these reports set the stage for the development of the environmental management structure.

2. Parks Canada. This agency has a major interest and role which, in the simplest of terms, is that of the 'land manager'. Once the Banff Highway Project is completed, Parks Canada will have full operating and maintenance responsibilities. As a consequence, Parks Canada appeared as an intervenor throughout the EARP Panel Hearings, to ensure that its responsibilities and obligations were satisfied.

Two major staff groups in Parks Canada maintained an ongoing interest in the project:

1) The Western Regional Office - responsible for environmental monitoring and management; and
2) The Park Superintendent and the Warden Service - responsible for the supervision and operation of all facilities within the Park.

Public Works Canada (PWC). The role of PWC is that of "road builder", to design and construct the highway and following this, to turn it over to Parks Canada. As stated by PWC in the Panel Hearings, the highway is intended to provide the "best example of environmental design". Under the terms of federal EARP, PWC was both the initiating department and the proponent. It had the full responsibility for preparing and submitting the Environmental Impact Statements for Panel review and recommendations to the Minister of the Environment. Following the Minister's subsequent decisions, PWC undertook to build the Banff Highway Project in accordance with the Panel's conditions and in the spirit of this undertaking.

To carry out its responsibilities, PWC subdivided the project into two major areas of responsibility, both of which are handled by the Architectural and Engineering Services (A & E Services). These responsibilities cover all aspects of design and include preparation and tendering and complete field supervision of construction.

Environment Canada. The final responsibility for all environmental protection in the Park rests with Environment Canada (the Department within which Parks Canada is housed). As a consequence, this agency was involved in the EARP Hearings, and in all phases of the project's design and construction.

The Environmental Management Structure Adopted

A project with the environmental complexities of the Banff Highway Project and the distinctly different roles of Public Works Canada and Parks Canada required the establishment of some form of interdepartmental management. The need was recognized well before the initiation of the process of submission to EARP by both PWC and Parks Canada. An interdepartmental co-ordinating body, the Parks Canada Steering Committee, was formed in the fall of 1978.

At that time Parks Canada had already had some experience in major project development in National Parks and the concept of a steering committee approach was not entirely new.

While the use of a steering committee would appear to have set the stage for effective interdepartmental liaison, the Environmental Assessment Panel in the Phase I review encountered criticism by those involved. Most agreed that the "Steering Committee" approach had not really achieved what it set out to do.

The Panel in its report viewed this as a major deficiency and provided specific directions to resolve it. It considered that there was "a need to clearly delineate responsibilities between government agencies to permit effective communications and to ensure that the project takes place in an environmentally acceptable manner".

To achieve this, the Panel recommended that a committee structure should be established with PWC, Parks Canada and the Environmental Protection Service of Environment Canada. Other agencies would be represented by invitation. The role of the committee structure was to assure the highest level of environmental management for the Banff Highway Project. Terms of reference include:

(i) facilitating design standards
(ii) environmental standards and practices
(iii) aesthetic standards
(iv) further studies and resulting mitigation requirements
(v) special environmental conditions in contracts
(vi) ensuring that the conditions contained in this report are implemented.

The Panel also recommended the appointment of an Environmental Co-ordinator. His or her role would be to handle daily operational issues in overseeing field construction work. This individual, according to the Panel's recommendation, must be suitably qualified, would report to the Project Manager, and would have sole responsibility for on-site environmental management. The Panel also observed: "that special efforts be made by all parties to ensure effective communications in order to allow the project to be designed and constructed in an environmentally acceptable and aesthetically pleasing manner".

<u>The Committee Relationship Adopted</u>

There were two separate stages in the evolution of the environmental management committees. The first stage covered the period between the Panel's recommendation in October 1979 and April 1981 and was handled by a Steering Committee. During this time, Phase I designs were commenced and the stage set for preparation and submission of the EIS and the EARP review of Phase II. A rather important procedural step also occurred at this time. It was agreed that the Chairman of the Steering Committee was to be a senior Parks Canada representative with PWC serving as Secretary.

The second stage was initiated in April 1981, although agreement in principle about the committee structure was concluded a year prior by PWC, Parks Canada, and Environment Canada. With construction scheduled to start in June 1981, the Chairman of the Steering Committee, then Park Superintendent P.A. Lange, formally initiated the structure recommended originally by the EARP Panel. The committee structure was subdivided into a Policy Committee, a Senior Committee, and four sub-committees - Design, Environment, Construction and Public Relations. The composition of these committees is shown in Figure 1.

BANFF HIGHWAY PROJECT
COMMITTEE STRUCTURE

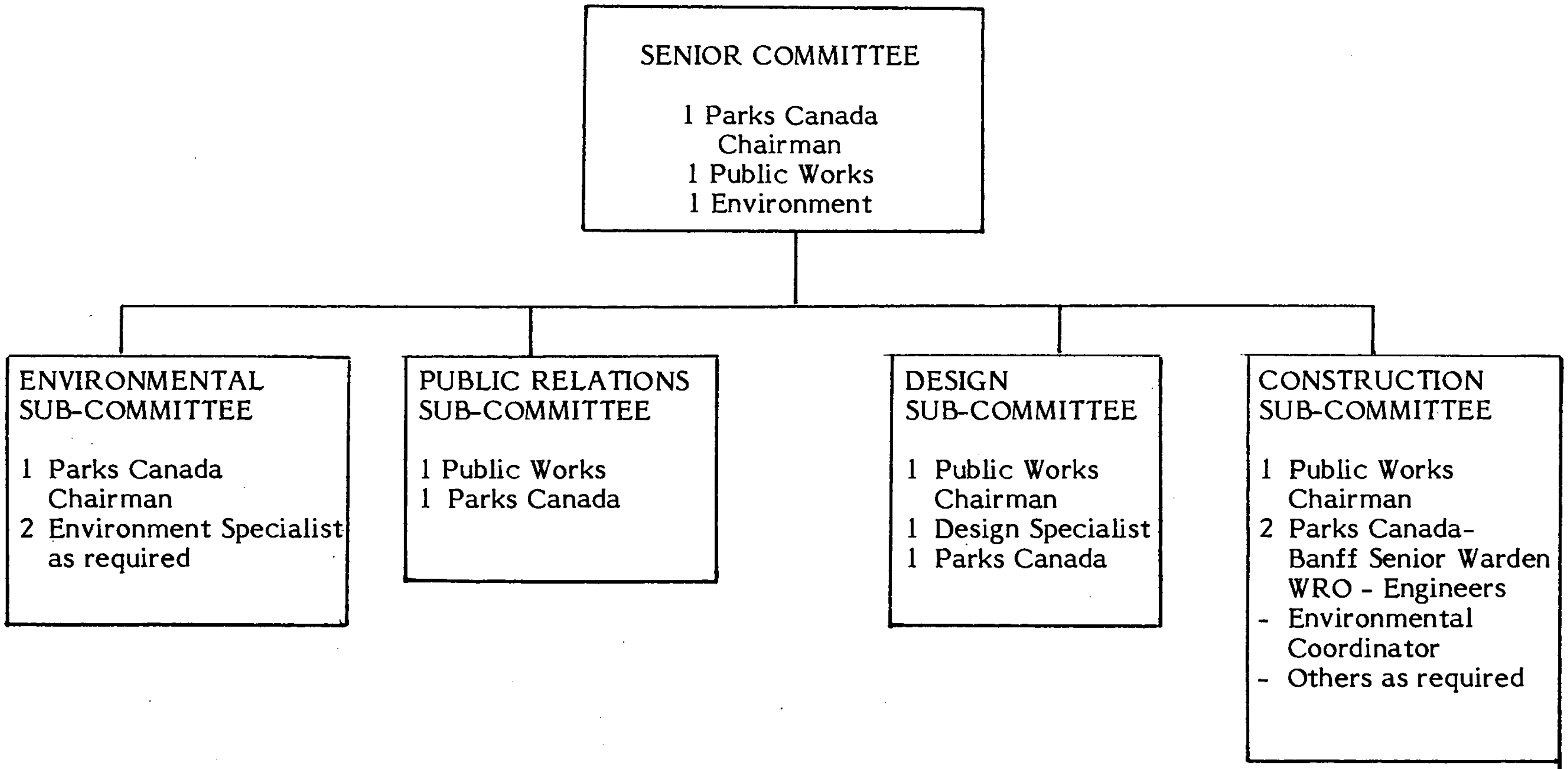

FIGURE 1 CHAIRMEN FOR SUB-COMMITTEES REPORT TO SENIOR COMMITTEE AND MAY BE JUNIOR MEMBERS (NON-VOTING IF VOTING IS REQUIRED)

Senior Committee

This committee consists of a chairman from Parks Canada (currently the Park Superintendent), the PWC Regional Manager (A & ES) and a senior representative of Environment Canada. Inclusion of a representative from Environment Canada is seen as an extension and an assurance of continuity of the department's involvement in the EARP process.

The Senior Committee's primary responsibility was to coordinate the work of the four Sub-committees and to make decisions relative to the Banff Highway Project.

The Policy Committee is a more senior committee to which the Senior Committee could turn in case it needed policy direction. It is intended to play a background, and not an active, role in project management.

Design sub-committee is responsible for overseeing PWC's design of the highway and to ensure that the design meets the high functional, environmental and aesthetic standards set out in the Environmental Impact Statements and recommended by the EARP Panel. A major aspect of the sub-committee's activities is liaison and collaboration with other sub-committees to ensure the achievement of this objective.

Environmental sub-committee is responsible for overseeing environmental studies and for initiating the necessary investigations to ensure that the highway's design and construction are carried out to the standards appropriate in a National Park and as defined by the EARP Panel. The Chairman of this sub-committee is a senior member of the Parks Canada Western Region. The rest of the sub-committee consists of two environmental specialists - one from PWC and the other from Environment Canada. Additional representation occurs through the involvement of the Environmental Co-ordinator for PWC.

Construction sub-committee is responsible to ensure that construction of the Banff Highway is carried out in accordance with the design to ensure the achievement of high environmental and aesthetic standards. It is chaired by PWC's Deputy Project Manager and includes the Assistant Park Superintendent for Banff National Park and a representative of the Environmental Protection Services of Environment Canada (Edmonton). Through the Environmental Co-ordinator, day-to-day contacts are maintained with designated Banff National Park staff and others involved in the Project.

Public Relations sub-committee was responsible for dispersing information to the public on the Banff Highway Project. It has now been replaced by an individual public relations person reporting to the Senior Committee.

The Environmental Co-ordinator is responsible to the Project Manager, PWC, for day-to-day environmental surveillance of the project. This responsibility extends to all aspects of environmental management, in both design and construction stages, and includes participation in the sub-committees through the Project Manager.

Several aspects of the Co-ordinator's duties warrant mention. He is a PWC employee whose role extends to participating, through the Project Manager, and the Design and Environmental sub-committees, in the development of design requirements for mitigation. Furthermore, he is responsible for developing day-to-day working relationships with on-site construction supervisors, foremen and equipment operators to ensure the field achievement of environmental impact mitigation measures.

The Environmental Co-ordinator was selected from the Park Warden Service. This was done in order to ensure that the individual knew and understood the National Parks Act, park policies and operations. These qualifications, together with the need for construction experience and for a degree of interpersonal skills, were used to make the selection in mid-1981, prior to the commencement of construction, of Andy Anderson.

Functions of the Management Structure

Design Reviews and Approvals

The review and approval process for the Banff Highway Project was subdivided into four stages:

- Pre-design discussions to identify the environmental issues. These involved the Design and Environmental sub-committees, consultants, Parks Canada and others as suitable.
- Preliminary design package review (design approximately 50% completed)
- Intermediate design package review (design approximately 75% completed)
- Final design package review - Tender level (design specifications and contract 100% completed)

The responsibility for the design review process rests with the Design sub-Committee.

- This Committee convenes a pre-design conceptual level meeting where complex large projects are reviewed with the other sub-Committees and invites other interested parties. Design proposals are presented and discussed in detail.
- When design drawings and proposals are 50 percent complete, circulation is made to all Design and Environment sub-Committee members, to Parks Canada and to other interested parties with the request for return comment.
- This same step may be repeated at the 75 percent design stage.
- When design and contract documents are 100 percent completed and ready for tender, the Design sub-Committee distributes them to these same parties for review and acceptance. While many individuals and organizations were involved in this design review, major contributions were consistently made by the Environmental sub-Committee.

In the design review process, an effort was made to obtain early agreement on the key environmental issues and their design treatment. Later design reviews became simply a means of confirming that the design had proceeded as initially agreed.

The approach to design reviews and approvals described here was agreed to and practiced as described in the early phases of the project. With fast-tracking and with changes in personnel, the review process became more rushed and less fully followed.

Operationally the Design sub-Committee appears to have functioned as an arm of the PWC's Architectural and Engineering Service Branch, with most of the sub-Committee's activities occurring by the circulation of design documents and specifications through the Chairman to the reviewers. As the project proceeded, this seems to have become formalized using the traditional engineering review practices of checking off responses against circulation.

The time allotted for review and response was about two weeks at the initial project stages. As "fast-tracking" proceeded, this was drastically reduced, sometimes to the point that only three days review was possible before the tender call.

Tendering and Contractor Selecting

PWC has been totally responsible for the tendering and contractor selection process and the approach used for all Banff Highway Projects follows its standards. Detailed specifications and drawings are accompanied by general conditions and the PWC standard tender document. Tender calls were made for individual projects, with award based solely on price and ability to be bonded for the undertaking.

In terms of environmental management of project development, the tendering and contractor selection process is a critical element. While the design drawings form a key component, the specifications contain the detailed directions on construction technique and materials. Adequacy of the tender documents is therefore one part of the Design sub-Committee's responsibilities with the environmental clearance being achieved through circulation to and response by the members.

Review of a select number of contract documents indicates that standard provisions were used. These include:

1) provision for the protection of environmental and aesthetic features, i.e., operational restrictions and fitting the project into its surroundings;
2) techniques for excavation (soil and rock) and the handling of surplus material; and
3) techniques for the landscaping and restoration of cut areas.

There was and continues to be a recognition that design drawings and specifications cannot fully convey the need for an on-site environmental protection mentality. To help offset this, "pre-tender" briefings were convened by PWC with site problems and environmental sensitivities discussed by the Environmental Co-ordinator and the Project Manager or Deputy Project Manager. Finally, and following award, briefing sessions were again held by the Environmental Co-ordinator with contractors and the work force.

Construction sub-Committee

This Committee is distinctly different from the Senior Committee or the other sub-Committees in that it mainly involves day-to-day site development operations. To achieve this, the Committee adopted two operational styles. Its on-site activities involved the PWC Deputy Project Manager, the Assistant Superintendent of the Park, and the Environmental Co-ordinator (who was not a formal member of the sub-Committee), all of whom handle problems by telephone or communicate generally in an informal manner. The remaining member from the Edmonton office of the Environmental Protection Service tends only to be involved in the more significant issues, when site visits are warranted.

This operational style, while the obvious solution to effective handling of daily on-site issues, does not function in the same way for the review of designs and specifications circulated by the Design sub-Committee. In such reviews, the members of the Construction sub-Committee function as individuals, drawing more often on their roles in working with other groups or sub-Committees - the Warden Service or design groups. Each member then responds on an individual basis to material circulated for review. Rarely has the Construction sub-Committee had to meet as a body to review materials submitted to it by the Design sub-Committee.

Management of Surprise

All the possible impacts of an undertaking of the magnitude of the Banff Highway Project cannot reasonably be identified, and fully predicted in advance of their occurrence. The critical measurement of any management system lies in the manner and success by which it copes with unexpected or "surprise" events. Such events will and do occur, and responding to them is one of the important functions of environmental management systems.

Some of the examples that follow represent situations in which a considerable degree of on-site experimentation was necessary. This often resulted in a reversal of the usual project approval process in that the design initiation occurred in the field. Circulation back to the Design sub-Committee was then necessary to ensure consistency with other project elements and to incorporate the new findings in future designs and specifications.

Carrot Creek Borrow Pit. This is located on the north side of the Trans-Canada Highway at km 1.8. Field exploration had not uncovered the fact that this pit contained a large and exceptionally high quality aggregate deposit. When this was determined, Construction and Environmental sub-Committees concluded that:

1) the pit should be enlarged and deepened considerably to take advantage of the deposit,
2) it should be progressively filled back with non-putrescible wastes including construction material to partially eliminate the deep cuts,

3) fencing should be extended into and around the pit to allow a longer period for waste disposal,

4) a human fence stile should be incorporated to allow passage into the surrounding woodlands, and cross country ski trails; and

5) ungulate grazing areas should be incorporated in the cleared sections around the pit.

Animals jumping to their deaths. The construction of the Cascade River Bridge and the elevated road sections below the steep mountain slopes above the Vermillion Lakes created situations in which deer drawn to the surrounding grazing lands underestimated vertical drops associated with new retaining walls which were hidden by Jersey barriers. These animals, in following traditional pathways, simply leaped off the wall to access the lower grasslands. A number of deaths and crippling injuries resulted.

Although most of these structural features will eventually be isolated from animal trespass through the use of fencing systems, a solution was necessary to handle the construction phase.

The proposal advanced by the Environmental Co-ordinator and the Environmental sub-Committee was to use a temporary and inexpensive system of vertical rods along the top of the walls or, where dangerous differentials exist, strung with hanging reflective tape (glo-guard wildlife reflectors). The result was an effective visual warning, not unlike the coloured symbols placed on glass doors or windows to ward off birds and in some cases people. Animal deaths due to this problem were eliminated.

Drainage and icing problems in animal underpasses. Multiple use of underpasses to solve both drainage and animal passage, simply does not work from the latter viewpoint. Monitoring of underpass usage by the Warden Service indicated that ungulates will not use an underpass with an iced floor. The solution developed jointly by all sub-Committees in the field has been:

1) for underpasses in place, provide alternative drainage route by intercepting flow and routing away from underpass,

2) for future installations, determine potential groundwater elevations and drainage routes and locate underpasses so that they remain dry year round.

Healy Creek Borrow Pit. The steep side slopes originally planned for the Sunshine Interchange would have required the use of expensive Jersey barriers. The alternative of flattening the slopes from 2:1 to 3:1 was cheaper and this change was recommended. As it improved safety and made the interchange more acceptable aesthetically, the change was agreed to by the Environmental sub-Committee. The major environmental impact caused by this change (as well as other unplanned needs for borrow) was an increase in fill requirements from the Healy Creek Pit from 350,000 m^3 to almost 500,000 m^3. As a result, pit redesign became necessary. The area of potential disturbances increased and this in turn led to a major revision in the extraction and rehabilitation plans for this pit.

A great deal of effort has been applied to the management, operation and reclamation of borrow pits. This has become one of the major concerns of the Environmental sub-Committee. It is not a problem that is unusual in environmental management. The management structure was called upon, in this case, to interact rapidly, with factual and accurate reactions to each subsequent component. Only when this was done could the overall financial and environmental implication of the initial problem be measured and a decision made on the right course of action.

In the example given, the solution was arrived at through interaction of the Environmental sub-Committee with construction Project Management, the Warden Service and the Park Superintendent's office.

The preceding are examples of situations which could not have been foreseen in the initial design. Successful management of such events or surprises would appear to require:

1) a quick and accurate field identification of the problem and the assignment of knowledgeable personnel to resolve the alternatives;
2) a corporate willingness to recognize that the problem exists; and
3) special contingency funds to handle unexpected events.

Experimentation

Experimental environmental management is a technique for handling a situation where a problem is recognized but no solution is known to exist. Sometimes the problem and alternative solutions cannot be tested until project development reaches the stage where the problem can be measured. This capability was built into the Banff Highway Project, and there are several critical examples of experimentation.

Road fence locations. This feature of the project required a careful field assessment of location to resolve a trade-off between visual impact and habitat considerations. In the design stages the sub-Committees recognized that a final decision could not be made until the road structure and slope grading were completed. Only at this stage could the highway be driven by car and locations evaluated.

As in the examples of surprise, the solution started in the field with the Environmental Co-ordinator first reviewing alternatives with the Warden Service, the Environmental sub-Committee, and the Park Superintendent's office and then circulating locational plans for sub-Committee approval. The next step involved the Design sub-Committee and PWC Project Manager finalizing the fencing contracts to carry out the location scheme. Even these fence locations have, in some cases, proven to be experimental. After viewing the installed fence, a number of (generally minor) adjustments have been made. Fencing has been moved or additional shrubs and trees have been used to screen the fence.

Cattle gate experiment at Valley View Picnic Site. Fencing along the Highway's right-of-way requires a method of animal access control for public facilities which require vehicle access. A similar and much more complex problem exists at the East Gate and other access points.

In the case of the Valley View Picnic Site, public access to the site by private car was considered essential. Several control gate arrangements were considered but each confronted the problem of vandalism. Swinging gates could be left or forced open with the result that uncontrolled ungulate entry could occur. The control technique selected, that of a cattle gate, had been used in other parks but the results were not well enough known to be applied without further work. The strategy adopted was to test the cattle gate system and to set up a monitoring program through the Warden Service to observe and report back to the Park Superintendent, the Environmental Co-ordinator and the sub-Committees.

Revegetation Experiments. One of the problems identified in the EARP review was how to revegetate the dry south-facing slopes. The Environmental Co-ordinator and the Environment, Design and Construction sub-Committees are presently involved in continuing to experiment with various solutions.

From the standpoint of environmental management the requirements for experimentation are:

1) identification of the problem;
2) definition of the parties responsible for developing and monitoring the experiment; and
3) clarification of the "action-route" to effect wider use of the solution.

In the Banff Highway Project the responsibility for managing the experimentation was given to the Environmental sub-Committee. Definition and resolution then became a shared responsibility with the Design and Construction sub-Committees.

Monitoring, Evaluation and Reporting Programs

Because it is important from the standpoint of environmental management, all participants have agreed to monitoring and evaluating the mitigation features incorporated into the Banff Highway Project. The purpose of these programs is threefold:

1) to provide feedback and allow an adjustment in the environmental management program to reflect what is occurring;
2) to provide technical information for future use concerning the suitability of the mitigation measures (and the conditions under which the measures are effective); and
3) to provide information to the public so that the objectives of the first two points are seen to be met.

The need for comprehensive monitoring and evaluation was stressed in the EARP Reports, and setting aside the financial and technical resources for these tasks is seen as being an integral part of the project.

At the outset, the Panel recommended that the findings of Phase I be incorporated into Phase II and that this program of monitoring and evaluation be undertaken in a formal, scientific manner with annual reports being produced on the findings. The overall responsibility for monitoring and evaluation was identified by the Panel as that of Parks Canada. The Senior Committee was then given the responsibility for ensuring that evaluation and annual reports were prepared and made public.

So far a wide range of monitoring programs were under way. These programs include:

- Underpass utilization and fence effectiveness - field survey carried out by the Warden Service;
- Highway kills - the Warden Service continues to monitor highway and rail line kills, and take a census of animals and population impacts;
- Chinaman's Creek Diversion - special monitoring study undertaken by a consultant;
- Hydroseeding Failures - special report prepared by consultants on the experiences gained in the km 0.0 to km 5.5 sections;
- Vegetation Studies of Grasslands - prepared by consultants for PWC on grasslands restoration;
- Heritage Resources Impact Assessment - special study along route for potential archaeological sites;
- Landscape Architecture Design Philosophy - special study of the philosophy and approach to be applied to projects such as the Banff Highway Project; and
- Special field studies - undertaken by the Environmental Co-ordinator, the Environmental sub-Committee, and the Park Warden Service on topics such as impact of blasting noise on the Vermillion Lake eagles and mountain sheep. The documentation of the project is being extended to include the preparation of material in a form suitable for public use.

Evaluation of the Management Structure

Operational Arrangements

A substantial degree of evolution and refinement occurred in the management structure as the Project progressed. At the outset, well in advance of the EARP Panel proceedings, the coordination of PWC and Parks Canada interests was through a Steering Committee. This Committee existed from Phase I to the conclusion of the Phase II EARP Review.

Approximately one year after the release of the Phase I Panel Report, a Committee structure was assembled in accordance with the Panel's recommendations as shown earlier on Figure 1.

We believe that the operating style of the Committee was much more interactive than implied by Figure 1. A more realistic appreciation of the function of the Committee is given in Figure 2. On this basis, a number of observations can be made:

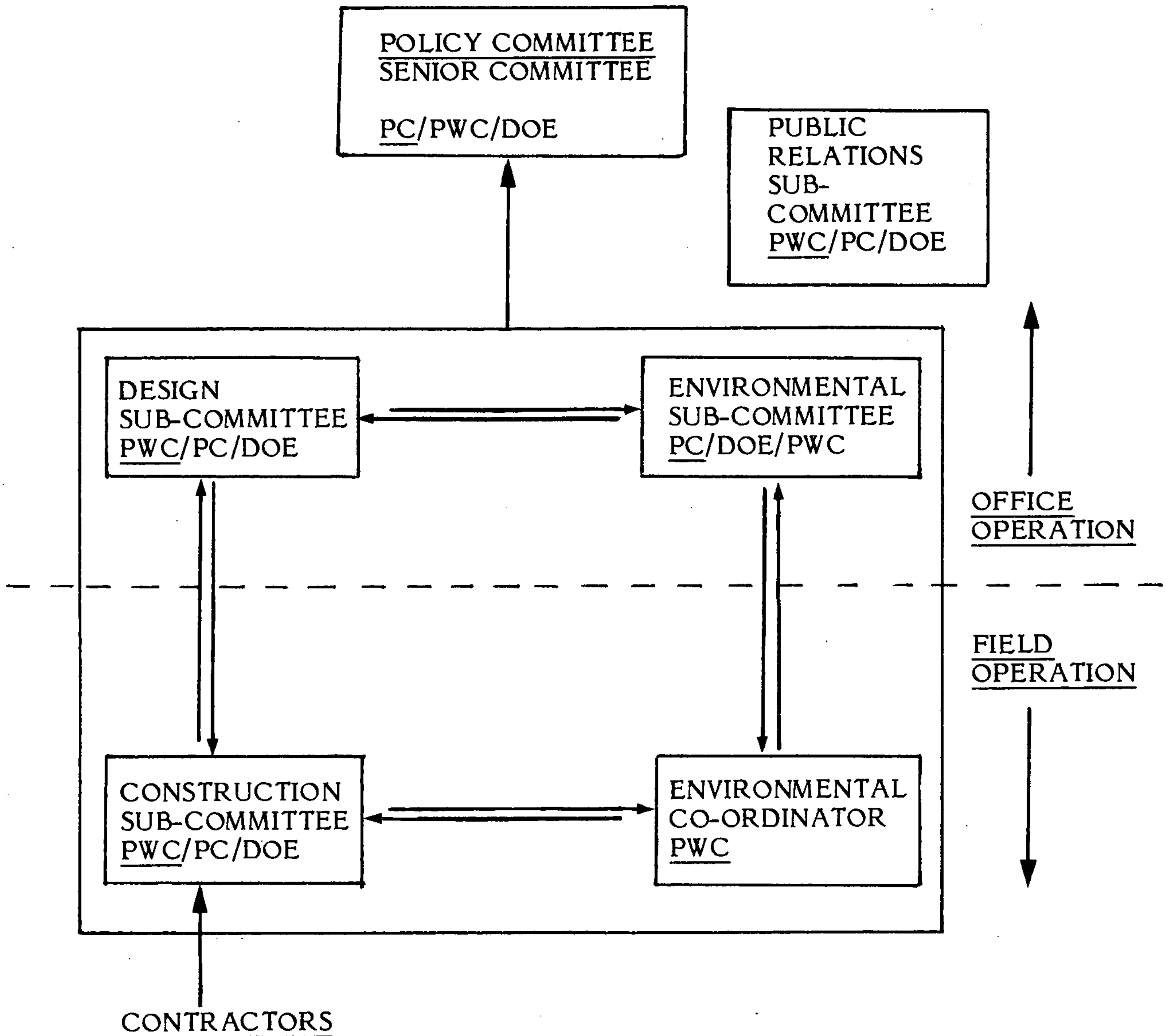

FIGURE 2 FUNCTIONING OF COMMITTEES

- the Senior Committee has functioned as the senior body with the responsibility of resolving conflicts at the sub-Committee level. This committee has been called upon to handle topics outside the responsibility of the lower committees (e.g., resolution of the review process for Phase III);
- the Policy Committee, shown beside the Senior Committee, has the same status. This Committee, however, has not been operational;
- a distinction is drawn between those sub-Committees which are office operations and those which are field-oriented. As one would expect, field operations tend to have to deal with day-to-day issues and so frequently operate in an ad hoc manner with on-the-spot meetings and telephone calls solving many of the problems;
- a total of four sub-Committees was established, three of which have been active throughout much of the Project. The Public Relations sub-Committee, however, has now been dropped and its responsibilities assigned to one individual who is developing a full-fledged program. This individual reports to the Senior Committee;
- the Environmental Co-ordinator is shown separately to indicate the special reporting roles he faces;
- the Construction sub-Committee has a series of clearly defined responsibilities. Since its membership includes PWC, the Park Superintendent's office and Environment Canada, the interests of the agencies flow through the members. All communications to the contractors must be through PWC. The interests of the Warden Service are represented by the Superintendent's office. Finally, Environment Canada's broad mandate is guided by its member;
- the Design sub-Committee is responsible for generating drawings and contract documents for circulation and review, and finally for the tender calls. The operational mode follows a prescribed routine for the review and approval of drawings and specifications;
- to a certain degree the Environmental sub-Committee functions in the same manner. There is, however, a difference in that this committee's responsibilities involve a far greater need for on-site inspection - hence the reporting linkage to the Environmental Coordinator; and

- design review involves the circulation of draft review material to all sub-Committees (except the Public Relations Coordinator) and to all interested parties - Park Superintendent's office, the Environmental Coordinator, etc. This review would appear to be not only effective but efficient.

By and large, the structure defined on Figures 1 and 2 has worked well. There are, however, a number of areas where operational difficulties can arise and changes should be considered.

On-site environmental problems, for example, are to be supervised by the Environmental Coordinator, who, as an employee of PWC, reports directly to the Project Manager and to the Construction sub-Committee. But he also reports to the Environmental sub-Committee and a reporting overlap clearly exists. This has become a sensitive issue when on-site environmental protection results in costly extra expenditures.

To complicate matters further, the Environmental Co-ordinator was selected (for a variety of good reasons) from Parks Canada Warden Service. Not only does he have long established connections with Parks Canada, but he has a thorough grounding in the Park resource management philosophy. The result of this overlap in reporting is to accentuate the potential for misunderstanding and disagreement. If the personalities of the individuals (Environmental Co-ordinator and Project Manager) clash, as they have at times, the results could be serious not only to the people involved but to the overall objective of sound environmental management.

One of the tests for determining how well a management structure works is to see what happens when a surprise problem arises. The problem of animals approaching the elevated concrete median separators and leaping to their deaths was such a problem. In the field, the Project Manager and the Environmental Co-ordinator immediately considered alternative ways to effectively alert animals and decided on the use of reflecting tapes. Additions were authorized for all danger zones and the problem was eliminated.

From our observations, the management structure has been able to respond effectively to unplanned events given time for the individuals to work out the proper solutions. Fast-tracking, without the addition of more personnel qualified to help with environmental management, has put undue stress on the ability of the parties responsible for resolving the problem. Fast-tracking should have been accompanied by pre-planning and staffing for this necessity.

Responsibility for monitoring of underpasses and resolving experimental features, such as fencing, gates and road access points or borrow pit reclamation, was delegated to the Environmental sub-Committee with the Environmental Co-ordinator assisting in the development of the plans and, where required, with the field monitoring. This arrangement seems to have worked well; the Environmental Co-ordinator frequently meets with this sub-Committee. The sub-Committee, in turn, has been able to convey the results of such studies to the Design and Construction sub-Committees for implementation.

Concluding Remarks

While the committee and coordinator arrangements recommended by the Panels for Phase I and II appear to have worked reasonably well, there are revisions which would improve the system.

1) Staff continuity in small committee arrangements is essential. Changes which occurred in the Banff Highway Project from the EARP Review stage through to the final design and construction stages presented difficulties simply because more recent staff members did not have the involvement and in-depth understanding of the Panel's recommendations or of the commitments made by their predecessors who participated in the review. Several techniques exist to minimize this potential: the buddy system with fall-back staff fully acquainted with a program; extensive briefing of new participants on the project; and careful selection of replacements with commitment to ensure consistent approach.

2) Confusion in reporting. The Environmental Co-ordinator's role warrants better definition. Given the nature of the Banff Highway Project and the interest of the major participants, PWC and Parks Canada, it would seem more logical for the Environmental Co-ordinator to report to the Environmental sub-Committee Chairman rather than to the Project Manager.

3) Awkward committee representation. The Construction sub-Committee frequently functioned in an informal, ad hoc manner. Much of its real action occurs in the field on a day-by-day basis. Placing a representative on this committee who is located some distance away simply means that his or her role will not be meaningful. Such an individual should either be assigned full-time to the Project or selected from closer sources.

Design reviews. The Design sub-Committee appears to function most of the time on paper only. It would be simpler if PWC's Design group replaced the Design sub-Committee.

From an environmental standpoint, the major input comes from the Environmental sub-Committee. This committee would benefit from the transfer of the EPS representative on the Design sub-Committee. By increasing its resources, the Environmental sub-Committee would be better able to provide prompt reactions to design submissions.

Annual reports. These were identified as a necessity by the EARP Panels and thus far have not been prepared. The extensive and costly programs being carried out by PWC and Parks Canada should not be simply forgotten. They constitute a very important lesson in environmental management - a legacy for future projects. Action should be taken immediately to rectify this deficiency.

Public information. It is necessary to maintain a basis for public information and education on the project's environmental measures. To be truly effective, these tasks should be separated. Public information can best be handled locally, where daily knowledge of construction schedules is available and the ability exists to correct a deficiency or problem identified by the public.

Numerous techniques exist to better inform local people and those using the Highway. These include:

1) information handouts at control points (e.g., East Gate) to inform travellers on the reasons for fencing systems, the underpasses, and so on;
2) a speaker's bureau - where the local public can call to arrange for project speakers; and
3) identified phone lines for information (currently this is provided by the Park Superintendent's office).

The other aspect of public education requires resources and the ability to stand back and examine a project to highlight the features worth recounting. Location of this capability is independent of the site as long as access costs of travel are reasonable.

Our overall conclusion is that the environmental management structure used on this project with minor suggestions for improvement is quite suited for use elsewhere. Admittedly there were problems. Changes in key personnel, fast-tracking and budget constraints all had their impacts. In spite of this, the environmental management structure put in place by the formal review process has functioned quite well and the project has been carried out in an environmentally satisfactory manner.

AN EVALUATION OF THE PROCEDURAL ASPECTS OF THE SHAKWAK PROJECT ENVIRONMENTAL PROGRAM

Richard B. Spencer *

Introduction

This paper is a synopsis of the procedural aspects of an environmental follow-up study of the Shakwak Highway Project. The major objective is to examine the administrative methods employed by Public Works Canada (PWC), the proponent, and Indian and Northern Affairs Canada (INAC), the regulator, for implementing environmental objectives resulting from the Shakwak Project Environmental Review Process. Successful procedures were to be identified and recommendations advanced for more effective means of implementing environmental protection on future projects.

In 1977, Public Works Canada (PWC) and the United States Department of Transport Federal Highways Administration (USFHWA) jointly proposed the Shakwak Highway Improvement Project. The USFHWA originally approached PWC because of a perceived need to upgrade the road link between southeastern Alaska (at the port of Haines) and the Alaskan interior (see Figure 1). The project was to involve improvements to the Haines Road between the Alaska-British Columbia border (km 70) and Haines Junction, Yukon (km 255); and to the Alaska Highway between Haines Junction (km 635) and the Yukon-Alaska border (km 1966).

These highways were originally constructed during World War II to provide land routes to Alaska should it be invaded. The Alaska Highway was later upgraded to provide an all-weather surface for civilian traffic. In 1974, Canada agreed to maintain the Haines Road for year-round use. In each of the next two winters, however, drifting snow in the sub-alpine area between Three Guardsmen Pass and the British Columbia-Yukon border forced frequent road closures. This condition created interest in modernizing the road prism and alignment. Negotiations

* The author was assisted in the preparation of this paper by a Steering Committee composed of government officials from the Yukon, by technical advice from Robert Baker of Environment Canada and Marg Crombie of Indian and Northern Affairs Canada, and by Cole Pederson and Lynn Maslen.

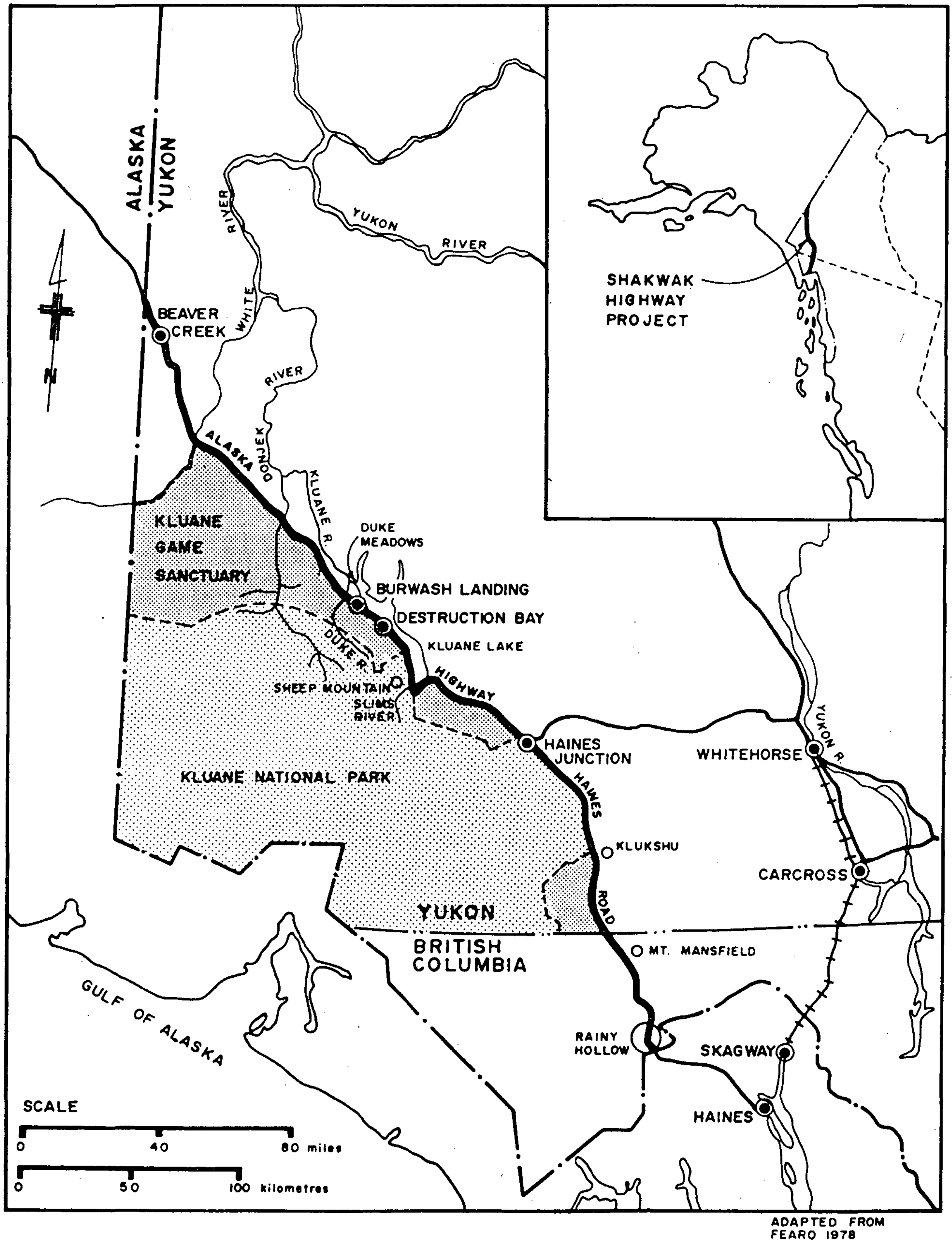

FIGURE 1 SHAKWAK HIGHWAY PROJECT

between U.S.A. and Canada concerning this suggestion developed into the 1977 Shakwak Highway Improvement Project proposal.

The proposal called for the Haines Road to the upgraded and paved to a design speed of 80 km/hr. and the Alaska Highway upgraded and paved to 100 km/hr. The U.S.A. was to pay costs of construction, and Canada was to provide construction management and maintenance funding.

The United States National Environmental Policy Act (NEPA) requires that environmental impact assessments be prepared for federal construction projects before federal government funds can be spent. This includes projects in foreign countries. Since all construction was to occur in Canada, PWC acted as lead agency for the project and submitted it to the Government of Canada's Environmental Assessment Review Process (EARP) for a panel review.

To meet both countries' needs for environmental assessment, the Federal Environmental Assessment Review Office established a review panel to conduct hearings and make recommendations on the project. The panel established guidelines for both EARP and NEPA. Public Works Canada (1977) retained Thurber Consultants Ltd. to coordinate the preparation of an EIS.

The EIS Guidelines for the Shakwak Project required that eleven aspects of the environment be addressed: climate, terrain, hydrology, vegetation, fish resources, wildlife resources, people, land status, traditional and historic resources, recreation and tourism, and aesthetics. Upon receipt of the EIS, the Environmental Assessment Panel scheduled a series of public hearings. They were held between 3 March and 10 March, 1978 in Whitehorse and in the Yukon communities of Haines Junction, Burwash Landing, Destruction Bay and Beaver Creek. The USFHWA held two public information meetings in Haines, Alaska as required by the NEPA.

In 1977, the U.S. Congress had authorized $58.67 million for the project. That amount was based on a cost estimate for the project prepared in the 1960's. Of these authorized funds, Congress appropriated $37 million for immediate use. This amount was apportioned by the United States Office of Management and Budget so that it was in fact available to USFHWA for actual spending.

In June of 1978, the Panel submitted its recommendations to the Canadian Federal Cabinet. Cabinet approved the project subject to the EARP Panel recommendations, and right-of-way clearing commenced in the Haines Junction area that autumn.

In 1979, it became clear to USFHWA that only the already appropriated $37 million would be available for the project. Therefore, that agency and PWC agreed to concentrate their construction in the Rainy Hollow and Haines Junction areas (Figure 1). The construction segments near Haines Junction (7 and 8) (Figure 2) were completed and chip sealed by 1981; the Rainy Hollow realignment was completed and asphalt surfaced in 1982. In 1984, USFHWA received new funding sufficient to finance construction of the segment immediately north of the Rainy Hollow realignment (Segment 2). This segment is scheduled for completion by 1986.

In 1984, a follow-up study of the Shakwak Project addressed its procedural and technical aspects. Fisheries, revegetation and aesthetics were selected as the focus of technical studies. Procedural or management investigations concentrated on:

- type of environmental assessment and review;
- regulatory permit terms and conditions;
- construction contract environmental terms and conditions;
- environmental monitoring; and
- external reporting requirements.

The Shakwak Project was chosen for follow-up study because it was one of several northern projects proposed in the late 1970's that was subjected to a full EARP review and actually constructed. In addition, it was the first occasion of a highway project in Canada's northern territories being subjected to the full Environmental Assessment and Review Process. It marked one of the first occasions that northern regulatory agencies were confronted with issuing permits for a highway project that had undergone such a rigorous environmental review. In fact, the Shakwak Project marked the first time in the Yukon that many environmental practices were attempted on a Yukon Highway construction project, and, from that point of view, the project was unique.

Descriptions of Procedural Aspects

EARP Review

Panel Recommendations

The Environmental Assessment for the Shakwak Highway Project concluded "...that it will be possible to carry out the project without significant adverse environmental or social impact if appropriate procedures are followed and certain conditions are met" (FEARO 1978). It recommended the project proceed as

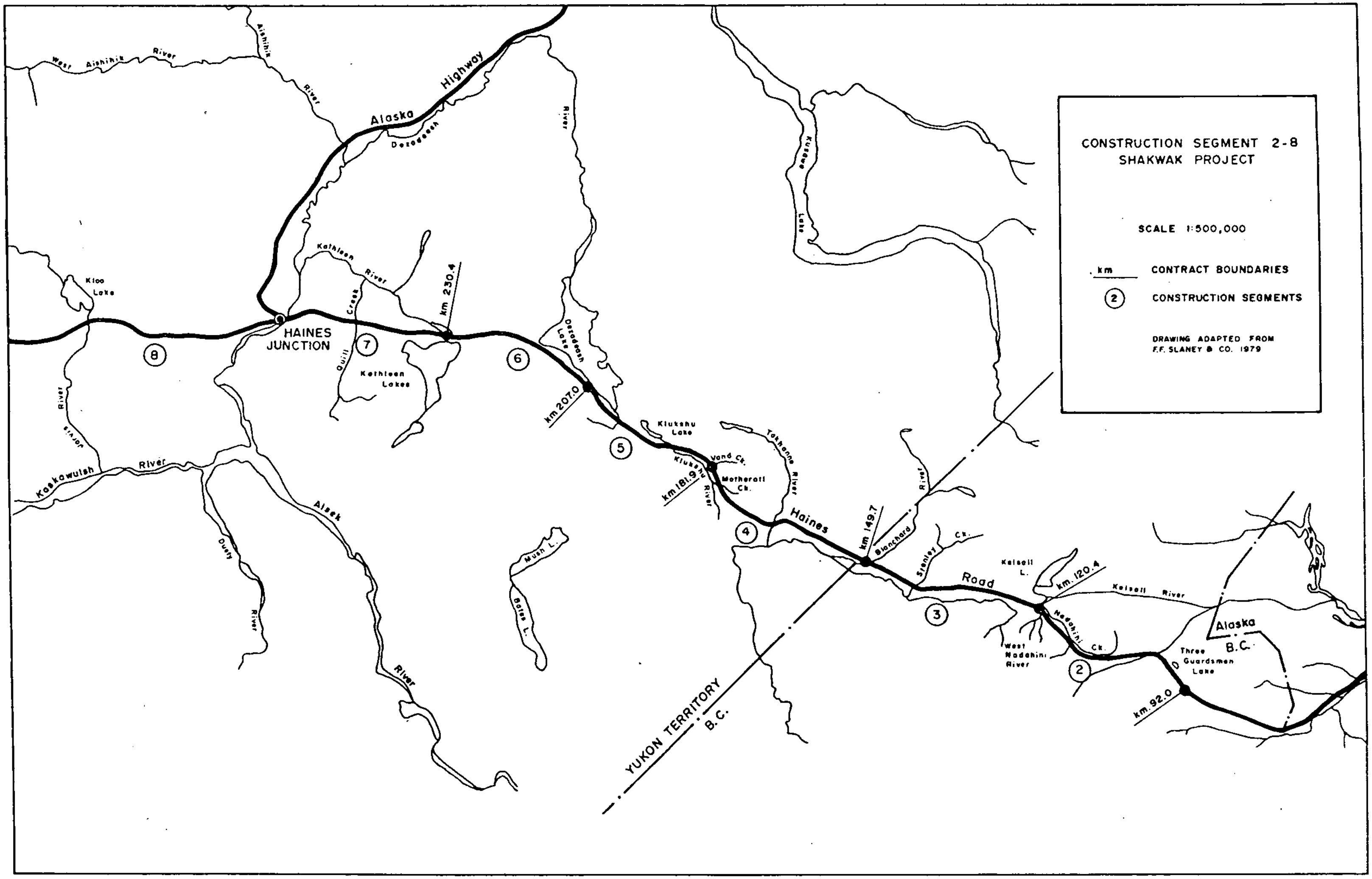

FIGURE 2 CONSTRUCTION SEGMENT 2-8, SHAKWAK PROJECT

scheduled and specified thirty-four recommendations within five categories - project management issues, physical and engineering issues, ecological issues, social and economic issues, and other issues.

Project management issues were mainly concerned with the relative roles of the Shakwak Review Committee, the Environmental Co-ordinator and regulatory agencies affected by the project. The Shakwak Review Committee was directed to "continuously review the project and to report annually to the federal Minister of Environment and Yukon Territorial Council...". The Panel urged that a permanent Environmental Coordinator be appointed immediately to allow early input to the first year's scheduling and project design. Upon appointment, the Environmental Coordinator was directed to establish early contact with regulatory agencies and to submit regular reports to the Shakwak Review Committee. The Panel recommended that regulatory agencies coordinate their activities to avoid both duplication of effort and overlooking of environmental issues. It also recommended that these agencies develop a common land use permit and that its terms and conditions be developed by the most directly affected agencies.

The Panel made six ecological recommendations dealing with fish, wildlife and revegetation issues. Four of these referred directly to technical subjects covered in this report:

1) stream crossing designs should be submitted to regulatory agencies for review in time to permit their proper evaluation;
2) federal and territorial game management agencies should address potential problems of over-harvest of both fish and wildlife by increasing their management and enforcement activities and their staff sizes;
3) the results of design-stage studies undertaken by the proponent should be incorporated into project design and scheduling; and
4) the proponent should pursue plans for detailed reclamation and revegetation studies as proposed and submit the plans for approval one year prior to construction.

The Panel endorsed the proponent's position on scenic design of the highway and recommended the continuous involvement of a landscape architect on the project design team.

The Panel's physical and engineering recommendations dealt with extraction of borrow materials, insulation of stream banks in permafrost areas, design of the roadway in communities, winter maintenance guidelines and a comparative assessment of route alternatives for the Rainy Hollow realignment.

Recommendations concerning socio-economic issues dealt mainly with the impacts of construction crews on communities in the project corridor and the possibilities of local residents being given preference for hiring and contracting for the project. These issues lie outside the scope of this review.

Implementation

Three mechanisms were established to deal with administrative issues concerning environmental management of the project: appointments of an Environmental Coordinator, a Shakwak Review Committee, and a coordinating body to streamline regulatory procedures (Shakwak Steering Committee).

Environmental Coordinator. This position was originally established within PWC's Shakwak Project Management. It was to ensure that environmental quality requirements were met during design and construction. Duties of the position included:

- field checks of construction activities;
- instruction of project management and contractor staff on environmental constrains and philosophies; and
- preparation and submission of regular reports to the Shakwak Review Committee on progress in the application of environmental conditions.

By 1980, PWC had incorporated responsibility for the Shakwak Project with the duties of the Regional Environmental Coordinator based in Vancouver. Public Works Canada believed that environmental protection duties could be carried out by way of periodic visits, because by 1980 design was completed for segments 1-10, and construction was completed in three of the four segments that had construction funding.

For the first two years of the project, the Environmental Coordinator made construction inspections at least bi-weekly. These inspections formed the basis of the required annual reports (Spencer, 1979, 1980 and Hudson & Ruby, 1981). The coordinator also conducted some of the design-stage studies described in the EIS. When design-stage studies were made by consultants, he served as the main contact between them and project management.

The Environmental Coordinator initially reported directly to the Shakwak Project Manager. The Project Manager translated the Environmental Coordinator's findings into action at the project site. The Environmental Coordinator also communicated directly with the Project Engineers. He had no authority to halt construction or penalize contractors for noncompliance with contract specifications or environmental principles.

For the period August-December 1980, the environmental coordination duties were assumed by the Project's Design Engineer. The Regional Environmental Coordinator first inspected the project in the spring of 1981. Since then that person has visited Shakwak Project approximately twice annually.

Although instruction of all construction labour on environmental matters and philosophies had originally been proposed, this proved unworkable. The high turnover rate in labour would have required too many briefings to assure the entire work force was briefed. To compensate, the Environmental Coordinator held briefing sessions with the contractor's supervisory staff and developed an environmental manual of site-specific guidelines. These described conditions at some of the more sensitive sites, gave them a reference number and kilometre reference, and described the appropriate treatment for the condition. The reference number was keyed to an environmental sensitivity sign placed at the location (Figure 2-1).

Shakwak Review Committee. This Committee was composed of members of the Yukon Territorial Government (YTG), Environmental Protection Service (EPS), and Indian and Northern Affairs Canada (INAC). Its terms of reference, established by FEARO (1978), were to:

1) review and report on the manner in which the Panel's recommendations and the proponent's commitments were being implemented;
2) coordinate the review and evaluate the adequacy of further studies and resultant mitigation measures required for the project; and
3) exercise and ombudsman function when existing channels of communication among groups interested in the project appeared to be ineffective.

The Committee was to report annually to the Minister of the Environment and the Yukon Territorial Council, and these reports have continued to be published annually through the project's life. If it was dissatisfied with the implementation of commitments or recommendations, the Committee would report this to the Minister

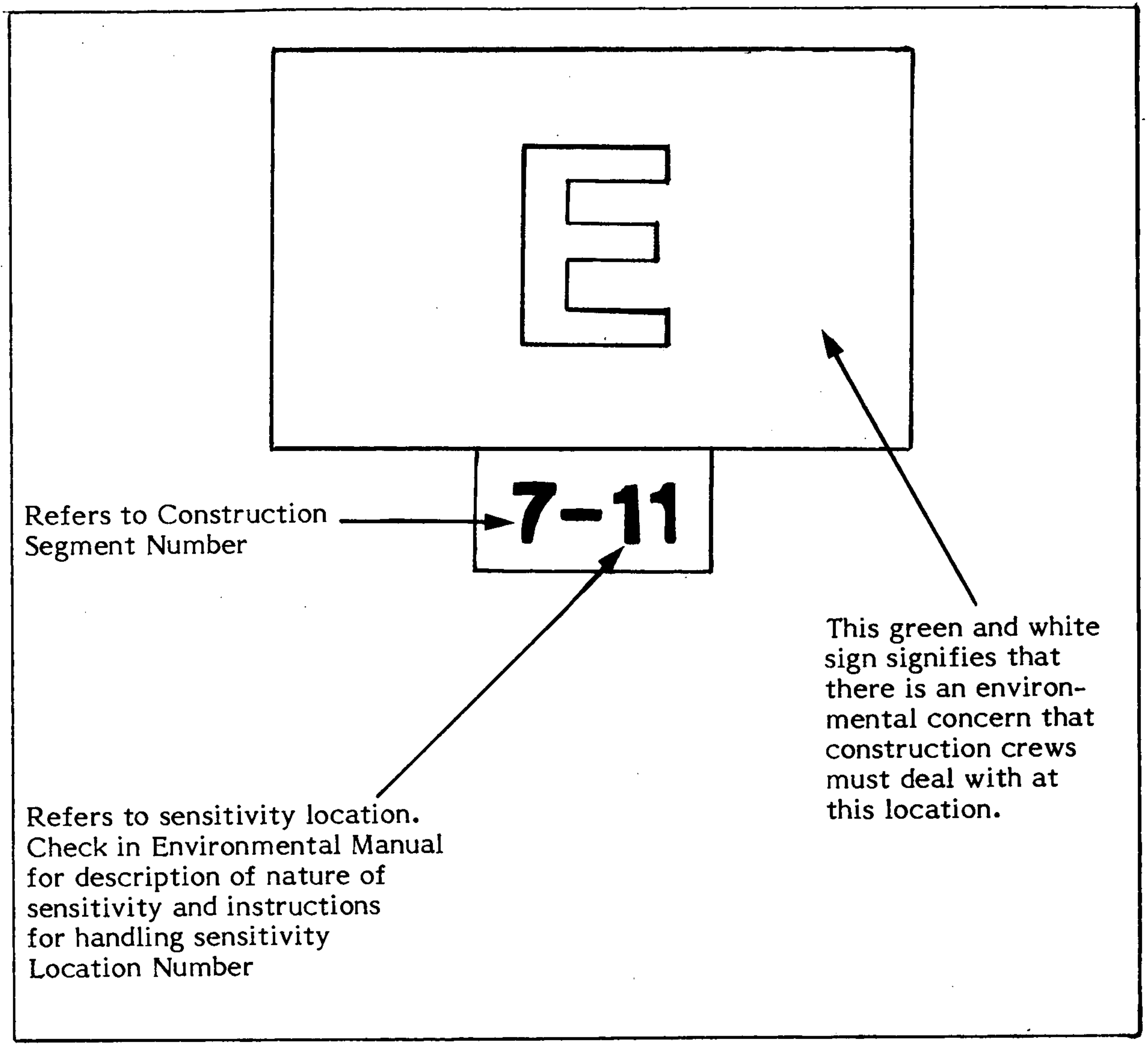

FIGURE 2-1 ENVIRONMENTAL SENSITIVITY SIGN FORMAT (after Spencer, 1979b)

of the Environment. The Minister could then seek solutions in negotiations with the Minister of Public Works.

The Shakwak Review Committee met regularly to discuss the Project. It maintained regular contact with the Environmental Coordinator and Shakwak Project Management. It also received the annual report of the Environmental Coordinator, inspected the corridor annually, and submitted an annual report to the Minister of the Environment.

Shakwak Environmental Steering Committee

The major regulatory agencies formed this joint body in order to coordinate permit requirements and inspection procedures. Member agencies included: Canadian Wildlife Service; Environmental Protection Service; Department of Fisheries and Oceans; Kluane National Park; Land Use Division, INAC; Water Resources Division, INAC; Game Branch, YTG; Highways and Public Works, YTG; and Resource Planning, YTG.

The Steering Committee established a common procedure for granting permits at each stage in construction. Land use permits were required for clearing, grubbing and grading the right-of-way, for establishing engineering or construction camps, for geotechnical investigations, and for construction of stream crossings. Special permits were required for burning, quarrying, timber export and water use.

The Steering Committee also performed a special role for sections of the highway constructed in the Province of British Columbia. The committee supplied B.C. regulatory agencies with sufficient background information to permit terms and conditions. In addition, INAC conducted site inspections for the Province of B.C.

Preparation of Permit Terms and Conditions

It seems clear that the Panel had intended the Shakwak Environmental Steering Committee incorporate the findings of the EIS and design-stage studies into permit terms and conditions. This would require some review by members of the Committee to familiarize themselves with the details. Additionally, these same measures were to appear as terms and conditions of construction contracts.

Although provided with the EIS, Panel report and design-stage studies, the Shakwak Steering Committee Chairman and land use engineer determined that permit terms and conditions would be based on PWC's briefing to the Committee on environmental sensitivities.

Water authorizations or permits were required for construction of some facilities required to meet fish passage guidelines (Dryden and Stein, 1975; Dane, 1978). The review process for these was more stringent than for terrestrial matters. Typically, a design and rationale prepared by Shakwak project engineers for a proposed culvert was submitted to INAC (Water Resources). Water Resources referred the design to Fisheries and Oceans, suggested changes to the design, or suggested a new design. The final design became a condition of the contract document and authorization.

Preparation of Contract Specifications

All contract documents prepared for the Shakwak Project contained environmental protection clauses. All contracts included:

- clauses routinely included in all PWC highway construction contracts;
- clauses specific to Shakwak Project only; and
- special measures specific to certain Shakwak construction segments.

Depending on the type and location of contract, the Environmental Coordinator provided the responsible engineer with a list of the environmental specifications to be included in the contract. The Environmental Coordinator reviewed and commented on contract specifications before they were issued to prospective contractors. They, in turn, could incorporate the measures into their costing.

Contracts were written with some allowance for special environmental protection actions. For instance, some specified an area allowance for handclearing and, once fish streams were identified by the design-stage studies, the locations for handclearing were communicated to the contractor. Requirements for variable-width clearing were accommodated within the clearing limit allowance.

Fish protection specifications typically concerned time windows for instream construction activities and preparation of engineering designs for fish passage structures. Specifications concerning eventual revegetation addressed surface soils handling measures within the right-of-way and borrow areas. Specifications concerning aesthetics were closely tied to those for revegetation and concerned such items as abandoned right-of-way treatment and backslope rounding. The contract specifications, right-of-way plans and clearing limits were designed in such a way that, if the contractor stayed within the clearing limits, problems could be minimized.

Enforcement and Monitoring

Compliance monitoring, surveillance monitoring and enforcement for the project were performed by:

- the PWC Environmental Coordinator for Shakwak Highway Project (self-monitoring, surveillance);
- Resource Management Officers or Land Use Inspectors from INAC (compliance monitoring, enforcement);
- Enforcement Officers and habitat personnel from Fisheries and Oceans Canada;
- Shakwak Review Committee (surveillance); and
- Public Works Canada and USFHWA Engineering Personnel (self-monitoring, surveillance).

Shakwak Environmental Coordinator. For the first two years of the project, the Shakwak Environmental Coordinator was located in Whitehorse. He conducted a surveillance program to assure PWC's compliance with their own environmental commitments, with environmental terms and conditions in construction contracts and in regulatory permits. These inspections have continued, but less frequently throughout the project's life.

Typical subjects of these inspections are:

- installation, scheduling and construction of fish passage culverts;
- compliance with materials handling specifications with a view to reclamation;
- borrow area materials handling procedures;
- right-of-way clearing procedures; and
- local hiring activities.

Resource Management Officers or Land Use Inspectors. Regulatory inspections for compliance with the terms and conditions of land use and water permits were the responsibility of INAC's appointed Land Use Inspectors. During construction, they sometimes inspected the project on a weekly basis.

Part of the project was located in the Province of British Columbia and under agreement with that province, INAC prepared terms and conditions for their permits and conducted inspections on behalf of the province.

There was considerable communication between Land Use Inspectors and the Shakwak Project Environmental Coordinator. Land Use Inspectors had the authority to halt construction. Penalties for noncompliance were available for use.

On occasion, Fisheries Officers inspected the project but played no significant role as their concerns were addressed by land use permit terms and conditions. These were enforced on Fisheries and Oceans' behalf by INAC Land Use Inspectors.

The Shakwak Review Committee made one annual inspection of the project during the construction season. This was mainly an overview or briefing reconnaissance hosted by PWC.

Project engineers were responsible for compliance with all environmental terms and conditions in contracts for their construction segments. As the land use permits were an integral part of these, project engineers continually conferred with the Environmental Coordinator and inspected the project daily during construction.

Methods

Procedural Aspects

Interviews with persons knowledgeable about the project and review of pertinent reports and files were the primary methods for examining procedural aspects of the project. In particular, the knowledge of the present (Kingman pers. comm.) and past (Spencer pers. comm.) Environmental Coordinators was helpful. Pederson's (1982) thesis was also referred to.

Part of the examination was a comparison of procedures used on the North Canol Road Project in the Yukon and the twinning of the Banff Highway in Alberta. By interviewing persons connected with these projects and by examining permits and contracts issued for the projects, it was possible to determine:

- if the specificity and potential effectiveness of terms and conditions in construction contracts and regulatory permits had improved over the life of the Shakwak Project;
- if the wording of terms and conditions in contracts and permits had changed between the Shakwak and the North Canol Road Projects. Theoretically, with the Shakwak experience, builders and regulators should have improved contract and permit wording with a view to more effective environmental management; and

- the results of differing procedural aspects, in terms of improved integration of environmental management principles.

Results and Discussion

Procedural Aspects

Procedural aspects of Shakwak Project were assessed in regard to:

- type of assessment and review;
- environmental coordination;
- permit terms and conditions;
- environmental terms and conditions for construction contracts;
- environmental monitoring efforts; and
- external reporting requirements.

A comparison of the Shakwak Project with the Banff Twinning and North Canol Road Projects serves as a basis for discussion. By comparing the three projects under the above topics, it should be apparent if the experience from the Shakwak Project was successfully transferred within that project to later-constructed segments and to the North Canol Road. In addition, the projects are compared in order to assess whether certain procedures associated with each project were more or less effective.

Type of Assessment and Review

The Shakwak and Banff Twinning Projects were subjected to full EARP reviews including:

- preparation and public issuance of an EIS;
- public hearings, and
- issuance of a Panel report containing findings and recommendations (FEARO, 1978, 1979).

An Initial Environmental Evaluation (IEE) was prepared by INAC (1982) (the proponent) for the North Canol Road Project. It was reviewed by the Yukon Regional Environmental Review Committee (RERC). (This is a review process one level less stringent than a full EARP.) Although the IEE was available for public review, the IEE was not distributed to the public and no public hearings occurred. Yukon RERC prepared no formal report and recommendations for public distribution.

The Shakwak and Banff Panel Reports recommended establishment of outside review bodies to scrutinize the proponent's efforts in regard to environmental management and to report on efforts to implement findings outlined in the EIS and Panel Report. Yukon RERC recommended no formal review body to monitor the links between environmental planning and review and implementation of the results of the exercise during construction for North Canol Road Project.

As indicated earlier, the Shakwak Panel Report recommended establishment of the Shakwak Review and Steering Committees. The Steering Committee was essentially a sub-committee of the Land Use Advisory Committee (LUAC).

The Banff Highway Panel Report recommended a Review Committee be established to "ensure that highway design and construction meet the high environmental and aesthetic standards necessary in the Park". The committee was to facilitate design approvals, monitor environmental standards and practices as well as aesthetic standards, review the further studies program, and assure special environmental conditions were included in contracts (FEARO, 1979).

A proliferation of committees resulted as the initially-appointed Committee appointed a sub-committee and each new committee in turn established another subordinate to it. Eventually two main and four sub-committees were formed. The original became basically non-functional, the "Senior Committee" (subordinate to the first) eventually met only on a few occasions for more complex matters and of the four sub-committees (public relations, environmental, design, and construction), only the environmental sub-committee played a particularly active role. It worked closely with the Environmental Coordinator for Banff Twinning Project.

While the practicality of all of the other seemingly inactive committees is questionable, the environmental sub-committee appears to have been successful in assuring that environmental concerns were integrated into construction planning. Highway planning became more of a cooperative effort by Public Works Canada, Parks Canada and Environment Canada. There was some criticism that new issues outside of those identified in EIS and by the hearing process worked their way into the project through this sub-committee (Tywoniuk pers. comm.). Not all sub-committee members were completely familiar with the details of the review process the project had undergone.

The Shakwak Review Committee was successful in facilitating communication between PWC and DOE at the highest level. It acted as a form of watchdog, but its one annual physical review of the project could be criticized as being inadequate no matter what success the environmental program enjoyed.

While the Land Use Advisory sub-committee was successful in streamlining and standardizing the permitting procedure for the Shakwak Project, it could be criticized for insufficiently communicating with INAC enforcement staff to upgrade inadequate permit terms and conditions. This committee relied heavily on PWC staff to identify environmental sensitivities upon which land use permit terms and conditions were based. Indian and Northern Affairs Canada requested that this procedure be the basis of permits despite the fact that the EIS-developed material was available for review by the Steering Committee.

This procedure appears to be a function of how Land Use Advisory Committee reviews road projects in general - on a segment by segment basis, not on the basis of a project in its totality. There appears to be no formalized process by which government (LUAC) can translate general environmental information (as it appears in an EIS document) into site-specific permit requirements or requirements specific to a particular road segment. There results from this inadequate process the potential for some issues going unaddressed by permit terms and conditions.

Government (INAC) established no special committee for the North Canol Road Project to assure that findings of the IEE and "design stage" studies program were implemented (Crombie pers. comm.). The process for implementing findings was as follows: The Land Use Advisory Committee received a copy of the IEE and reviewed other background material and developed permit terms and conditions on that basis. For the Canol Project, land use permit terms and conditions concerning fish habitat protection measures (handclearing locations) and reclamation procedures all improved over Shakwak Project.

Crombie (pers. comm.) considers the experience gained from Shakwak and other Projects as important factors leading to the development of more precise permit terms and conditions for Canol Project but thinks other factors are more influential:

- General terms and conditions used for the North Canol Road reflected 1984 revisions to standard land use operating terms and conditions. These were more definitive than the previous ones.
- Fisheries and Oceans Canada employed a fisheries habitat technician with some highway planning and construction experience. This person provided

more specific operating conditions regarding fisheries for each project under review by LUAC.

Notwithstanding these developments, the issue of translating general concerns to segment or site-specific terms and conditions still stands.

Environmental Coordination

At inception, the Shakwak Project Environmental Coordinator position was an integral part of the project management team. The Coordinator reported directly to the Project Manager, and at the same level as the deputy project manager, geotechnical engineer and bridges engineer. He also communicated directly with Project Engineers who were responsible for design and construction of specific construction segments. The Coordinator did not communicate directly with the contractor, nor did he have the authority to instruct a contractor to stop work in the interest of environmental objectives. This form of communication was done through the Project Engineers.

Presently the Environmental Coordinator develops environmental specifications that appear in contract documents. Prior to issuance, he reviews the documents to assure that these specifications are included. Following his review, the documents are forwarded to higher authority for a final review before issuance. Inclusion of the environmental specifications in the contract is a major tool for implementing environmental objectives for the project. Should these specifications not appear in the contract, the effectiveness of the Environmental Coordinator and the environmental program would be reduced.

For the first two construction seasons, the Coordinator inspected the project at least bi-weekly. The potential for some less-desirable construction practices to have occurred was possible had the frequency of monitoring been less. For instance, in 1984 when the Coordinator position had become part-time, heavy machinery was driven through several fish streams in Segment 2. With more frequent environmental supervision, this may not have occurred. Use of environmental sensitivity signing could also have prevented this.

Reaction to the original Environmental Coordinator's sensitivity signing system was mixed. While some observers regarded the signs as an effective tool and a visual reminder to construction staff of the environmental program's importance, others were less enthusiastic. Some thought that the signs could attract unwanted attention to such sensitivities as raptor nests even though the locations of such features were not specified.

There was never any evidence that the Coordinator's lack of authority to communicate directly with the contractor hampered the effectiveness of the environmental program. In fact the Coordinator's recommendations, when communicated by the Project Engineer, probably had more credibility with contractors.

The Banff Highway Environmental Coordinator was an employee of Public Works Canada and, by definition, the position reported to the Project Manager. In practice, however, at the project outset, the Environmental Coordinator was the "eyes and ears" of the Environmental Committee (Leeson pers. comm.). The frequency of his site visits was daily (the Coordinator was stationed at the project site) (Anderson pers. comm.).

From a purely management perspective, the loose reporting arrangement between the Banff Environmental Coordinator and Project Management had the potential for causing difficulties. The success of this relationship would be highly dependent on the goodwill of project management, the Environmental Coordinator and the Review Committee. Introduction of new personnel unfamiliar with special background to the relationship could lead to a breakdown in effective relationships. This actually occurred on the Banff Project when PWC personnel changed. In addition, it would be awkward for Parks Canada and DOE staff to hold PWC responsible for the ineffectiveness of environmental protection measures that they had in part developed.

The Environmental Coordinator position for the North Canol Road Project is presently part-time, staffed by the Environmental Coordinator for PWC's Pacific Region. In practice, the Coordinator's role is advisory and site visits are made approximately bi-annually. This represents a change from the way the Shakwak Project operated at its inception. Obviously construction monitoring when not site-specific and not made regularly reduces the potential effectiveness of this function. A bi-annual visit does not provide an adequate level of inspection.

Permit Terms and Conditions

Land use permits attached to a regulatory mechanism are not issued in Banff National Park. The Park Superintendent simply issues letters of authorization (Leeson pers. comm.). For the Banff Twinning Project, these letters reflected the continual input of PWC, Parks Canada and DOE. Environmental monitoring of the stipulations in the letter of authorization was entrusted to the Environmental Coordinator.

The advantages of this Banff System are as follows:

- One can be more specific about the intent of environmental procedures in the form of a letter (the Park was not restricted to a set of standard terms and conditions).
- The concept of cooperation and teamwork has the potential to be more creative and productive than the adversarial relationship that exists between permit issuer and permittee.

In the case of the Banff Highway Project, the system appears to have functioned largely because of the personnel involved representing the various agencies. With some exceptions the working relationship that they developed during the environmental assessment process leading up to construction was transferred to the construction phase.

While there are advantages, there are some potential difficulties attached to this arrangement:

- compliance monitoring can be difficult to enforce without a permit that is integrally linked to regulations,
- there is potential for abuse in a setting where a building agency or proponent is put in a position of monitoring its own compliance with authorizations issued by another controlling agency.

Contract Terms and Conditions

The Environmental Coordinator for the Banff Highway Project developed environmental terms and conditions for contracts and reviewed contract specifications before they were tendered. In addition, the Environmental sub-committee had input and final review prior to tendering.

For the North Canol Road Project, environmental terms and conditions were inserted by the Project Manager. He had the ability to consult with the PWC Pacific Region Environmental Coordinator regarding the wording of these terms and conditions and the advisability of including them. On the basis of the examination of contract documents for the Project, this system was not an improvement over the Shakwak Project.

Over the first four Shakwak Project segments that were constructed, the wording of contract terms and conditions improved in their potential effectiveness:

- The specifications regarding how stripped right-of-way surface soils were to be respread improved.
- Additional erosion control measures were specified for construction Segments 1 and 6.
- Slope-rounding was added and the extent described as a requirement.

The degree of rounding was actually relaxed between construction Segments 6 and 1a (1.5 m) and construction Segment 1b (1.0 m).

Contract clauses over the first four construction segments had the potential to show greater improvement - especially in regard to materials handling with the objective of reclamation of the right-of-way and borrow areas. This apparent inability by project management to improve the wording of contract clauses had major significance for the eventual success of the reclamation program. Reasons why the wording did not make greater improvement can possibly be explained by one or a combination of some of the following factors:

- The Environmental Coordinator's inability to identify and act on the problem in a timely way.
- By the time the problem had been identified, wording of contracts for construction Segments 1 and 6 had been prepared.
- Project management perceiving the wording to be sufficient, providing appropriate verbal instructions were communicated by the Project Engineer to the contractor.
- Project management's reliance on the wording in the land use permits to be improved (as worded, the permittee had certain latitude in regard to materials handling).

Environmental terms and conditions for the North Canol Road Project contracts improved over Shakwak's only to the extent that wording of the land use permits improved. For example, "handclearing" was defined and specified in the plans. Less erosion control clauses appeared in the specifications while the land use permits greatly improved in this regard (Table 1).

TABLE 1 EVOLUTION OF CONTRACT SPECIFICATIONS ON YUKON HIGHWAY PROJECTS

Subject	Shakwak 8	Shakwak 6	North Canol
Fish	No handclearing mentioned	No handclearing mentioned or location specified	Handclearing at defined locations specified on drawings
	Fish construction windows located, specified	Fish construction windows located, specified	Fish timing windows specified
Reclamation/ Erosion Control/ Aesthetics	Windrowed topsoil in R.O.W. specified for re respreading	Windrowed topsoil in R.O.W. specified re respreading but wording purportedly improved	No change from Shakwak 6
	No sediment traps specified	No sediment traps specified	Sediment traps specified
	Topsoil storage at lateral limits of borrow areas specified	Topsoil storage at lateral limits of borrow areas specified	No information about storage of topsoil at borrow area lateral limits
	No mention or backslope rounding	Backslope rounding specified	Backslope rounding specified

Environmental Monitoring

Environmental monitoring or surveillance for Shakwak Project was conducted by the Shakwak Environmental Coordinator. He monitored for compliance with the contract specifications, the land use permit (which formed part of the contract) and for apparent success on problems associated with any of the environmental protection measures. Project engineers were responsible for individual construction segments. They had responsibility for all terms and conditions within the contract, including environmental, but generally left those to the Environmental Coordinator's discretion. Land Use Inspectors were responsible for compliance with terms and conditions of the land use permit and water authorizations issued by INAC. Enforcement officers and habitat personnel from Fisheries and Oceans Canada were responsible for certain conditions in the water authorization or permits.

Monitoring responsibilities for the North Canol Road Project were similar, with the exception that the Project Engineer had increased responsibilities because the Environmental Coordinator's inspection schedule was much reduced.

Monitoring responsibilities for Banff Double-Laning Project rested with the Environmental Coordinator who was responsible for ensuring compliance with contract terms and conditions and the letter of authorization by Parks Canada, and the Project Engineer who was responsible for the same.

Certainly there are apparent shortcomings associated with the fact that all environmental monitoring for the Banff Twinning appeared to be self-monitoring by the proponent. There was a good deal of faith on the part of the Environmental Sub-committee and Parks Canada that the Environmental Coordinator would always remain impartial and that the project would continue to be the result of a "team effort".

External Reporting Requirements

The Shakwak and North Canol Projects required the proponent to prepare an annual report on the environmental program. The Shakwak Project required the Shakwak Review Committee to prepare an annual report for the Minister of the Environment. Although not required, the Environmental Coordinator of the Banff Twinning Project prepared an annual report. The concept of the annual reports allows outside interests better access to information about successes and failures of an environmental program that has been subject to a public review process.

Of the required annual reports for Shakwak Project, the Environmental Coordinator's had greater technical value and, consequently, greater value for potential improvement in environmental management of highway construction.

Conclusions

Procedural Aspects

Type of Assessment and Review

It appears from the review of the Shakwak, North Canol Road and Banff Highway Projects that comprehensive permit terms and conditions can be developed for a major highway construction project without a full EARP. Despite the absence of a full EARP process for the North Canol Road Project, land use permit conditions were equally or more comprehensive, better worded, more instructional and more site-specific.

More than the type of review process, it appears that a formalized process for translating results of environmental assessments at any level into permit conditions controls the potential environmental success of a project.

Environmental Coordination

Environmental quality of the Shakwak Project benefitted from the assignment of a full-time Environmental Coordinator. Construction can move so quickly that without frequent monitoring there is always potential for environmental error. The level of cooperation from project engineers was enhanced by the Environmental Coordinator being part of senior management for the project. This also signalled a high level of commitment to environmental quality. In the experience of the author, the fact that the Environmental Coordinator for Shakwak Project had to communicate with the contractor through the project engineers did not hamper attainment of environmental objectives. In fact, this process assured that the contractor did not receive conflicting instructions from the proponent. This minimized the risk of claims being filed by the contractor.

The clear separation of the Environmental Coordinator's responsibilities from those of the regulators avoided the potential for conflicts of interest to develop in regard to compliance monitoring. This was not the case for the Banff Highway Project. The Environmental Coordinator for that project performed the dual roles of monitoring for the proponent and regulator. The opportunity for conflict of interest is obvious.

Regulatory Permit Terms and Conditions

The effective wording of land use permits issued through the first four construction segments of the Shakwak Project did not improve in response to environmental performance. The Shakwak Steering Committee did not appear to recognize some of the signals that indicated permit wording should be improved. This condition may have resulted from one or some of the following reasons:

- The Steering Committee (LUAC) depended too greatly on Shakwak Project staff as a source of information for developing permit terms and conditions.
- Lack of a formalized process for translating environmental assessment findings into permit terms and conditions.
- Lack of a formalized process for assuring that experiences from other projects (incorporating the input and experience of inspection staff) was translated into updated and specific permit terms and conditions for new projects.

It appears, however, that the Shakwak Project eventually provided a useful learning process for proponents and regulators. Some of the weaker-worded permit terms and conditions for that project were significantly upgraded for the North Canol Road Project, although this may be attributed generally to an overall upgraded set of standard terms and conditions for all projects.

Contract Writing

The completeness of construction contract environmental terms and conditions benefit from review by an Environmental Coordinator. Terms and conditions for the Banff Project were probably more comprehensive because of the team or cooperative approach to their development. The ideas of a group are likely to be more creative and comprehensive than those of an individual.

It does not appear that PWC fully utilized their experience with the Shakwak Project to improve environment-related contract terms and conditions for the North Canol Road Project.

Environmental Monitoring

Environmental monitoring for the Shakwak Project was for compliance only at every level (by the Environmental Coordinator, Project Engineer, Regulatory Agency, Shakwak Review Committee). There was no program of biological or effects monitoring. If a purpose of environmental monitoring is refinement and evaluation of mitigative measures, then the Shakwak Project to some extent fell short of this objective. The data base developed for the EIS and from design stage studies limited possibilities for this activity.

External Reporting Requirements

The formal stage of EARP is a public process. The public and other interested agencies should have the opportunity to maintain contact with the successes and failures of projects that have undergone public review. For that reason, some form of external reporting, as with the Shakwak Project annual reports of the Environmental Coordinator and the Shakwak Review Committee, were desirable. In addition, this form of external reporting allows adjustments to be made at a very senior level in the bureaucracy. Of the above two reports, however, the Environmental Coordinator's was more useful as a technical document for recording environmental management successes and failures. It appears that the Shakwak Project annual reports could have been better utilized for the North Canol Road Project.

Recommendations

Procedural Aspects

Type of Assessment and Review

The most important factors to determining comprehensiveness and potential effectiveness of environmental permits were the self-motivated familiarity of LUAC members with pertinent issues and the fact that updated standard operating terms and conditions for land use permits were prepared by the time the North Canol Road Project came on stream. These factors were more important than the fact that a full EIS had been prepared for the Shakwak Project and a special committee struck to steer the project through the permitting process.

For future northern highway projects, it is recommended that the main working tool for builder and regulator be an environmental protection plan based on the EIS, rather than the EIS document itself. Environmental protection plans are standard tools for many jurisdictions and facilitate the translation of general EIS issues into site-specific terms and conditions.

Environmental Coordination

The concept of an Environmental Coordinator for major highway projects is worthwhile and should be applied to all such projects. It is recommended, however, that in cases where part-time coordinators are made responsible for a project, that the frequency of their field inspections be increased and that the coordinators be on site at key times (e.g., for installation of fish passage culverts).

For occasions when the environmental coordinator cannot be on site, the project engineer must be fully briefed on all environmental objectives and issues in order that he may temporarily assume the Environmental Coordinator's duties. There must always be a proponent representative at the job site responsible for environmental protection. There are, however, potential problems associated with persons responsible for engineering and associated functions having dual responsibilities for environmental matters.

Finally, it is recommended that prior to the contractor and his equipment being relieved from the job site, the Environmental Coordinator make a final inspection and approve environmental aspects of the completed project.

Permit Terms and Conditions

From this follow-up study, it was determined that land use permit terms and conditions did not adjust quickly enough to very obvious field evidence that they were not working. This problem is closely related to monitoring by the regulator's inspection staff. The present monitoring system is geared more to measuring compliance rather than effectiveness of mitigation measures. It is recommended in future that:

- the focus of inspection routines be adjusted to incorporate "effectiveness" monitoring as well as compliance monitoring; and
- a formal mechanism be established whereby the observations of inspectors about "effectiveness" are incorporated in each new set of terms and conditions for new permits. This must be done in a timely manner - especially if they involve an ongoing project.

It is also recommended that highway developers assure that environmental terms and conditions inserted in their contract documents precisely describe the procedures required to meet environmental objectives (e.g., step-by-step methods of developing and reclaiming borrow areas). Any existing manuals that describe acceptable procedures should be provided to contractors.

Highway developers should establish within their organizations a formal evaluation process for contract environmental terms and conditions with a view to continually upgrading these to address current and changing conditions.

For the Shakwak Project, there were some inconsistencies between contract terms and conditions and permit terms and conditions. Both proponents and regulators in future must assure that there is consistency between these two sources of terms and conditions.

External Reporting Requirements

For all projects that have undergone some form of public review, it is recommended that annual reports be prepared on the effectiveness of environmental efforts. These reports should provide the public with formal and continuing communication on the project and give environmental assessment practitioners an opportunity to review the successes and failures of environmental programs. They should be prepared by the proponent or regulator and should focus on the effectiveness of the environmental practices and on unexpected complications and how they were handled. It is important that documents of this nature are given wide distribution to potentially affected and interested parties.

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PERSONAL COMMUNICATIONS

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THE EFFECTIVENESS OF MANAGEMENT TECHNIQUES APPLIED TO THE ENVIRONMENTAL ASSESSMENT AND IMPLEMENTATION OF THE SARNIA TO MONTREAL PIPELINE

James A. Rowsell
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Introduction

The Sarnia-Montreal petroleum pipeline was planned and constructed during the 1974-1976 period by Interprovincial Pipe Line Limited. It is taken as an example project to investigate management techniques used to mitigate and monitor a variety of watercourse crossing impacts. Analysis of the documentation surrounding the planning and implementation phases affords a method to centre on and quantitatively assess some pertinent management issues. Analysis of guideline compliance provides a similar means to evaluate the processes of establishment and implementation of management techniques.

The Project

The Sarnia-Montreal 30-inch (76 cm) pipeline was originally seen as a means to guarantee petroleum deliveries to eastern Canada during a period of supply uncertainties related to the Middle East oil embargo. The planning and construction periods were consequently subject to some urgency. At the same time, guidelines and regulations whereby environmental assessment of the project could be developed, were in developmental stages.

Environmental Setting

The east-west route followed by the pipeline crosses numerous streams and rivers which flow southward to Lake Ontario and other parts of the Great Lakes drainage system. The route crosses some of the most highly urbanized and most valuable agricultural land in Canada (Figure 1). The transected watercourses and valleys fall within wide ranges of biophysical characteristics. Examples from within these ranges include: ephemeral streams, perennial and navigable rivers, watercourses with very high to very low water quality, highly productive cold-water salmonid streams and warm-water streams, and streams with deeply incised valleys or with wide floodplains. Extremes of overburden erodibility and slope stability are represented.

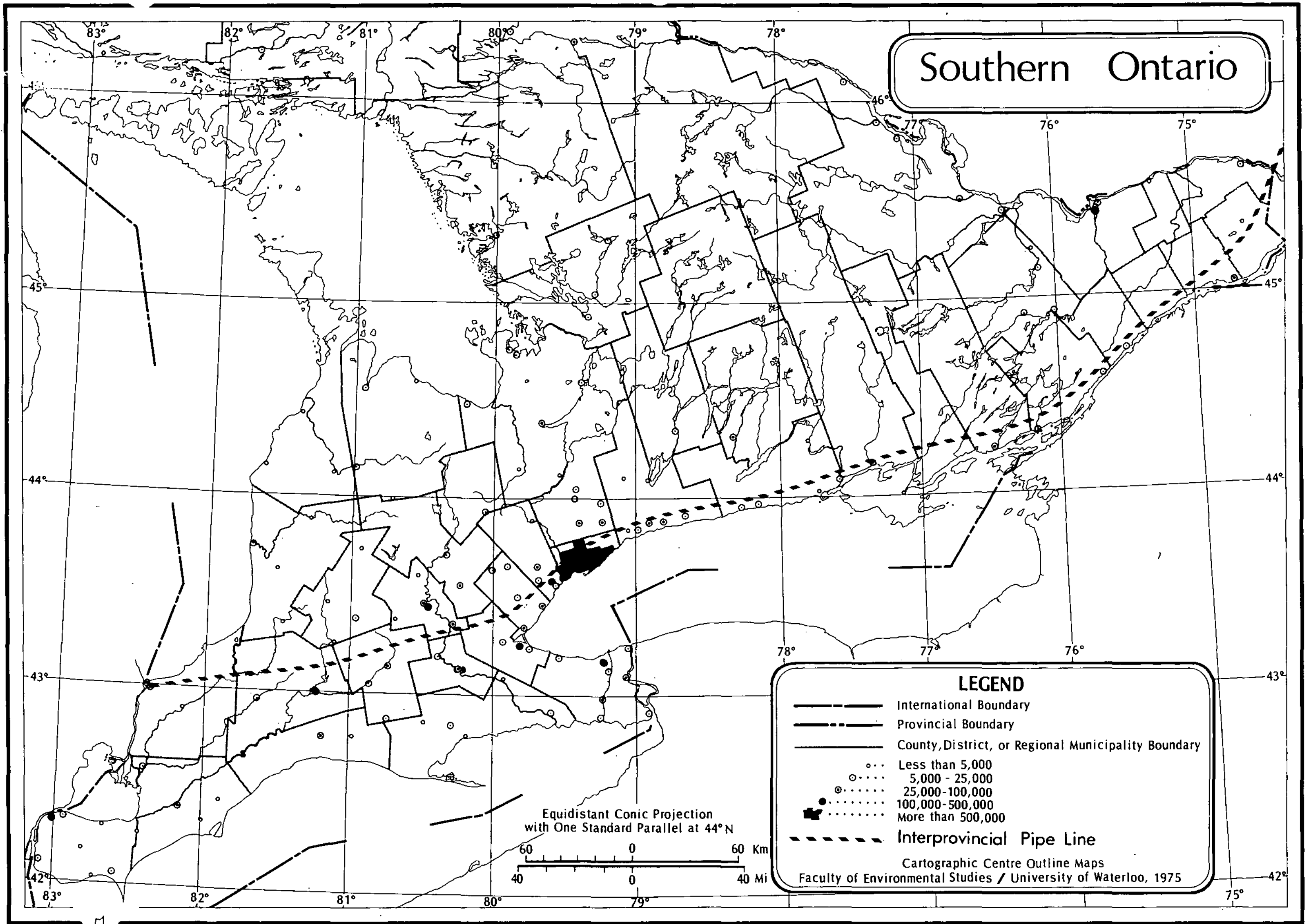

FIGURE 1 SARNIA - MONTREAL PIPELINE ROUTE

Jurisdiction and Concerned Parties

The federal National Energy Board (NEB) had essentially complete jurisdiction in directing the proponent Interprovincial Pipe Line Limited (IPL) to file environmental information, to propose impact mitigation procedures, and to conform to NEB's standards for pipeline integrity and environmental protection. The NEB's quasi-judicial regulatory function covered virtually all phases of the project from planning through operation. The NEB provided draft guidelines to IPL, reviewed the Application, held Hearings concerning the proposed project, set Terms and Conditions for additional information input as well as construction and operation procedures, and monitored activities in the field.

Many other agencies took an active interest in the project during planning and implementation periods. IPL contracted environmental consultants to prepare the bulk of the Application but was itself responsible for proposing impact mitigation procedures. IPL contracted Bechtel Canada Ltd. as project manager and project engineer. Bechtel prepared environmental specifications for construction contractors to follow and maintained environmental and engineering surveillance teams during the construction period. An Environment Canada task force was seconded by the NEB to review the Application and this federal agency of its own accord, also fielded construction and rehabilitation inspectors. The Ontario government intervened in the Hearings, mainly by requesting that its own pipeline construction guidelines be accepted by the NEB. (This request was not adopted.) Ontario government agencies as well as public landowners also fielded inspectors on their own accord, frequently in conjunction with nonregulatory federal inspectors.

Follow-up/Audit Methods

The objectives of (a) identifying management techniques and (b) evaluating the effectiveness of those techniques, were met in several ways. Some methods were empirical, derived from the aggregate form of project documentation. Others were modelled on other follow-up/audit studies in the literature.

Management Technique Identification

Two general methods for identifying management techniques are available to the environmental auditor:

1. Review of project documentation (including project related guidelines etc.) and extraction of a technique list (unsupervised itemization).
2. Assembly or adoption of a technique list which can be or has been elsewhere shown to be comprehensive and applicable, with subsequent categorization of specific project related techniques (supervised itemization).

There is considerable benefit in using a supervised technique identification method, especially in comparing various projects. Such a method permits project assessment from a "present tense" time frame and can draw upon technique listings from the past literature. However, by judging a past project by present standards, the environmental auditor may overlook the fact that all such techniques may not have been available or known about during the historic setting of that project. The task of deriving a comprehensive list of "stock" management techniques was not pursued for this project, although potentially suitable listings were observed in the literature (Skinnarland 1978, Ontario Ministry of the Environment 1978, Environment Canada 1978) and were applied as a method of techniques listing and follow-up analysis. However, these will not be discussed further in this paper.

Management techniques were taken to include those recommended within guidelines, regulations and the proponent's formal declarations of policy; they also included actual techniques used, as identified within project correspondence and inspection reports. Three major documents were reviewed and management techniques were itemized from them. These documents were (a) the draft guidelines for Application information filing (National Energy Board 1974), (b) IPL's 1974 Policy for mitigation of environmental impacts, and Bechtel's (1975) environmental specifications for construction contractors. In addition, the sum total of project documentation, inclusive of letters, reports, memos, and meetings minutes, was reviewed and each item was categorized as inclusive of a series of alternate management oriented issues (see Figure 2).

Management Technique Effectiveness Evaluation Methods

Evaluation of management technique effectiveness was completed using several methods:

1. Communique Analysis
2. Guideline Compliance Analysis
3. Comparison of NEB and EARP Mechanisms

(1) Date of communique (DD.MM)

(2) Issue Category: This letter-number code refers to the types and amounts of attention given to specific issues related to watercourse crossings, as follows:

1: Jurisdictional.
1a: Pertaining to navigability, streambed ownership.
1b: Pertaining to permits, easements, options etc.
2: Transmittal or query of information ONLY.
3: Discussion of administrative process (including scheduling).
3a: IPL/Bechtel process.
3b: NEB process.
3c: Interagency process (governmental).
3d: IPL (Bechtel): Government interface process
3e: IPL: NEB interface process
3f: Guideline process
3g: Internal process
4: Discussion of environmental concerns
5: Discussion of reports
6: Discussion of operations
6a: Construction
6b: Rehabilitation
6c: Planning
7: Discussion of problem operations
7a: Construction
7b: Rehabilitation
7c: Planning
8: Discussion of successful operations
8a: Construction
8b: Rehabilitation
8c: Planning
9: Miscellaneous, Agricultural & Financial

Up to three sets of information are given for each entry. The first entry indicates that >50% of the information is in the assigned category; the second indicates 25 to 50% and the third, <25% (for computations, ratio is 6:3:1). Where a zero occurs in the second position only, the first entry indicates >75% and the third, <25% (for computations, ratio is 8:0:2). When a zero is in the third position, the first entry represents >50% and second <50% (for computation, ratio is 6:4:0). When the second and third entries are zero, the first entry is 100% (for computation, ratio is 10:0:0). The ratio values are used in computations in Figure 5.

(3) Site. This entry indicates the relevancy level of the information to watercourse crossings as follows:

G: information NOT directly related to watercourse crossings.
W: information generally applicable to watercourse crossings.

1:	North Thames River	7:	Wilmot Creek
2:	Grand River	8:	Ganaraska River
3:	Bronte Creek	9:	Trent River
4:	West Oakville Creek	10:	Moira River
5:	East Oakville Creek	11:	Raisin River
6:	Credit River		

FIGURE 2 LIST OF ISSUES AND CODING FOR COMMUNIQUE ANALYSIS (CODES REFER TO FIGURES 4 AND 5)

4. Application of External Criteria to the IPL Project
5. Review of Previous Follow-up Studies on the IPL Project
6. Canvas of Pipeline Regulatory Personnel via Workshop Analysis.

Only the first two are discussed at length in the present paper:

Communique Analysis

Several steps were taken in analyzing the project documentation (communiques). Step One involved listing all documents chronologically, as well as review and summary of their contents. (Figure 3 provides an example from the Preconstruction period.)

Step Two involved further information summary by assigning coded values for the following classes of information (see Figure 4 for an example):

- source, destination of document;
- type of communique;
- length of communique (pages);
- apparent manpower effort expended in communique preparation and reading;
- percentage of message dealing with each of 11 example watercourses; and
- types of issues discussed.

The results of Step Two permitted further analysis of the degree of effort expended by segregated project participants in communicating watercourse related concerns. This effort measurement relates to attributed quantities of time spent by the originator of a communique in document preparation, as well as by the recipients in reading the communique or attending a meeting.

From this, Step Three follows directly: it involves the summing of effort expenditures by (a) agency involved, (b) project phase, (c) specific watercourse, and (d) issue category (see Figure 5 for an example of the latter).

Compliance Analysis

Management techniques for watercourse crossing impact mitigation and monitoring were also evaluated with respect to whether or not, and the degree to which, the guideline stipulations were adhered to, either in a general, non-site-specific manner or with respect to implementation results at a series of 11 example watercourse crossings. For guidelines whose stipulations were quite specific, such as Bechtel's environmental guidelines for contractors, a semi-quantitative rating

PRE-CONSTRUCTION PERIOD COMMUNIQUES

25.02.74	Letter. Advises IPL that NEB expects IPL to use guidelines (NEB 1974 ca) as much as possible in preparing Application report; also that NEB will require 5 copies of 1:50K topographic maps of the planned route, 2 of which go to provinces of Ontario and Quebec. Attached copy of NEB (1974 ca).
03.04.74	Letter. NEB and OMNR timetables for Hearings etc. Attached copy of Ontario guidelines Draft 2 and NEB Notice of Hearings.
05.04.74	Letter. Maple Dist. OMNR requesting information on the Sarnia-Montreal pipeline and a route map.
16.04.74	Memo. Information on legalistic process which Bechtel will have to go through when constructing pipeline on public land.
11.06.74	Letter. Informs re pipeline to be constructed, that SE Region OMNR has sent out copies to Dist. Mgrs. involved.
28.06.74	Letter. Enclosure of 11.06.74 to Maple, Lindsay, Cambridge OMNR Dists.
02.07.74	Memo. Request for information on navigability of waters as listed in an attachment and mention of process of easement granting to IPL.
19.07.74	Memo. Redirection of information on navigability as in Memo (02.07.74) and route maps, to Dist. OMNR requesting comments on navigability.
08.08.74	Memo. Reply from Lindsay OMNR Dist. on navigability status. Wilmot Ck. & Ganaraska R. not navigable.
15.08.74	Memo. Acknowledges receipt of memo 02.07.74. Lists Credit R. as navigable degree 1.
31.01.75	Letter. Refers to prior visit of addressee; includes the following:
23.01.75	1. Memo. States concurrence with a Memo of 23.05.72.
08.01.75	2. Memo. Asks for opinion on whether IPL is subject to Ontario Public Lands Act in reference to water crossings, a list of which was in author's hands.
15.03.72	3. Letter. Indicates that IPL may construct a pipeline across a navigable stream with approval of the Minister of Transport and does not require provincial or other authority except from NEB.

FIGURE 3 EXAMPLE OF STEP 1 IN COMMUNIQUE ANALYSIS PROCESS: SUMMARIZATION OF PROJECT COMMUNIQUES

Date (1)	Cat. (2)	Site (3)	Tp. (4)	Source (5)	Addressee (6)
A. PRE-CONSTRUCTION PERIOD					
1974					
03.04	3d02	G	M	A1	A2:4,A10,A11,A16, A18,A22
05.04	420	W	M	A23	A18
16.04	1b3d0	G	M	A6	A18
11.06	3g20	G	M	n.a.	n.a.
28.06	23g0	G	M	A7	A23,A25,A26
02.07	1a00	W5,7.1,8.1,12.3	M	A6	A18
19.07	1a00	W	M	A18	A23,A25,A26
08.08	1a02	7.2,8.2,12.6	M	A26	A18
15.08	1a00	6	M	A23	A18
1975					
08.01	1a00	W	M	A6	A12
23.01	1a00	W	M	A13	A6
31.01	1a02	W	L	A6	F
10.04	3a1b6c	G9,W1	NM	A18	F1:6,A8,B5
11.04a	200	G	M	A17	A1
11.04b	1a00	W9,7.0,12.1	L	K1	A27
14.04	3d6c3a	G9,W1	M	B12	B1:4
16.04	1a40	W	L	A26	K1
17.04	3c3d0	G	M	A1	A3:5,A10:11,A14, A16,A18,A22
02.05	3g3c0	G9,W1	M	F1	A23,A25,A26
05.05a	6c04	W4,12.2; 1,3, 4,5,6,8,10,11 (.4)	L	F1	B5,A18,A30,B6,B13
05.05b	6c04	6	L	F8	J15
08.05	7c43d	W9,12.1,7.0,8.0	M	A26	A15,A18,A19
16.05	7c43d	W9,12.1,7,0,8.0	L	A7	A1,A26,B5,F1
20.05	1a1b3d	6	L	J15	F8
21.05	43c0	12.7;1:11 (.3)	M	A1	A16,A18,A22,B5
03.06	1b3f0	W	L	B7	A26,F1
05.06	1a1b0	W8,12.2,9.0	L	H1	D1
25.06	6c42	G8,W1,6.1	M	F7	A23
27.06	3C1a6c	W	L	D2	A18
08.07	3d3f6c	W	L	J7	F1
15.07a	1b3g0	G	M	A6	A18,A25,A26,F8
15.07b	3d1b0	G5,W5	L	A6	F8
16.07	8c53d	G	L	A23	F
17.07	3f3d4	W	L	A26	A18,D2
21.07	1a3d0	W	L	A23	D2
24.07	3f40	W,7.0,8.0	M	A27	A28
31.07	203d	G5,W5	L	J7	A26
06.08	23d4	W	L	F7	A27
08.08a	1b3d6c	G5,W5	L	J7	F1,J8
08.08b	26c0	G8,W2	L	F7	A23
11.08a	23d4	W	L	J7	A26
11.08b	6c00	W5,G5	N	n.a.	F7,A27,A26,A33,A34
12.08	7c3f0	W	L	J10	F7,F2,A27
13.08	3f7c3d	G3,W5,12.2	L	J7	F1,J8,A31,J9,J13, F2,A27
15.08a	3d7c0	G	L	B5	A18

FIGURE 4 EXAMPLE OF STEP 2 IN COMMUNIQUE ANALYSIS PROCESS: QUANTIFICATION AND CODING OF COMMUNIQUE DATA

	Pre-Construction			Construction			Post-Construction		
Issue Category	Effort	n	Mean Median	Effort	n	Mean Median	Effort	n	Mean Median
1A	9.95	16	.62 .62	.64	1	.64 .64	.00	0	
1B	16.38	8	2.05 .42	1.36	2	.68 .68	1.87	2	.94 .94
2	8.98	15	.60 .41	7.43	9	.83 .46	5.00	10	.50 .34
3A	24.44	3	8.15 .58	.00	0		.92	1	.92 .92
3B	.00	0		.32	1	.32 .32	.00	0	
3C	10.74	4	2.69 2.65	14.12	5	2.82 1.65	5.05	4	1.26 .66
3D	27.56	23	1.20 .41	2.70	5	.54 .30	8.95	11	.81 .34
3E	.00	0		.00	0		.00	0	
3F	19.06	8	2.38 1.94	5.74	4	1.44 1.41	9.03	1	9.03 9.03
3G	3.89	5	.78 .62	2.21	3	.74 .74	.00	0	
4	17.44	15	1.16 .41	3.46	4	.87 .67	.00	0	
5	.59	3	.20 .16	4.87	1	4.87 4.87	4.00	3	1.33 1.01
6A	.00	0		26.38	6	4.40 .35	55.89	7	7.98 9.74
6B	.00	0		12.16	3	4.05 .13	176.88	42	4.21 1.13
6C	37.54	12	3.13 1.05	.31	1	.31 .31	16.11	10	1.61 .67
7A	.00	0		35.02	12	2.92 .50	28.63	8	3.58 3.05
7B	.00	0		28.81	20	1.44 .41	103.22	30	3.44 .59
7C	7.29	6	1.22 1.23	11.17	5	2.23 2.23	1.33	2	.67 .67
8A	.00	0		.60	1	.60 .60	5.48	2	2.74 2.74
8B	.00	0		1.62	5	.32 .32	38.53	25	1.54 .84
8C	1.83	3	.61 .73	.00	0		1.24	1	1.24 1.24
9	.00	0		.31	1	.31 .31	.21	1	.21 .21

Notes: EFFORT: man-hours expended
n = number of communiques where issue is mentioned

FIGURE 5 EXAMPLE OF STEP 3 IN COMMUNIQUE ANALYSIS PROCESS: EFFORT EXPENDED BY ISSUE CATEGORY scheme was used to assess compliance (see Figure 6 for an example). A summary of this information was then undertaken to achieve an understanding of compliance to groups of guideline stipulations (Figure 7) and with regard to individual watercourses (Figure 8).

Results

Communique Analysis

Documentation of the activities surrounding the IPL project was moderately complete but access to some file data 10 years after project completion was not without difficulty and significant information record gaps occurred.

The communique analysis was found useful in demonstrating strengths and weaknesses in the environmental management stages of project development. Good communication of details, such as when and what mitigation and monitoring activities are to take place, are of key importance to efficient project management. Less obvious, but certainly as important, is the communication of jurisdictional responsibilities, alterations in construction plans, and a host of other details. Indications of good project management include evidence of logical and complete record keeping. Indications of suspected poor project management include absence of documentation, delays in responses, and evidence of excessive documentation related to certain issues. Thus, not only the content of the communiques, but their frequencies, their originators and recipients, and their timing, all have potential for assessment of management effectiveness.

Communique analysis revealed the following strengths and weaknesses in project management related to communications and record keeping.

1. Documentation of construction period activity lagged behind that of either pre- or post-construction periods; inspection reports were not rapidly produced nor widely disseminated until after construction terminated. Channels of communication were not kept open.
2. The amount of information (both generated and disseminated) regarding any of the 11 example watercourses was minimal except for those at which extensive rehabilitation had become necessary; for the latter, effort expenditures in communications were excessive.

	Watercourse Location Codes (1)					
	1 7	2 8	3 9	4 10	5 11	6
	Compliance Ratings (2)					
EC-2 Clearing, Grubbing and Grading						
a) Clearing						
i. Only those trees which interfere with construction or safe operation of the pipeline shall be removed.	4 0	3 3	2 n	0 0	0 0	0
ii. When stumps are not to be grubbed, the height of the stump shall not exceed six (6) inches, and the branches on stumps of all coniferous species shall be removed.	n 0	n n	0 n	0 0	0 0	0
iii. Where low-growing trees and shrubs exist on the Construction r-o-w, every attempt shall be made to leave as many as possible... undamaged.	0 0	0 0	0 0	0 0	0 0	0
iv. Branches or limbs of trees which may be damaged by construction equipment must be adequately pruned. Where specified by landowner, the wound on the living tree exposed by pruning shall be dressed with an accepted compound.	n 0	0 0	2 0	0 0	0 0	0
v. All merchantable timber...shall be trimmed and cut into commercial or designated lengths and stacked along the edge of the construction r-o-w unless otherwise noted in the 'Line List'	0 0	0 0	0 n	0 0	0 n	n

(1) Location Codes:

1. North Thames River
2. Grand River
3. Bronte Creek
4. West Oakville Creek
5. East Oakville Creek
6. Credit River
7. Wilmot Creek
8. Ganaraska River
9. Trent River
10. Moira River
11. Raisin River

(2) Compliance Ratings:

4: complete compliance, considerable evidence;
3: compliance, some evidence;
2: partial or conflicting evidence on compliance;
1: almost no compliance;
0: no information;
X: noncompliance;
n: not applicable.

FIGURE 6 COMPLIANCE TO BECHTEL CONSTRUCTION SPECIFICATIONS

Guideline Category (**)	Number (Percentage) of Guideline Compliance Entries in Category						
	4	3	2	1	0	X	n
Clearing (5)	1	2	2	0	41	0	9
(%)	2	4	4	0	75	0	16
Grubbing (5)	0	5	0	0	42	7	1
(%)	0	9	0	0	76	13	2
Grading (7)	13	1	6	2	38	10	7
(%)	17	1	8	3	49	13	9
Trenching (3)	0	0	2	0	20	2	9
(%)	0	0	6	0	61	6	27
Backfilling (3)	0	0	2	0	15	6	10
(%)	0	0	6	0	45	18	30
Cleanup (6)	0	6	6	3	35	8	8
(%)	0	9	9	5	53	12	12
Restoration (5)	17	8	6	2	17	4	1
(%)	31	15	11	4	31	7	2
Fueling/Vehicle Maintenance (7)	1	0	0	0	73	3	0
(%)	1	0	0	0	95	4	0
Water Crossings: General (6)	0	0	0	0	47	6	13
(%)	0	0	0	0	71	9	20
Sloping Approaches to Streams and Stream Banks (15)	15	17	19	4	86	24	0
(%)	9	10	12	2	52	15	0
Stream Proper and Streambed General (8)	0	2	3	0	81	1	1
(%)	0	2	3	0	92	1	1
Special Measures - Siltation Control (5)	1	1	0	0	47	0	6
(%)	2	2	0	0	85	0	11
Granular Backfill (2)	0	0	0	0	22	0	0
(%)	0	0	0	0	100	0	0
Test Water (4)	3	0	3	0	5	4	29
(%)	7	0	7	0	11	9	66
General Housekeeping (2)	0	0	4	0	15	3	0
(%)	0	0	18	0	68	14	0
Dewatering (1)	0	0	0	0	11	0	0
(%)	0	0	0	0	100	0	0

(**): Number of guideline headings in category.

FIGURE 7 SUMMARY OF BECHTEL GUIDELINE COMPLIANCE BY GUIDELINE CATEGORY

Location	Number of Guideline Compliance Entries in Rating Categories						
	4	3	2	1	0	X	n
North Thames R.	3	4	5	5	49	4	14
Grand R.	7	7	10	2	47	7	4
Bronte Ck.	7	6	7	0	53	3	8
West Oakville Ck.	6	0	6	0	42	20	10
East Oakville Ck.	6	0	6	0	46	16	10
Credit R.	2	3	6	1	46	17	9
Wilmot Ck.	0	7	1	2	63	2	9
Ganaraska R.	2	7	2	0	63	4	6
Trent R.	3	4	3	0	64	1	9
Moira R.	3	3	3	0	63	2	10
Raisin R.	12	2	2	0	62	0	6
Total	51	43	51	10	598	76	95
Mean	5	4	5	1	54	7	9
% of Total Ratings	5.5	4.7	5.5	1.1	65.	8.2	10.

FIGURE 8 SUMMARY TABLE: BECHTEL GUIDELINES COMPLIANCE

3. A moderate effort had been expended in clarifying jurisdictional details which should have been known or publicized at project initiation by either the NEB or the proponent.
4. Communication between the NEB and any other agency, including the proponent, as well as between construction contractors and any other agencies, including proponent, apparently occurred much less frequently than communications among provincial government agencies, the proponent and the proponent's engineer.
5. Archival functions within several organizations appear to be inferior. Specifically, the NEB and several provincial agencies appear unable to retrieve or direct researchers to environmental and inspectoral information. Archival information was most readily accessed from noncentralized repositories such as district level Ontario ministry offices, IPL's files and Conservation Authority offices. Construction contractors had little information on file while extensive corporate rearrangements within Bechtel posed problems in information access.
6. During the Sarnia-Montreal project, government and quasi-government organizations with little or no jurisdiction engaged in considerable effort. This

"hidden" effort did not show up on project books but indicates a significant economic investment by public representatives.

7. Communications records of certain types were not adequately represented in the project documentation. Telephone records, telexes, personnel time sheet summaries (including inspectors' and contractors' logs) and records of meetings of concerned parties, were all ill-represented.

8. Communique subject matter was further supportive of the following observations noted by other workers (Ontario Ministry of the Environment 1978; Environment Canada 1978), as well as in the compliance assessment and other parts of the current study:

   a) absence of detailed impact mitigation planning;
   b) incomplete NEB specifications of IPL environmental protection obligations;
   c) lack of site specific detail for watercourse crossing characterization and construction activity planning;
   d) uncertainty concerning enforceability of NEB Orders;
   e) whimsical and overly expedient decisions on some watercourse restoration measures;
   f) reticence of proponent to produce site specific information on watercourse crossings;
   g) lack of construction schedule;
   h) frequent inability of project engineer to convey appropriate watercourse crossing recommendations to contractors;
   i) failure of proponent to take timely advice of nonregulatory agencies;
   j) failure to communicate problem solutions among contractors; and
   k) shortage of time to permit proponent to devise appropriate impact mitigation measures or research specific characteristics of watercourses prior to construction window.

Guideline Compliance Analysis

New Draft Guidelines for Application Content

These guidelines had been drawn to the proponent's attention prior to the latter's indication of intent to construct the pipeline. However, project documentation reveals that the guidelines were not binding, and that the NEB's intention for the proponent to follow the guidelines in his Application was not clearly communicated until a few days before the Application was submitted. The guidelines are relatively specific but it is clear that neither the proponent nor the proponent's environmental consultants used them to model their Application submissions. As a result, general noncompliance to their stipulations is a rule rather than an exception. Figure 9 provides a summary listing of compliance and noncompliance items.

Bechtel's Environmental Specifications for Contractors

Bechtel's environmental specifications document was relatively detailed and included many of the considerations regarded as important by interveners at the hearings. It is a suitable document by which to judge the compliance to a host of specifically recommended construction and restoration practices. It was not present within the Application document but became available only in May, 1975 - i.e., only four months prior to construction start-up. The level of detail was sufficient to compare stipulation compliance at the 11 example watercourse crossings studied.

Little backup information was available to judge compliance on 65% of the guideline stipulations (Figure 8). The information base (largely inspection reports) sometimes provided conflicting or unsubstantiated evidence for compliance to additional stipulations. Considerable variability existed among the sites as to the amount of compliance type information available as well as the degree to which compliance occurred.

This analysis permits some conclusions as to the guideline categories for which inspection and other reports did not furnish sufficient detail to enable compliance assessment. The following categories were most readily assessed by the surveillance program:

Restoration
Backfilling
Grading
Test Water
Sloping Approaches
Cleanup

Categories for which compliance could be less frequently established (i.e., for fewer than 25% of stipulations) included:

NONCOMPLIANCE

1. maps of route at 1:50K scale were not included; hence most details suitable to this scale were not included;
2. no detailed plans for minimizing wildlife harassment;
3. no plans for safeguarding endangered species;
4. no commitment for protecting waterfowl;
5. little or no information on unavoidable effects on water quality;
6. little or no information on effects on groundwater and runoff;
7. no estimate of vegetation clearing requirements;
8. no plans for maintaining/creating vegetative buffer strips at watercourses;
9. partial compliance in evaluating stability of valley walls and shorelines; very little compliance in proposing mitigation measures at same;
10. no data on depth of scour but some on depth of pipe were provided;
11. site specific designs for watercourse crossings were generally absent;
12. minimal compliance in proposing methods to minimize fish and aquatic habitat impacts;
13. no data on proposed fish passage structures;
14. no construction schedule;
15. little information on preventing toxic materials from reaching watercourses; and
16. no information on quantities, sources, etc., for hydrostatic test water.

COMPLIANCE

1. data on wildlife habitats were included but not fully so, and not at the perceived level of required detail;
2. description of water body characteristics was partially complied with, but not in detail, and not all water bodies;
3. partial compliance in describing waste disposal practices;
4. partial compliance in plans for vegetation restoration;
5. full compliance in describing recreational areas;
6. partial compliance in describing use of pesticides;
7. information on environmental emergency procedures and anticipated spill quantities was provided; and
8. partial compliance in proposing methods for surveillance during and after construction.

FIGURE 9 IPL COMPLIANCE TO NEB APPLICATION GUIDELINES

Categories for which compliance could be less frequently established (i.e., for fewer than 25% of stipulations) included:

Granular Backfill

Dewatering

Fueling/Vehicle Maintenance

Stream Proper/Streambed General

Siltation Control

Grubbing
Clearing

Some stipulations in the guidelines were not applicable to the watercourses studied. Other stipulations were keyed to a list of "major" river crossings without a definition of how the category was chosen. Conflicting inspection reports occurred with a noteworthy frequency, reflecting a difference of opinion on what constituted compliance. This may indicate either a bias among different types of inspectors and/or lack of clarity in the stipulations. They included the stipulations from the following categories:

Restoration
Sloping Approaches
General Housekeeping

In addition to the above, the following observations are made with respect to the Bechtel guidelines:

1) clearing stipulations did not explicitly list a requirement for treatment of damaged vegetation unless such treatment was requested by the landowner;
2) numerous stipulations were overly general and failed to provide standards whereby contractors could judge the merit of their construction and restoration efforts;
3) there were few or no stipulations which required the contractor to document his daily construction progress, methods or problems;
4) stipulations on erosion control measures to be taken on watercourses were vague and the onus for preparation of such measures was placed on the contractor without adequate instruction on what constituted acceptable methods; in contrast, stipulations for erosion control in the trenching operation were more detailed;
5) the Fueling and Vehicle Maintenance stipulations, though detailed and sufficiently precise for bulk storage facilities, were not sufficiently comprehensive in dealing with other types of machinery;
6) stipulations regulating the amount of time involved in watercourse crossing activity were vague;
7) there were no stipulations on storage of topsoil; and

8) there were few stipulations on the recommended types of equipment to be used for construction at watercourse crossings.

IPL's Policies for Environmental Impact Mitigation

Assessment of IPL's Policy document (contained with its Application to NEB) indicates that moderately complete compliance to stated goals was achieved. However, these policies were very general, lacked almost any indications of site specificity or technique specification, and as such, were not readily adaptable to comprehensive compliance assessment. Even so, the statements in the Policy formed the closest documented approximation of an outline of an impact mitigation and monitoring program relevant to the Sarnia-Montreal pipeline. A summary of the compliance assessment follows:

Noncompliance

1. a construction schedule was to be drawn up; no detailed schedule was located in project documents;
2. stabilization of riverbanks to prevent erosion was frequently delayed or ineffectual; and
3. disturbance to streamside habitat was not minimized at some crossings.

Compliance

1. construction specifications were drawn up;
2. physical characteristics of the pipe and use of pipe weights were specified in drawings;
3. regrading of bank slopes equal to the original slopes was largely effected;
4. longer term bank stabilization was obtained;
5. non-jeopardization of lamprey control program;
6. rectification of streamcourse alignment after construction was effected;
7. hydrostatic water was taken in accordance with governmental approval; and,
8. staff environmentalists monitored construction.

No Supporting Evidence for Compliance

1. guarantee of sufficient water flow to maintain downstream habitats and water supplies;
2. for some watercourses, no data on construction and rehabilitation measures were documented;

3. no evidence that the pipe was buried beneath the scour line in watercourses;
4. 100% X-ray of welds at major river crossings lacked evidence; and
5. post-construction maintenance and spill contingency plan updating was not documented.

Discussion

The discovery of apparent faults in the processes of establishment and implementation of environmental management techniques with respect to the Sarnia-Montreal pipeline is a facile undertaking. Other reviewers have pointed fingers at the processes while few have fully considered the aura of urgency under which the project evolved. The authors would like to emphasize that object lessons generated from the Sarnia-Montreal project have already been learned well by the NEB, the pipeline industry in general, and Ontario government pipeline regulators. Therefore, some (but by no means all) of the following comments on the implications of strengths and weaknesses of the environmental assessment process, are dated and self-evident today.

Communique Analysis

Communique analysis is a useful method to uncover the variety of management issues which took on importance for proponent, regulator and concerned parties. In this respect the degree of importance can be audited. This documentation is also a potential source for hindsight qualitative judgements.

Both actual and documented communications, especially by the regulatory agency, were sporadic and incomplete. Improved opportunities should be made available for a proponent to discuss environmental concerns with the NEB prior to and during project implementation. Correspondence of all types should be documented in the public record and certain classes of interchange (such as passing along of inspection comments) should be mandatory and scheduled.

Construction summaries and results of monitoring and inspection at watercourse crossings were not prepared in a timely manner during the construction period. It is suggested that construction contractors, inspectors and monitoring personnel be compelled to file complete records on a day-to-day basis, and that these be reviewed by assigned regulatory personnel and passed along to the regulatory surveillance review office personnel. Concerned agencies and landowners should be informed about construction progress at watercourse crossings on almost as frequent a basis.

Information generated and disseminated about watercourse crossings was minimal throughout most of the pre-construction and construction period. Watercourse crossings by pipelines form one of the most important environmental issues. It is therefore suggested that site specific information be more explicitly solicited by proponents' consultants from government, public landowner and other agencies.

Project related documentation was unavailable from certain agencies. Documentation of all project records and communications, including telephone calls and meetings, should be retained by the regulatory agency, proponent, all contractors and interested agencies, and filed in chronological order. Included here are records of manpower and monetary expenditures relating to the project, even those incurred by nonregulatory public agencies. All photographs should be identified as to location and date. Such records should be kept for a minimum of 10 years and preferably for the operational life of the project. On major pipeline projects, an information officer should be appointed from within the NEB or applicable regulatory agency, with a mandate to file and catalogue all project related documentation. The proponent should assign personnel to serve similar tasks. This work could be merged with cost-control functions in the respective organizations. Periodic summarization of communications should be completed and results made available to concerned agencies.

The jurisdictional implications of the Sarnia-Montreal pipeline, with respect to watercourse bed ownership and proponent obligations to meet various organizations' permit and guideline requirements, were not spelled out at project initiation. The proponent and regulatory agency should clarify and broadly publicize such implications at the earliest stage possible, so as to reduce wasted research and communications efforts by agencies unfamiliar with the proponent's mandates.

Compliance Analysis

Recommended impact mitigation measures were not adequate in preventing short-term impacts of erosion and sedimentation at watercourse crossings, but they were effective in limiting longer term (10 year) impacts. It is suggested that a "pre-audit" or circumspect review of EIS impact mitigation proposals be instigated at the review stage. This would determine whether such proposals are sufficiently site and activity specific, and can be tested using the suggested monitoring methods. In the context of watercourse crossings, the pre-audit would weed out generalized statements such as "the crossings will be done in as short a time as possible" - and replace them with more precise specifications such as "this crossing is scheduled to take 3 days using the methods and equipment listed below; alternative plans are also presented to accommodate unusual weather patterns and terrain conditions". The pre-audit would also ensure that the monitoring/inspection effort is specifically tailored to see that these proposals are actually met.

Little constructive use was made of existing data bases by the proponent in quantifying expected impacts and developing both monitoring and impact mitigation programs. Such information may not have been readily available during the brief period when it was being synthesized for the Application document. Watercourse chemical, physical and biological data, as well as land or water use baseline data stemming from the operations of government, private consultants, industry, institutional researchers, etc., should be centralized, collated and where possible, digitized so as to increase its availability at the data collection stage of project EIAs and to limit EIA duplication in collection effort. This information can then be used to form baseline descriptions valuable in formulating monitoring programs and more concrete impact predictions.

Scheduling of construction activities was virtually nonexistent. Improved schedule submissions and updates should be required of proponents; exact times and durations for watercourse crossing activities and for slope rehabilitation work should be included. The schedule should be made available to all concerned parties.

Application information content was not specified by binding and timely requests by the regulatory agency. Binding regulations should be provided to the proponent well in advance of Application preparation. (This is now the case with NEB Applications, although not with all corresponding provincial pipeline regulatory agencies.) Sufficient discretionary power should rest with the regulator to modify requirements for information depending on the scope of the project.

The environmental specifications for contractors constructing the Sarnia-Montreal pipeline were moderately detailed and could be tested for later compliance. However, they were not binding (via performance bond) and in some cases were not specific enough and/or were not always applicable to the major environmental concerns at watercourse crossings. Specifications should be written in as unambiguous a manner as possible and should form an integral part of the Application document so that the stipulations can be assessed during the pre-audit stage for their conformance to the intentions and mechanisms of impact mitigation and monitoring programs submitted at the same time.

Further, all construction guideline stipulations should be itemized and addressed in construction inspection records. During inspections, the completion of a standard written checklist of observations, along with photographs, should be mandatory. Items on the checklist should correspond to stipulations in the guidelines. Completed checklists should be reviewed by the regulatory technical review personnel who have had past experience in the project EIA review. Checklist review results should be circulated to local nonregulatory government agencies during the course of construction. The proposed checklist form should be submitted with other EIA submissions for review.

Construction inspectors, as representatives of nonregulatory agencies, should be included in the monitoring scheme insofar as they are likely to be inspecting anyway, and insofar as downstream effects of pipeline crossings are within their jurisdiction. As there has been a shortage of qualified environmental inspectors on past pipeline projects, this activity should be encouraged. During EIA review (including NEB Hearings), such agencies should be identified and should be made familiar with the approved inspection procedure when Application approval has occurred.

There was a general absence of continuity between the pre-construction and construction periods with regard to personnel involved in review and inspection tasks. The NEB is well suited to following through on EIA review recommendations, since its mandate covers all aspects of project planning and implementation/operation. It is recommended that a greater degree of continuity be established by appointment of regulatory personnel to follow a project through these sequential phases.

A project proponent should include chronological goals for impact mitigation within his final EIA submission -- goals which are testable using unambiguous monitoring methods that conform with regulatory agency (or other in-place tools, such as chemical analysis methodologies, biotic indexation, density, distribution or population estimation methods, or monitoring site selection methods, etc.).

Conclusion

Project documentation (communique) analysis and compliance analysis are two methods available to the environmental auditor for follow-up on past projects.

Continued work should be done to improve follow-up/audit methodologies and tailor them to specific classes of project. Increased use of econometric and numerical methods is recommended. An agency to coordinate the administration and refine the execution of follow-up/audits should be established.

Primary recommendations which follow from the Sarnia-Montreal pipeline audit are:

1. Environmental monitoring of projects is or can be conceived of as virtually synonymous with a refined inspection procedure. Inspection processes now in place should be improved via more complete documentation of preselected inspection targets.
2. Until, or unless, sophisticated watercourse crossing classification/planning data bases are realized, site specificity in EIA documentation can be expected to require significant effort and time commitments to ensure adequate short term impact mitigation.
3. Increased efforts on the parts of proponents and regulatory agencies in documenting economic and manpower costs of impact mitigation and monitoring are warranted so that improved management techniques can be identified.

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ENVIRONMENTAL MANAGEMENT OF THE ALASKA HIGHWAY GAS PIPELINE PRE-BUILD - A HINDSIGHT ANALYSIS

Margaret A. Davidson

Introduction

The purpose of this paper is to review the environmental management process implemented during the development of the Alaska Highway Gas Pipeline Pre-build, to present some conclusions regarding the effectiveness and efficiency of the process, and, based on these, to make general recommendations regarding environmental management of future resource development projects.

Environmental management is considered here to encompass the institutional arrangements, procedures and activities established to control the anticipated and unanticipated negative impacts of a project on the environment. Ideally, the environmental management process spans the three major phases of project implementation: the pre-construction planning and review phase, the construction phase, and the operation phase. This study concentrates on the project planning and construction phases.

The Alaska Highway Gas Pipeline (AHGP) was first conceived in 1976 and was billed at that time as potentially the largest privately-financed venture even undertaken in the world (Northern Pipeline Agency, 1980). The pipeline was to deliver gas from northern Alaska to the lower United States, extending through Alaska, the Yukon, British Columbia, Alberta and Saskatchewan (Figure 1).

In July, 1980, the Canadian government approved construction of the southern portion of the pipeline through Alberta, B.C. and Saskatchewan, termed the "Pre-build", to export Alberta gas to the United States (Figure 2). Construction took place from 1980 - 1982. At present, only the Pre-build has been completed and the future of the northern segments is uncertain.

The complex environmental management of this project was particularly interesting due to the Pre-build's length (849 km), the intense public interest generated by the project, and the involvement of a special federal agency, three provincial jurisdictions, and two proponents. The Alaska Highway Gas Pipeline was regarded as a federal project. However, because the pipeline would traverse provincial lands, the three provincial governments were considered co-regulators of the project.

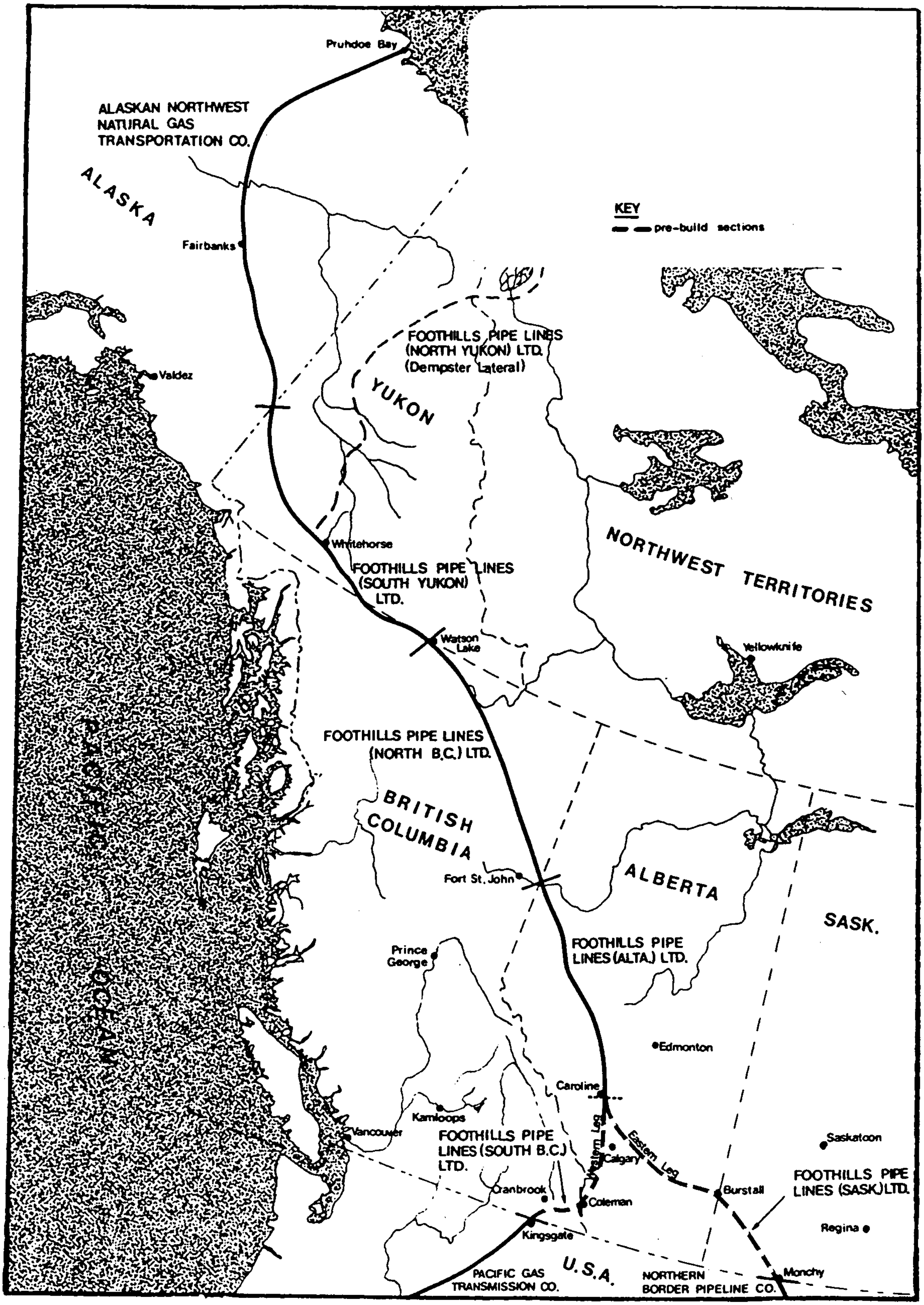

FIGURE 1 LOCATION MAP

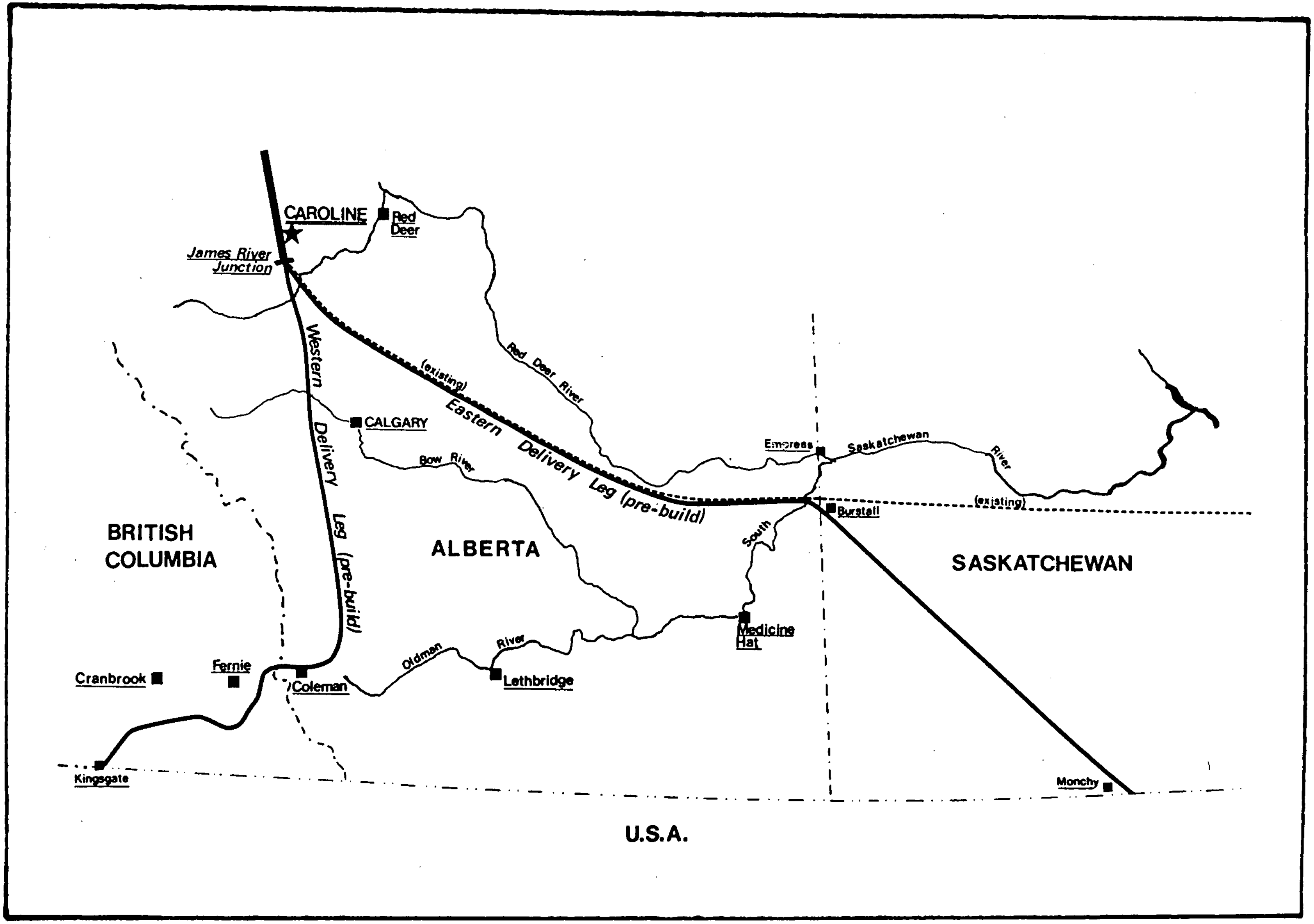

FIGURE 2 LOCATION OF ALASKA HIGHWAY GAS PIPELINE PRE-BUILD

Information on which the study is based was obtained through: 1) review of documents prepared during development of the project and related publications, and 2) interviews to obtain the views of key participants such as proponent personnel, consultants, and federal and provincial government officials involved in managing the project. Twenty-five such interviews were conducted.

For the purpose of the analysis, efficiency was defined as the relative level of effort or expense in identifying, analyzing, reviewing and managing environmental impacts, and effectiveness as participants' level of satisfaction in achieving goals and objectives.

Institutional Arrangements and Responsibilities

The government agencies which played a central role in environmental management of the Pre-build, and their responsibilities, are indicated in Table 1. Each government established its own 'single window' agency or committee to coordinate environmental management responsibilities.

Federal Government

The Northern Pipeline Agency (NPA) was established by the federal government to administer all relevant federal acts and to streamline and speed up the approvals process. The NPA's mandate was both to facilitate efficient and expeditious planning and construction of the pipeline and to minimize environmental impacts. While NPA officials saw this dual role as "complementary and mutually reinforcing", critics argued that the NPA was placed in an ambiguous, if not conflicting position (Sharp, 1981).

British Columbia

While Alberta and Saskatchewan signed formal Master Agreements with the Federal Government regarding revenue and cost-sharing arrangements for the Pre-build, such an agreement was not reached with British Columbia. In addition, senior provincial officials decided not to sign an Administrative Agreement with the NPA without the formal Master Agreement between the two governments in place, although it was recognized that such an agreement was necessary to coordinate their joint management responsibilities. Nevertheless, the NPA and the Foothills Assessment Steering Committee (FASC), the single-window committee established by the Government of British Columbia, agreed to collaborate on development of terms and conditions for construction of the provincial segment of the Pre-build,

TABLE 1 GOVERNMENT ARRANGEMENTS AND RESPONSIBILITIES

Project Phase	Federal	British Columbia	Alberta	Saskatchewan
	Northern Pipeline Agency	Foothills Assessment Steering Committee	Federal and Intergovernmental Affairs	Department of Mineral Resources
Pre-Project Planning and Review	- develop terms and conditions - review and approve proponent Plans and Procedures Manuals and detailed procedures and designs	- coordinate provincial participation - provide input to terms and conditions - coordinate, review and approve ANG's Plans and Procedures Manual	- coordinate provincial participation - provide input to terms and conditions - coordinate, review and approve NOVA's Plans and Procedures Manual and detailed procedures and designs	- coordinate provincial participation - provide input to terms and conditions - coordinate, review and approve NOVA's Plans and Procedures Manual and detailed procedures and design
		Regional Provincial Staff	Development and Reclamation Review Committee	
		- develop conditions for provincial permits	- review and advise on NOVA's detailed procedures and designs	
			Regional Provincial Staff	
			- develop conditions for provincial permits	
Construction	Northern Pipeline Agency Surveillance Staff	Provincial Field Coordinator	Relevant Provincial Agency Representatives	Relevant Provincial Agency Representatives
	- continuous field surveillance	- continuous field surveillance to provide independent provincial presence and ensure that permit conditions were met	- part-time field surveillance to ensure that permit conditions were met	- periodic spot checks

and on review of the proponent's plans, procedures and designs. A less-binding Memorandum of Understanding regarding these arrangements was signed nearly three months after the start of construction.

Review of the proponent's detailed designs and development of conditions to be attached to permits such as stream crossing permits were to be handled by regional offices of the provincial Ministry of Environment and other relevant ministries. Although the province ultimately chose not to assign provincial staff to work with the NPA as surveillance officers, as originally intended, the B.C. Ministry of Environment assigned a field coordinator to provide an independent provincial presence during construction and to facilitate liaison with regional managers.

Alberta

The Alberta Government designated the Department of Federal and Intergovernmental Affairs to act as the coordinating agency for the Alberta segments of the pipeline. An administrative Agreement was made between the NPA, Alberta and Federal and Intergovernmental Affairs (FIGA) formalizing arrangements to collaborate in drafting terms and conditions for the Alberta segments, in reviewing the proponent's plans, procedures and designs, and in joint surveillance of pipeline construction.

The Interdepartmental Development and Reclamation Review Committee, which is the group normally responsible for reviewing provincial pipeline applications, was given an advisory role to FIGA and the NPA during review and approval of the proponent's plans and procedures. Regional provincial staff were assigned to establish permit conditions such as timing windows for stream crossings, and to work with the NPA surveillance staff to provide on-site surveillance during construction.

Saskatchewan

The Saskatchewan government's activities regarding the Saskatchewan segment of the Pre-build were coordinated through the then Department of Mineral Resources (now the Department of Energy and Mines). As with Alberta, the government signed an Administrative Agreement formalizing arrangements to cooperate and consult in developing terms and conditions for the Saskatchewan segment, and in reviewing the proponent's plans and procedures. However, unlike Alberta, the Saskatchewan government decided not to provide staff to work with the NPA in providing continuous surveillance of pipeline construction, preferring instead to have representatives from relevant provincial departments conduct spot checks as needed.

Proponent Arrangements and Responsibilities

While Foothills Pipe Lines (Yukon) Ltd. was the overall proponent responsible for building the Canadian portion of the AHGP, companies with an interest in Foothills were given the responsibility of designing and managing construction of the various segments.

Alberta Natural Gas Company Limited (ANG) was the proponent responsible for the southeast B.C. portion of the Pre-build. In B.C., approximately 90 km of pipeline was constructed as "loops" (parallel pipelines attached at compressor stations which increase capacity) to an existing pipeline. Therefore, the project was perceived by the Chief Engineer as a relatively small looping project for which standard engineering and management practices would be adequate to minimize adverse impacts (Phillips, 1983, 32). Most of its environmental management responsibilities were contracted to other companies.

NOVA, an Alberta Corporation, a parent company of Foothills, was responsible for the Alberta and Saskatchewan segments. NOVA established a separate division, the Alaska Project Division (APD) to design and construct these segments. Environmental management was the responsibility of various departments within the APD. As a matter of corporate policy, the APD Environmental Planning and Design Department's objective was to build a pipeline that was exemplary in its treatment of environmental concerns (Chappel, 1985).

Environmental Planning and Review Phase

Baseline Studies and Impact Assessment

No formal environmental impact assessment was conducted for the Pre-build. The National Energy Board had held formal hearings on the overall AHGP in 1976-77 at which very general environmental information was considered. The NPA did not issue guidelines for baseline studies and no formal environmental impact statement was required of proponents. Therefore, the form and content of environmental studies and impact assessments were left to the proponent's discretion.

British Columbia

Several environmental reports were prepared on behalf of ANG through the 1970's as part of an earlier proposal to build a pipeline parallel to their existing one. While deficiencies such as excessive environmental description and little analysis or discussion of impacts were identified during review by the province (Lidstone, 1977), these were not addressed by ANG. When the southeast B.C. segment became part of the AHGP Pre-build, the province requested that the information base be updated (Phillips, 1983). However, ANG did not comply with this request and was not compelled either by the province or by the NPA to do so. While there was general consensus among provincial and NPA officials that the information base was, on the whole, sufficient for design review purposes, information on fisheries was apparently insufficient to determine impacts resulting from stream crossings (Langford, 1984). Lack of such information contributed to environmental management problems and delays during construction.

Alberta and Saskatchewan

While detailed baseline and impact assessment studies for the Alberta and Saskatchewan segments were not explicitly required by the NPA, or the provincial governments, the APD environmental coordinator felt that these were essential to detailed planning for environmentally sound pipeline development and, accordingly, initiated studies in 1978 to address all environmental concerns. Studies were designed to focus on areas of greatest concern and on ways of avoiding or minimizing impacts. Consequent studies, particularly those for fisheries and revegetation, were praised by provincial and NPA representatives for their thoroughness and innovative approach to impact management.

Environmental Terms and Conditions

The NPA issued terms and conditions to give the companies direction on the standards of performance to be achieved in constructing and operating the pipeline for each province. These evolved through discussions among the NPA, provincial agencies and each proponent over a two year period. The final versions were issued to proponents just prior to the start of construction.

In British Columbia, the FASC were dissatisfied with the NPA's terms and conditions because their wording was "too general to be effective in field management" (Ferguson, 1985). FASC wanted the terms and conditions to specify detailed planning and design requirements but the NPA did not accede to their request. Guidelines for more detailed procedures, plans and standards to meet provincial regulations were developed by provincial agencies and these were appended to the terms and conditions. However, these still did not fully provide the directives that FASC felt were necessary to elicit developments of site-specific mitigation procedures.

The NPA terms and conditions for the B.C. segment were very similar to those issued to NOVA for the Alberta and Saskatchewan segments. Neither province elected to attach more detailed guidelines. In Alberta it was felt that the existing regulatory process for pipelines was sufficient and that more detailed guidelines were unnecessary (Dalon, 1985).

The efficiency of the long negotiating process and the utility of the terms and conditions in assisting with planning the Pre-build were questioned by many interviewees, both from government agencies and the proponent companies.

Environmental Plans and Procedures

British Columbia

The NPA required that each proponent submit an Environmental Plans and Procedures Manual, indicating how it intended to meet the terms and conditions, for review by the NPA and provinces. Compliance with approved plans and procedures would then constitute compliance with terms and conditions.

ANG did not initiate the environmental planning and design of the B.C. segment of the Pre-build until several months before construction. The Environmental Plans and Procedures Manual was hastily prepared and contained mainly general statements of intent rather than details of procedures to be used. The more site-specific concerns contained in the appended provincial Guidelines were addressed by indicating that specific schedules, designs and procedures would be developed at some future date.

The NPA also required that environmental alignment sheets be prepared. Those prepared by ANG did not provide detailed site-specific instructions to the contractor and were thus considered by several interviewees to be of limited utility. A small number of detailed drawings were prepared to indicate procedures to protect the environment during certain construction activities but these were not keyed to alignment sheets. In addition, the environmental alignment sheets were not consolidated with the construction alignment sheets which indicate construction and engineering specifications. Contractors were required to comply with the construction specifications contained in the contract documents, as well as the NPA terms and conditions and provincial Guidelines, the Plans and Procedures Manual and the alignment sheets and drawings which were appended to the contract. Little effort was made during planning to integrate requirements and minimize inconsistencies and duplication (Stutz, 1983).

Alberta and Saskatchewan

Because of the APD Environmental Department's thorough, site-specific studies and their initiation of detailed planning for the Alberta and Saskatchewan segments two years before construction commenced, the Environmental Plans and Procedures Manuals prepared for the Alberta and Saskatchewan segments were regarded by most interviewees as uniquely detailed.

Innovative site-specific procedures and mitigative measures were planned and designed by the APD Environmental Department and their consultants to minimize impacts (Chappel, 1985). Everything that the APD could foresee was included in the detailed plans so that no major problems would occur during construction (Mitchell, 1985). Environmental atlases were prepared to identify and consolidate all environmental information to assist the government agencies in project review. Environmental alignment sheets indicating site-specific environmental concerns and detailed construction procedures to deal with them were prepared and keyed to numerous drawings of construction procedures. The information from these alignment sheets was then transferred onto construction alignment sheets. These were apparently unique in their level and detail and in including all categories of information (Chappel, 1985), and were praised by interviewees for their utility during construction.

There was consensus among provincial and NPA officials and APD staff that the planning and design of the Pre-build in Alberta and Saskatchewan went far beyond what had normally been required for information requirements were elevated as a result (Lang, 1985).

Government Review of Project Documentation

British Columbia

ANG did not prepare site-specific plans, designs and schedules and was not required by the NPA to do so. FASC found ANG's Environmental Plans and

Procedures Manual to be too generally worded and requested that environmental procedures be more specifically described and more emphasis placed on defining administrative and reporting systems (Phillips, 1983, 32). NPA environmental staff were also dissatisfied with the document (Yarranton, 1985). Nevertheless, the manual was approved both by the NPA and the province, one week after clearing for the southeast B.C. segment began.

Alberta and Saskatchewan

The advanced state of APD planning and their programs for implementing the procedures was a major reason why government review of the APD's plans and designs in Alberta and Saskatchewan was effective. In addition, both provincial governments had established agreements and a better working relationship with the NPA than the B.C. government. However, in Alberta the review process was complicated initially by communication and coordination problems, apparently due to the number of groups involved, and to interagency conflict. Such problems did not occur to the same extent in Saskatchewan, where very few agencies were involved in reviewing the APD's plans, the NPA and the APD were, on the whole, very amicable (Hnatiuk, 1985).

Environmental Management During Construction

Environmental Quality Control and Quality Assurance

Environmental quality control and quality assurance are activities undertaken by a proponent during construction. While a major component of environmental quality control is environmental inspection, quality control can also include pre-construction briefing of the contractor, orientation and training of activity inspectors, and the appointment of one or more field environmentalists to provide advice to inspectors and ensure that environmental procedures are implemented.

Environmental quality assurance is usually undertaken by a proponent's planning group and can include review of contract documents, assessment of the design of the quality control program, auditing the function and performance of quality control personnel, and providing advice and support to the field environmentalist.

British Columbia

Both the NPA's terms and conditions and the province's appended Guidelines required environmental inspection. However, the design and implementation of the environmental inspection program was left entirely to ANG's discretion. Documents prepared by ANG during project planning mentioned their environmental inspection program but gave few details and were inconsistent. However, it was noted that "environmental inspectors" (field environmentalists) were to have environmental training.

ANG contracted Quadra Engineering Ltd. to manage construction on their behalf. Quadra was responsible for the inspection program. Their approach, modelled on that developed by the APD Environmental Department for the Alberta and Saskatchewan segments, was to make individual activity inspectors responsible for ensuring that the contractor followed the environmental specifications. The field environmentalist's role was to provide advice to activity inspectors and ensure that they met their responsibilities. However, the initial field environmentalist hired had no previous environmental training. In addition, field environmentalists had limited authority to ensure that their advice was taken.

NPA surveillance officers and the B.C. field coordinator agreed that environmental inspection by Quadra was somewhat ineffective (Morrison, 1985; Langford, 1985). The major problem noted was that site-specific designs and procedures were missing and the environmental standards in the NPA terms and conditions and ANG's Plans and Procedures Manual were too general. Quadra managers thus had a great deal of discretion in deciding what procedures would be used as construction proceeded. Inspectors had no documentation to determine whether these decisions were appropriate to meet the intent of the contract documents and the contractor also did not always know what was expected of him.

ANG managers did not take an active role in construction management for quality assurance beyond reviewing inspection reports and occasional field observation, although they had daily contact with Quadra. The environmental consultant hired by ANG initially to prepare the Plans and Procedures Manual ultimately performed many of the auditing duties which are considered part of quality assurance, providing on-site environmental training and advice to environmental inspectors, liaising with government personnel, and auditing inspector's reports and other communications relating to environmental issues. However, he was not given formal terms of reference and had no authority to have his requests implemented (Stutz, 1983).

Alberta and Saskatchewan

The program instituted by the APD Environmental Department to ensure that environmental requirements and specifications were met was very thorough and comprehensive. Activity inspectors' sources of information included the contract specifications and the detailed, site-specific environmental designs and procedures that were indicated on the construction alignment sheets and drawings. In addition, an Inspector's Handbook listing the environmental concerns of each construction activity was prepared to assist activity inspectors. However, their major source of information was the trained field environmentalist assigned to each spread. While acting in an advisory capacity, one of his main responsibilities was to modify the plans and procedures as necessary during construction.

The field environmentalist provided field quality assurance to the APD office staff. In addition, the APD Environmental Department had a quality assurance role in that they reviewed contract documents, reviewed and assessed the design of inspection programs, audited inspection reports, conducted weekly on-site checks of inspection activities and the work of the field environmentalist, and provided support and advice to the field environmentalist.

Government Surveillance

British Columbia

The NPA, as the federal regulatory authority, had primary responsibility for surveillance during construction to ensure compliance with the Terms and Conditions (via the approved plans and procedures and other construction documents), and with provincial legislative requirements. The B.C. field coordinator had a surveillance role to ensure that conditions of provincial permits were met and to provide an independent provincial presence.

The NPA did not prepare a detailed surveillance program prior to the start of construction. Neither had arrangements with ANG and the province regarding working relationships and authority been established. The NPA hired surveillance officers just prior to construction. Consequently, they did not receive adequate briefing from the NPA head office and were not prepared for their fieldwork (Yarranton, 1985).

Because detailed schedules, standards, procedures and designs had not been prepared by ANG, the NPA surveillance officers were required to interpret and enforce compliance with the general terms and conditions. No criteria or guidelines were provided in the absence of detailed site-specific procedures ignored by Quadra. To add to their difficulties, surveillance officers were not given authority to enforce decisions in the field to prevent non-compliances with terms and conditions from occurring. The NPA's bureaucratic administrative arrangement and cumbersome reporting process often meant that by the time a decision on a non-compliance was made by more senior NPA staff, any environmental damage would already have occurred (Morrison, 1985).

By not providing provincial staff to act as NPA surveillance officers, the B.C. government opted out of a major role in NPA surveillance. The provincial field coordinator had to convey his requests through the NPA Senior Surveillance Officer and did not have adequate authority to change construction procedures. In addition, there was no mechanism to resolve disputes with the NPA over actions to be taken.

More than any other activity, water crossings and protection of fish became a focus of concern and administrative conflict during construction. Disagreements over the necessity and effectiveness of stream crossing techniques and lack of information on the fisheries resources of certain streams to be crossed culminated in opposing orders being issued to ANG by the NPA and the provincial court on behalf of the regional Ministry of Environment Water Management Branch. This conflict resulted in a construction delay of approximately one month.

Alberta and Saskatchewan

For a number of reasons, the NPA surveillance teams for the Alberta and Saskatchewan segments had fewer difficulties than their counterpart in B.C. In Alberta, jurisdictional disagreements and federal/provincial administrative problems in the field apparently were minimal (Wallace, 1985). A major reason was that joint surveillance responsibilities had been agreed upon prior to construction. As well, the NPA senior surveillance officer had previously been employed by the Alberta government and therefore had an established relationship with provincial surveillance officers. Another major factor was that the APD's planning and design process was so thorough and well documented, and their construction management for environmental protection so well-organized and cooperative, that surveillance officers had little difficulty overseeing pipeline construction. Few non-compliances occurred.

However, there were some administrative difficulties within the Alberta government regarding surveillance. Provincial surveillance activities had not been thoroughly planned and organized, and lines of communication were not clearly established prior to construction (Christiensen, 1985). At times, as many as ten different provincial surveillance staff were in the field as well as the NPA surveillance staff and APD inspection personnel (Wallace, 1985). The number of people present during construction was noted as excessive and therefore inefficient by many interviewees, although it was also noted that this gave the contractor far less opportunity to make mistakes or ignore specifications.

In Saskatchewan, where construction took place in 1981, the NPA conducted continuous surveillance. As noted, provincial agency representatives made periodic spot checks. Because of the lessons learned during 1980 construction on the longer lead time available, the NPA was able to thoroughly train its new surveillance staff for the 1981 construction. Construction proceeded without major incident.

Monitoring Studies

A number of monitoring studies were conducted during development of the Pre-build, some by proponents and others by government. Because monitoring is receiving increasing attention as a component of environmental management, it is useful to briefly outline the form and objectives of some of the monitoring, other than routine inspection and surveillance, undertaken for this project.

Yarranton (1984), in a survey of current monitoring practices for pipeline development, concluded that: "The most useful, and effective, monitoring programs...were those that were conceived at the project planning stage and which formed integral parts of environmental programs."

Many of the monitoring studies conducted, particularly in B.C., were initiated during construction, often in reaction to a concern on the part of company environmental staff, consultants or government agencies. Monitoring in B.C. was apparently often ad hoc, poorly designed, and baseline data were insufficient to allow meaningful conclusions. For example, water quality monitoring during stream crossings, requested by the B.C. Water Management Branch, apparently did not produce useful results (Stutz, 1983). Had a scientifically designed monitoring program for water quality and fisheries impacts been devised during project planning, the controversy regarding stream crossing techniques might have been avoided. To their credit, the ANG did undertake a monitoring study of fish and egg survival up- and downstream of certain river crossings, although the study was not conceived during project planning and baseline data were limited.

In contrast, several of the APD's monitoring studies were conceived during project planning and were oriented towards increasing cost-effectiveness. One type of monitoring which was an integral component of the APD's environmental management can be termed 'experimental' monitoring, involving scientifically designed experiments to test specific hypotheses or answer research questions about the probable outcomes of project-related actions. It can be used to reduce uncertainty, resolve disputes between government and industry, and assist in designing procedures which minimize or mitigate impacts. For example, the APD conducted a study of the effects on fish of instream blasting. However, by far the best example was an extensive, long-term revegetation monitoring program undertaken by the APD. As a result of this attention, the APD was extremely successful in reclaiming difficult soils, such as sand, and their procedures have since been utilized for other projects (Chappel, 1985). Another type of monitoring conducted by the APD can be termed "construction constraints" monitoring. For example, during certain river crossings, the provincial Fish and Wildlife Branch extended timing windows for instream construction when it was determined that the construction schedule would exceed these periods, on the condition that the APD demonstrate that fish were not present or were not obstructed. Thus detailed daily monitoring was conducted at or near the crossings. There were apparently considerable benefits to this form of practical, "problem solving" monitoring to minimize impacts, resolve disputes between government agencies and companies, and contribute to cost-effective construction (Walker, 1985). However, the APD fisheries consultant noted that the orientation and design of fisheries baseline studies would have been considerably altered had such monitoring been planned at that time (Furnet, 1985).

Qualitative post-project reconnaissance monitoring was conducted by the NPA and provincial agencies. The NPA also required that ANG conduct some post-project evaluation in B.C. because they were not pleased with the company's environmental procedures. Such post-project reconnaissance monitoring was not required of the APD. However, the APD environmental coordinator required that field environmentalists prepare post-construction environmental "as built" reports documenting problems with environmental procedures and any residual impacts which occurred, to assist with future environmental management. This exercise apparently yielded very useful information (Marteinson, 1981).

Conclusions and Recommendations

Institutional Arrangements

While conclusions regarding environmental management must be made with the recognition that the Pre-build was intended to be part of a much larger project, and was seen, by the NPA in particular, as a test case for regulating northern sections, there was consensus among interviewees that the Pre-build was over-regulated. Government involvement was seen as inefficient and only partially effective by almost every person interviewed. Because the federal government was involved to such a great extent, provincial governments also increased the extent of their involvement to ensure that their interests would be protected.

In B.C., the two governments' failures to agree on most issues and unwillingness to share authority and work cooperatively was the major factor affecting both the efficiency and the effectiveness of the overall process. Coordination between central and regional agency offices was also a problem. This problem occurred to a lesser extent in Alberta. It is apparent that, where jurisdictions overlap, clear administrative agreements are a necessary prerequisite to achieving satisfactory environmental protection.

In general, the 'single window' approach to environmental management is desirable because it simplifies the approvals process. However, in this case there were four 'single window' agencies and numerous other groups also wanting decision-making authority. To improve efficiency and effectiveness for future projects:

1. Formal administrative agreements between governments with overlapping jurisdictions should be made as early as possible in the planning phase of a major project. Such agreements should specify areas of jurisdiction and procedures for information exchange and review, surveillance and monitoring.
2. Regional staff should be made aware of all agreements between federal and provincial governments. Clear lines of authority and communication should be established as early as possible to reduce uncertainty and provide clear, consistent direction to proponents.

Environmental Planning

The environmental planning for the Pre-build was clearly much more advanced and detailed in Alberta and Saskatchewan than it was in B.C. While both the APD and ANG received similar terms and conditions to guide their planning, their responses were markedly different. Neither company received effective direction from the NPA on the level of detail and content expected from the planning work. In B.C., the FASC tried to elicit detailed planning from ANG but no mechanism existed to ensure that their requests were met.

While different projects will have their own specific requirements, a number of general recommendations can be made, based on the experience of planning the Pre-build.

1. Baseline studies and impact assessment should focus on areas of greatest concern and on ways to avoid or mitigate impacts. Developing or documenting general procedures should not be considered as an alternative to collecting specific information needed for project design, scheduling and site-specific procedures but can be effectively used to complement the more detailed design. As well, baseline studies should provide a basis for monitoring, where appropriate.
2. Government terms and conditions should be developed only where careful review has determined that existing regulatory controls and legislation may be inadequate. They should be provided to proponents as early as possible. These should provide a clear understanding of the government's environmental protection objectives and should be as practical as possible. Most importantly, specific direction should also be provided on the type and detail of documentation required, particularly regarding construction management strategies, and on criteria to be used for approval.
3. Reference to relevant plans, designs or specific techniques used on other projects should be encouraged to take advantage of experience gained elsewhere.
4. General environmental protection requirements should be stated in a Plans and Procedures Manual and in the contract specifications, and site-specific procedures indicated on the construction alignment sheets and associated detail drawings. Drawings should be keyed to the alignment sheets.

5. Effort and resources should be focussed more on developing site-specific procedures that protect environmentally sensitive areas than on producing Plans and Procedures Manuals which document general environmental standards an construction practices.

Government Review

Review of environmental plans and other construction documentation by government agencies is an important component of environmental management because it both informs the regulatory agencies of the degree to which government requirements are being/met and provides a means to correct deficiencies. However, the degree of success achieved in the environmental management of the Pre-build appears to have been dependent more on the level of proponent commitment to planning than on government review and approval of plans.

General recommendations for improving the review process are as follows:

1. Final authority and specific responsibilities in the review process should be clearly defined between levels of government and among agencies involved.
2. Criteria for approval of plans should be developed jointly by lead agencies and proponents, and should provide a clear understanding to proponents of government requirements and expectations. Those criteria should be satisfactorily met before approvals are given.
3. Government review should focus both on the extent to which the proponents' plans and designs meet government objectives, and on the management programs proposed to implement them.
4. Permits and approvals issued by government agencies should accurately reflect agreements reached during the review process.

Environmental Quality Control and Quality Assurance

Implementation of environmental plans and procedures depends on effective quality control and assurance programs as well as on clear and enforceable environmental protection requirements. Specific recommendations for improved quality control and assurance are:

1. Proponents should design an explicit quality assurance program which regularly audits the performance of quality control personnel, assesses the effectiveness of environmental management procedures, and provides support and advice to field environmentalists.

2. Proponents' environmental quality control and assurance programs, including details of responsibilities and authority, should be prepared well in advance of construction to provide for timely review by government.
3. Activity inspectors should have responsibility for the environmental concerns associated with their activity. Field environmentalists, explicitly denoted as such, should be a primary source of information and advice to inspectors during construction, and should have a mechanism for ensuring that environmental requirements are met.
4. Field environmentalists should be hired as much in advance of construction as possible to assist in construction staff training and orientation, and to become familiar with plans, procedures and other construction documentation, and their rationale.
5. The role and authority of environmentalists and activity inspectors should be clearly defined to all construction personnel. Field environmentalists should have environmental training as well as construction experience and should be chosen on the basis of their ability to communicate and get along with others.
6. Pre-bid and pre-construction briefings of the contractor on environmental matters should be held. Such meetings should discuss environmental concerns and types of procedures to be used to minimize impacts. The reporting arrangements, responsibilities and authority of inspectors should be indicated, as should formal lines of communication among contractors' representatives, company inspectors and government surveillance officers. Construction documentation supplied to the contractor should be minimized.
7. Following construction, the field environmentalist should be required to prepare a report documenting problems encountered in implementing plans and designs, field changes to plans and designs, and residual environmental impacts.

Government Surveillance

Surveillance activities are important to ensure that government objectives and regulatory requirements are met during construction. To increase the effectiveness and efficiency of surveillance, the following recommendations are offered:

1. A surveillance program should be prepared well in advance of construction. The program should indicate roles and authority of various levels of government involved in surveillance, the process for resolving disputes in the field,

responsibilities and authority of surveillance personnel, and the reporting system to be used.

2. Field authority should be sufficient to prevent minor non-compliances. For major problems, the reporting system should allow for quick decisions to prevent delays and maintain credibility.
3. The need for continuous surveillance and the appropriate number of surveillance officers required should be based on the size of the project, the environmental risk involved, and the level of preparedness of a proponent.
4. Where more than one government is involved in surveillance, one agency should be designated as the lead agency and a system designed to coordinate satisfactory levels of involvement and resolve disputes in the field.
5. Senior surveillance personnel should be hired as much in advance of construction as possible to permit familiarity with government terms and conditions and their rationale, as well as company documentation of plans, procedures and specifications, thus enabling a clear understanding of what is to be enforced. A role in government review of construction planning would facilitate this understanding.

Monitoring Studies

The benefits of monitoring are being increasingly recognized as a means of providing information at various stages of project development to make the environmental management process dynamic and adaptive. Trade-offs between practicality and the perceived benefits of a more rigorously scientific, long-term monitoring program must be made. In some cases, however, the latter may provide an opportunity to acquire knowledge that might be useful in planning or regulating a future project.

Recommendations for improving monitoring approaches (other than inspection and surveillance) are:

1. Monitoring programs should be designed cooperatively by proponents and regulatory agencies to address issues of uncertainty.
2. Monitoring programs should be conceived and designed as early as possible in the planning process so that baseline studies can collect information in the form of greatest utility, and time and resources will be spent on monitoring rather than impact assessment where it is determined that this would be more valuable.

3. Related to the above, explicit procedures should be established by the proponent and approved by regulatory agencies to ensure effective use of monitoring data in subsequent project management activities (feedback mechanisms).
4. Proponents should consider monitoring as a means of providing greater cost-effectiveness during project development. Government agency personnel should be alert to the possibility of using project implementation as a means of testing specific hypotheses about behaviour of environmental systems or of filling known data gaps that might be useful in their review of future development projects.
5. Where appropriate, government and the proponent should cooperate in the systematic design of long-term experimental monitoring programs that will contribute to improved environmental management procedures for future projects. Given the special nature of such programs, regulatory authorities could provide expertise, funding, continuity and could even assume long-term responsibility for the program.

Notes

This paper summarizes the findings of a forthcoming report prepared by Envirocon Ltd. in response to a request from the Environmental Protection Service of Environment Canada. The reader should review the report for a more detailed description of the history of the project, the issues, and the institutional arrangements, procedures, activities and events characterizing the environmental management process implemented. Funding for the research was provided by the Environmental Protection Service, Petro-Canada and the Polar Gas Project.

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REACHING AGREEMENT IN IMPACT MANAGEMENT: A CASE STUDY OF THE UTAH AND AMAX MINES

Anthony H.J. Dorcey
Brian R. Martin

Introduction

Excellence in impact assessment, monitoring and management (IAMM) results from the relevant people coming together and reaching agreement on the multitude of scientific and social issues that typically arise during the life of a project (see Dorcey, 1985; 1986). However, because IAMM situations vary greatly, who are the relevant people, how should they come together, and what constitutes an appropriate agreement are questions that are not easily answered. This paper describes one approach to follow-up/audit studies of two cases by focussing on these questions and identifying some of the key determinants of success in reaching agreement between the people who were involved with them.

Both case studies involve mine tailings disposal into coastal inlets of British Columbia. The Island Copper Mine of Utah Mines Ltd., beginning in 1968, and the Kitsault Mine of Amax of Canada Ltd., beginning in 1974, provide more than ten years of overlapping experience with IAMM. They are of particular interest because of their unique efforts to develop monitoring for impact assessment and management. At the time that Utah proposed its development Rupert Inlet, governmental processes for IAMM were in their infancy. There was little experience with marine tailing disposal anywhere in the world and this discharge was to be much larger than anything previously permitted on the B.C. coast. Though many issues were considerably better understood as a result of the Utah experience, significant uncertainties nevertheless remained as the Amax proposal for Alice Arm was developed and reviewed. The cases thus posed questions that, for their time, were on the frontiers of knowledge.

Although neither case has been through the more structured project assessment procedures introduced in recent years, they nevertheless provide valuable insights into the determinants of success in reaching agreement in any IAMM process. More specifically, they provide experience with the ongoing processes of assessment, monitoring and reassessment that should comprise impact management (Figure 1).

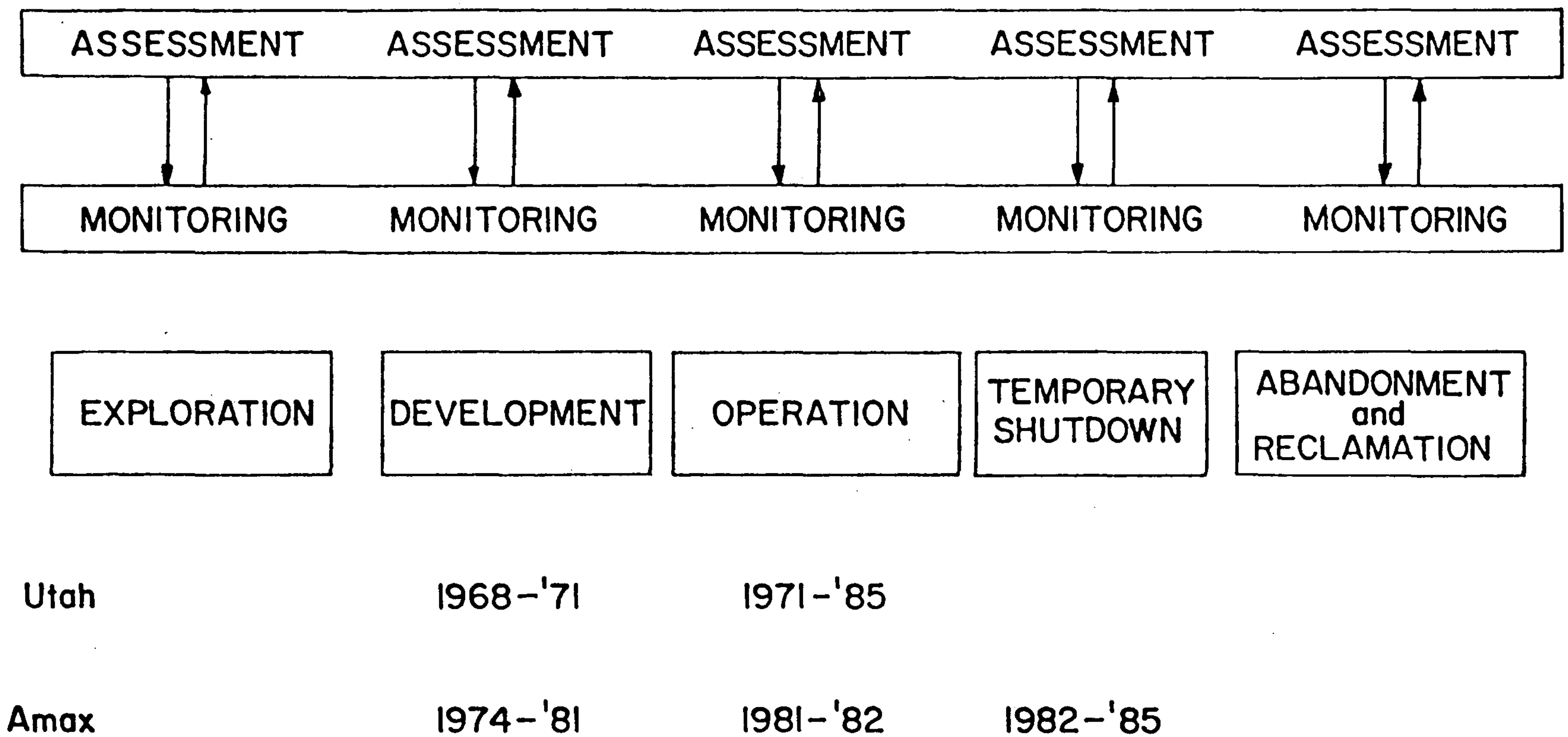


FIGURE 1 THE ONGOING PROCESS OF IAMM FOR A MINE

Thus this paper contributes to the subject of this volume in three ways: (i) it illustrates one approach to follow-up studies of IAMM; (ii) it assesses experience with several attempts to undertake follow-up/audit studies in two ongoing processes of IAMM; and (iii) it suggests changes that should be made to improve IAMM in general and follow-up/audit studies in particular.

In brief, based on an analysis of published reports, file materials, and interviews, we have concluded that in both cases there has been substantial innovation and success but, because they have been overshadowed by a number of controversies, these successes have not been well recognized.[1] Some of the major problems that arose would be less likely to occur today because of improved design of impact assessment and management processes. However, some of the critical difficulties that were encountered have not been given adequate attention in the IAMM literature, in particular the skills that people bring to these processes and the interdependence of personal skills and IAMM process design in determining success. Exactly the same factors would be crucial in determining the success of any procedures during follow-up and audit of IAMM.

After identifying the scientific and social issues that have arisen during the life of these projects, we summarize our judgement of the success in resolving those issues. We then select five of the administrative processes that were used in the ongoing assessment and monitoring during impact management, and analyse their strengths and weaknesses in resolving issues and reaching agreement. The paper concludes by suggesting the skill development and procedural reforms that are essential to the pursuit of excellence in IAMM.

The Case Study

The two cases have a long and complex history which is described and analysed in a forthcoming book (Dorcey and Martin, 1986). This paper summarizes only part of the analysis and focuses on the factors that contributed to success in reaching agreements between the scientists who were involved. Except to recognize that there were major difficulties because affected interests were not appropriately involved, these broader issues were not addressed in detail here. The reader should see the book for a more detailed description of the issues, events and analyses.

The Projects and Issues

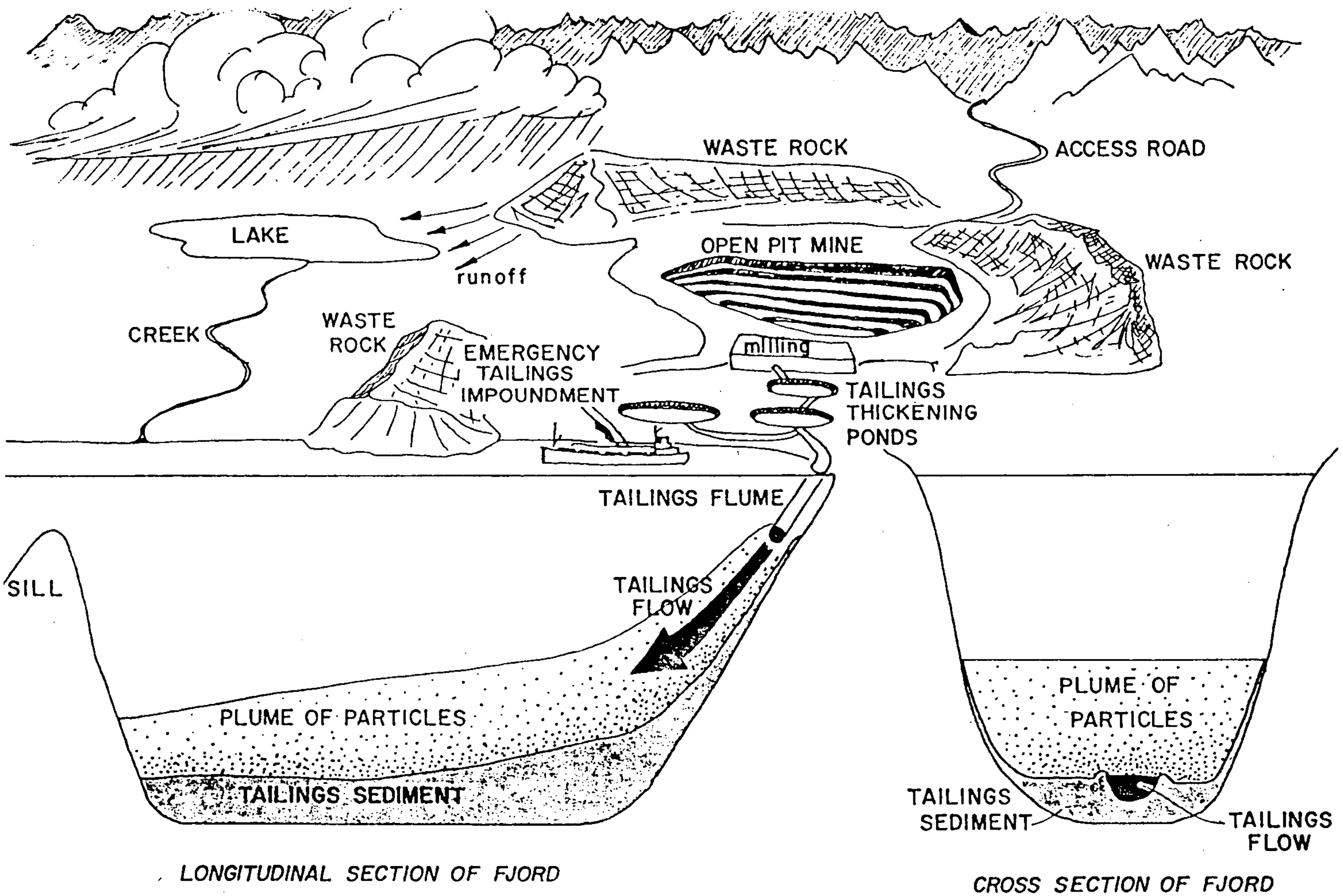
Both cases involved disposal of large quantities of mine tailings (the finely ground waste product from milling of the ore) into deep fjords (see Figure 2 for a schematic representation).[2] Tailings are mixed into a slurry, which is discharged from an outfall at depth (in these cases, 50 metres). The tailings subsequently flow down the inlet slope and largely settle on the inlet floor, though small percentages can become suspended and only slowly settle out of the water column. The alternative to marine discharge was in both cases land disposal, an option which was rejected by the companies and regulators during the assessment phases of both projects, but which re-emerged at various times throughout the projects' operational lives. The rejection of land disposal was based on the belief that it could have greater environmental impacts and be more costly.

The significant environmental questions were:

1. Would the tailings be more toxic if contained in the freshwater environment of an on-land tailings impoundment?
2. Were there threats to the long term integrity of a tailings impoundment in areas where rainfall was high, slopes steep, and earthquakes common?
3. Could a possibly toxic supernatant be contained in a tailings impoundment?
4. What was the value of habitats displaced by on-land disposal?

Over the life of these cases, a number of substantive scientific issues arose concerning marine disposal.

1. Fjord circulation: To what extent did vertical mixing occur in the fjords, to what depth did diving flood tides penetrate, and what were the velocities of bottom currents?
2. The distribution of tailings: What would be the final areal and vertical distribution of tailings sediments and suspended solids? Would suspended tailings be transported across the inlet's sill and spread turbidity and sedimentation beyond the fjord?
3. Toxicity: This complex problem involved numerous questions including: the propensity of metals to be biologically leached from the ore and waste rock; acute and sublethal toxicity of tailings effluent; the degree of bio-accumulation and biomagnification of metals in organisms; the safely allowable concentrations of metals and radium 226 in the effluent; the effect



Source: Rescan Environmental Services, 1984: 57

FIGURE 2 MINE-MILLING AND MARINE TAILING DISPOSAL PROCESS of seawater on dissolved metal concentrations as the effluent was diluted; and the possibility of diagenesis in tailings deposits.[3]

4. Deep benthic smothering: What were the responses of benthic organisms to varying degrees of deposition? Did they recolonize tailings? What were the trophic linkages between these communities and other fjord communities (e.g., pelagic, estuarine and intertidal)?
5. Nearshore benthic deposition: Did increasing turbidity and resulting deposition in upper levels of water column affect productivity, or were the effects primarily aesthetic?
6. Phytoplankton: Did turbidity affect phytoplankton productivity? Did in-situ phytoplankton production contribute significantly to the inlet's total productivity?
7. Salmonids: Were there indirect impacts on trophic levels linked to juvenile salmon, and resulting bioaccumulation of metals or reduction of food sypply?

Issues also arose concerning mitigation options and their cost-effectiveness (e.g., the size of the emergency tailings pond and altering the grading of the waste rock dump to encourage recolonization at Utah, and the removal of zinc (Zn), cadmium (Cd) and lead (Pb) from the tailings at Amax). These mitigation issues, however, have received substantially less attention than the questions relating to the consequences of marine discharge.

In addition to the substantive scientific issues, disagreements over the appropriate practice of science also occurred in varying degrees. These issues fell into a number of categories:

1. Determining relevant scientific questions: Disagreements developed over the importance of elements of both the assessment investigations and of the monitoring programs (e.g., emphases on physical versus biological components; relative importance of toxicity studies versus indirect impacts on trophic relationships; targeting of studies on commercially important species; focussing studies on issues of theoretical interest rather than practical import).
2. Methodological issues: These involved disagreements over the appropriateness of sampling designs and analytical techniques. There were also questions raised over whether long term trend monitoring or sets of short, well-defined special studies were more useful as monitoring tools.

3. The interpretation of data: Questions were raised over whether proponent's studies should merely present the data, or should be interpretative.
4. Data presentation and reports: These involved concerns over data availability and presentation, and the appropriate formats for different audiences (scientists, politicians, and laypersons).
5. Reviewing the results of investigations and monitoring: A variety of questions emerged: To what extent should industry, government agency, and other reports be reviewed, and under what conditions? (e.g., Who should be involved in these reviews? Should they be externally or internally reviewed? When should they be reviewed, before or after general distribution? What communications should exist between author and reviewer?)

These scientific issues were entwined in social issues which provided their context; participants' attitudes to the social issues strongly influenced the perceived significance of the scientific issues. Both inlets supported in varying degrees commercial, recreational, and native Indian food fisheries. Unsettled Nishga land claims adjacent to the Kitsault site further complicated these issues. Finally, environmental interest groups strongly opposed marine discharge in both cases. This complex set a substantive and methodological issues, operating within a charged social context, resulted in a continuing climate of tension between parties, although many of the disagreements were eventually resolved.

The Events

Table 1 summarizes the events of the Utah and Amax cases. It indicates that scientific issues emerged throughout the duration of these cases over a fifteen year period. It is important to note that in both cases there have been periods when particular issues that were the subject of considerable public controversy have tended to overshadow the extensive and continuing IAMM efforts by the companies, regulators and researchers.

Utah: During the pre-permitting assessment phase many of the scientific issues identified above were raised within the government agencies and by environmental interest groups. Concerns over toxicity dominated this period, particularly as there had been little experience with tailings discharge before, and none on such a major scale. The marine disposal option was chosen by federal and provincial regulators as a result of their judgement that tailings were less toxic in a marine environment.

TABLE 1 SELECTED EVENTS IN THE CASE STUDIES

Date	Island Copper Mine	Kitsault Mine
	Assessment Phase	
1968	• Department of Fisheries and Forestry initiates negotiations with Utah Mines.	• B.C. Moly Mine in production and discharging tailings to Lime Creek and Alice Arm.
	PUBLIC CONTROVERSY	
1969	• Utah applies to the Pollution Control Branch for an effluent discharge permit. Permit review begun by PCB, including referrals to provincial and federal agencies.	
	• Public concern leads to 160 formal objections. Environmental interest groups press for increased biological study.	
1970	• DFF and Utah agree over terms of effluent discharge.	
	• PCB holds a public hearing in response to formal objections.	
1971	• PCB issues effluent permit requiring monitoring.	
	Management Phase	
	• The University of B.C. Independent Agency is formed to design and evaluate the results of the monitoring program.	
	• Pre-operational monitoring begins 7 months before discharge commences.	
	• Environmental Protection Service takes over federal management of Utah discharge.	
	• Production commences.	
1972	• The UBC IA continues to oversee the monitoring program, supervises graduate student research, and produces annual summary reports.	• B.C. Moly Mine at Kitsault ceases production.
	• First provincial hearing to establish policies and objectives for mine effluents held, in part in response to Utah controversy.	

TABLE 1 SELECTED EVENTS IN THE CASE STUDIES (Cont'd)

Date	Island Copper Mine	Kitsault Mine
	• Unexpected surface turbidity arises and wider-spread vertical and areal deposition of tailings occurs.	
1973	• PCB and EPS meet and disagree over the significance of the turbidity. • Utah requests permit amendment to increase discharge.	• Climax Molybdenum of B.C. purchases the Kitsault Mine site.
1974	• EPS initiates a study of the impacts of marine discharge.	<u>Assessment Phase</u> • J.L. Littlepage Ltd. is commissioned to do background study of Alice Arm as a disposal area. • PCB and Climax initiate discussions on the acceptability of marine disposal.
1975	• Monitoring continues; UBC IA reports reviewed by PCB and EPS staff. EPS continues study.	• Climax applies to the PCB for an effluent disposal permit. PCB review of Littlepage reports begins, and is generally positive.
1976		• PCB informally recommends marine discharge, and that Climax directly negotiate with EPS. • EPS and DFO review of Climax's consultants' reports criticizes their methods and lack of predictions of the effects of tailings.
	PUBLIC CONTROVERSY	• Federal regulatory standards (the Metal Mining and Liquid Effluent Regulations) restrict marine discharge of tailings due to suspended solids provisions.
1977	• Utah permit amended to increase discharge. • EPS publishes a report critical of marine discharge and of the UBC IA's findings and this results in considerable public controversy.	• Littlepage summarizes 35 studies to date. • PCB resume recommends marine discharge after considering referrals and the lack of public objection, and its internal review.
1978	• Second round of provincial hearings on mine effluent standards is held. • A two-man committee is established to determine the facts with respect to this dispute (Waldichuk and Buchanan). • After internal review of the role of the UBC IA, UBC does not renegotiate its contract with Utah, and the UBC IA is superceded by a Technical Advisory Committee.	• Federal inter-agency committee established as a result of internal dissention and the lack of a formal review process for regulations, to review Climax proposal, but cannot agree on recommendations. Committee chairman presents report favorable to marine discharge.

TABLE 1 SELECTED EVENTS IN THE CASE STUDIES (Cont'd)

Date	Island Copper Mine	Kitsault Mine
1979	• Waldichuk and Buchanan interview EPS, UBC IA, and ICM staff, and review reports.	• PCB issues Climax a permit which requires a monitoring program. • DFO issues the Alice Arm Tailings Disposal Regulations, which also require monitoring. PUBLIC CONTROVERSY
1980	• Waldichuk and Buchanan publish a report which recommends no change in disposal methods but proposes more research.	• Nishga indicate concerns over safety of marine discharge, and as a result of the subsequent public controversy, the federal decision is reviewed.
1981	• Waldichuk and Buchanan report reviewed by PCB, EPS and Department of Fisheries and Oceans staff, and are critical of some of its conclusions and recommendations.	• The Minister of DFO establishes the McInerney Panel to provide an independent review of the safety of marine discharge. Management Phase • Operations commence. • Tailings spills and a plume occurs. • After review of reports and public hearings, the McInerney Panel reports that marine discharge is environmentally safe.
1982	• EPS internally reviews the ICM monitoring program, in response to lack of action in the aftermath of the Waldichuk and Buchanan report.	• Mine stops production due to deteriorating markets. • McInerney Panel produces interim report on monitoring.
1983	• As a result of increasing regionalization of WMB responsibilities, staffing changes, and the size of the ICM discharge, the ICM monitoring reports are more carefully reviewed by WMB staff, and the results discussed with ICM environmental staff.	• Monitoring and special studies continue. • McInerney Panel produces second report on compliance and monitoring results.
1984	• Discussions between EPS, WMB, and ICM on changes to the monitoring program result in fine tuning, but no major change.	• Monitoring working group to coordinate information and discuss studies is formed, including representatives of of DFO, EPS, IOS, WMB, Health and Welfare, and Amax.

Due to the remaining uncertainties over tailings behaviour, an independent agency, consisting of professors from the University of British Columbia (UBC), was established to supervise and interpret the monitoring program. It was the appearance of unanticipated surface turbidity which refocussed attention on the physical rather than chemical effects of tailings deposition and turbidity. The Island Copper Mine (ICM) tailings have not demonstrated significant toxicity, but the physical impacts continued to be questioned, particularly within the Environmental Protection Service of Environment Canada (EPS), which criticized the design of the monitoring program and its ability to determine these physical impacts. A two-person committee, drawn from a federal and provincial agency respectively, was established to resolve this dispute. Two years later, it concluded that there was no need to change the disposal methods but that there should be further research. By this time, the UBC independent agency had been reconstituted as the Technical Advisory Committee, which continues to review the monitoring program. The federal and provincial regulatory agencies and ICM's environmental staff now meet regularly to discuss the results and refine the monitoring program.

Amax: Both the company's consultants and the federal agencies applied a great deal of effort during this assessment in an attempt to define fjord circulation patterns and to estimate the biological resources of the inlet. Disagreements nevertheless persisted over a considerable period of time. Federal regulators initially questioned the advisability of approving marine discharge of tailings as opposed to land disposal. In contrast, the province quickly agreed with the company that marine discharge was more environmentally acceptable. Though the federal agencies eventually altered their position, the Nishga Tribal Council opposed marine disposal when it heard of the proposal. In response to the controversy generated, the Minister of Fisheries and Oceans appointed a review panel of university scientists to provide an external evaluation of the marine discharge proposal. Though this committee's conclusions have not been accepted by all, and particularly the Nishga, its conclusions did resolve much of the public debate.

Both these cases demonstrated the longevity of some environmental disputes, even in the face of major efforts to produce and interpret scientific issues were resolved, though often only after considerable time and resources had been applied to them. However, many scientific issues were resolved, though often only after considerable time and resources had been applied to them. The following section considers the success to date in resolving these issues.

Success in Reaching Agreements

The Resolution of Issues

Our assessment of the predictive success, and subsequent resolution of issues through monitoring, is given for both cases in Table 2. Seven substantive sets of issues are considered and are separated into assessment and management phases. (Issues of the practice of science, as well as social issues, were often intertwined with these substantive issues). Under the assessment phase, predictions are classified according to whether they were successfully or unsuccessfully made, or whether they were left unconsidered during the impact assessment. Under the management phase, our perception of the current level of agreement on the issues among those who have been involved is indicated. Note that agreement does not necessarily imply unanimity nor complete satisfaction but rather than the parties involved do not see sufficient reasons to make an issue of any differences at this time. Those issues which were not studied are noted.

The predictive success rate has been much greater at Amax than at Utah, in part because the environment was less dynamic, and in part due to learning from the Utah experience. Significant uncertainties, particularly those related to the indirect effects of tailings disposition and turbidity, do remain for both cases, however. A comparison of the two cases indicates:

1. The most significant failure in impact prediction at Utah involved the misunderstanding of fjord circulation processes, and a resulting error in predicting the areal extent of tailings deposition and surface and shallow water turbidity. Dense water from Quatsino Sound periodically entered Rupert Inlet during flood tides, and dove rapidly down the face of the sill, displacing turbid water up to the surface, and resuspending tailings sediments on the bottom. These suspended sediments were then transported outside Rupert Inlet on the ebb tide. This error in describing fjord circulation was not repeated at Amax, although an unpredicted slowly-settling mid-water tailings plume did develop.[4] In both cases fjord circulation processes of the inlet are now relatively well understood.

TABLE 2 THE RESOLUTION OF SCIENTIFIC AND TECHNICAL ISSUES

	Utah Mines Case							The Amax Case						
	Assessment Phase			Management Phase				Assessment Phase			Management Phase			
Scientific Issues that Arose	Predicted Correctly	Predicted Incorrectly	Uncon- sidered	Agreement	Partial Agreement	Unresolved	Not Studied	Predicted Correctly	Predicted Incorrectly	Uncon- sidered	Agreement	Partial Agreement	Unresolved	Not Studied
1. Fjord Circulation:														
- extent of vertical mixing		*		*				*			*			
- velocity of bottom currents		*		*				*			*			
2. Distribution of tailings:														
- areal extent of tailings deposition		*		*				*			*			
- vertical extent and degree of turbidity		*			*				*		*			
3. Toxicity:														
- leachability of metals from tailings and waste rock on land		*		*				*			*			
- leachability of metals from tailings in seawater	*			*				*			*			
- Ra 226 levels: background vs. tailings	n.a.			n.a.				*			*			
- degree of bioaccumulation	*			*				*			*			
- degree of biomagnification	*			*				*			*			
- diagenesis increasing sediment porewater metal levels			*				*			*				*
4. Deep Benthic Smothering:														
- response of benthic organisms to varying levels of deposition			*		*			*			*			
- extent of recolonization of tailings			*		*			*			*			
- effects on commercial epibenthic species (crabs, prawns, fish)	*				*			*			*			
- trophic linkages of benthos to other valued species			*			*				*				*
5. Nearshore Benthic Deposition:														
- effect of turbidity and deposition on biological productivity			*			*		*			*			
- trophic linkages to valued species			*			*		*			*			
6. Phytoplankton:														
- effect of turbidity on primary productivity		*		*				*			*			
7. Salmonids:														
- effect of process water intake on salmonid spawning success	?			?				n.a.			n.a.			
- effect of waste rock dump on juvenile salmonid survival			*			*		n.a.			n.a.			
- other trophic linkages to salmon			*				*			*				*
	4/19	6/19	8/19	9/19	4/19	3/19	3/19	14/18	1/18	3/18	15/18			3/18

2. Toxicity impacts were correctly predicted for both cases--although limited bioaccumulation of metals (possibly from sources other than tailings) has been selectively observed in the biota of both inlets, there is general agreement that the observed concentrations are not threatening to human health. The potential of the tailings or waste rock to leach metals biologically was incorrectly predicted during the Utah assessment...the original B.C. Research tests (1970) indicated they might potentially leach metals, but later on more sophisticated replications by EPS refuted this. The possibility of long-term increases in dissolved metal concentrations in sediments as a result of diagenesis is being studied; however collection of times series data, which will allow reliable predictions to be made, will require decades.
3. Deep benthic smothering was predicted to occur in both inlets. However no predictions of the response of infauna to this smothering, or of the extent of recolonization, were made at Utah (though extensive recolonization has been demonstrated by the monitoring results). Some impact was expected on crabs and other epibenthic species, but as no pre-operational population studies were done, the accuracy of these predictions is difficult to assess. At Amax, the extent of obliteration resulting from tailings was correctly predicted, as was successful recolonization. In neither case were the pre-operational or monitoring studies done which might have resulted in an understanding of trophic linkages between the deep benthos and other components of the fjords' food chains.
4. Nearshore benthic deposition was, as a result of the failure to understand fjord circulation processes, incorrectly predicted at Utah. The detailed effects of this deposition on shallow water organisms remain unresolved to date, but nearshore benthic habitats do support healthy communities (often on a new substrate of tailings). There has been no shallow water deposition or turbidity in Alice Arm, and therefore direct effects on intertidal and subtidal organisms have not occurred.
5. Direct effects on salmonid spawning were not applicable at Amax. At Utah mitigation measures were taken, but as the monitoring program did not explicitly consider salmonid escapements, the only available data are from fisheries officers' escapement estimates, which are not reliable enough to determine any but the most obvious impacts. The DFO data that are available show no unusual decline. The effects of the marine waste rock dump on

juvenile salmonids have not been explicitly included in the monitoring program, and therefore this issue has not been finally resolved. Neither the Utah nor Amax cases have led to an explicit consideration of the indirect trophic linkages from impacted organisms to salmonids. Although appropriate studies were not conducted, in neither case have obvious impacts on salmonids been noted.

The Difficulty of Issue Resolution in IAMM

From the case studies it is clear that some issues were more easily resolved than others. We have found it useful to think of the difficulty of reaching agreement on an issue as being somewhere on a spectrum of difficulty that stretches from "routine" through "difficult" to "impossible".

1. "Routine" issues are straightforward and can be easily resolved. They merely require people with appropriate knowledge and who represent the relevant interests to come together in a suitable process in order to reach agreement. The probability of them being wrong in their predictions is low. As a result, agreement is relatively less vulnerable to weaknesses in the individuals' interaction skills. For instance, the immediate concerns over apparently high Ra 226 concentrations in the Kitsault ore were rapidly dissipated among the broad spectrum of involved scientists following the discovery that analytical procedures for the original assay were faulty, and that Ra 226 levels were below the crustal average.
2. "Difficult" issues pose greater problems in reaching agreement but given time and resources to bring together people with appropriate expertise and who are representative of the relevant interests, agreement can eventually be reached. For these issues there is a greater probability of being wrong, and hence, a higher likelihood of surprising consequences. These issues require a process that first identifies agreements and disagreements on issues, then identifies agreements on investigations to resolve the disagreements, and finally reaches agreement on the basis of results.[5] Agreement on such issues is much more vulnerable to weaknesses in individuals' interaction and technical skills. Fjord circulation at Utah was an example of this. The original understanding of these processes proved wrong for a number of reasons: theoretical knowledge at the time was dominated by a single model which proved inappropriate to the case, the data available were ambiguous, and insufficient effort was applied to

collecting a data base which would prove or disprove the model; and the challenges to the company's interpretation were made confrontationally and responded to defensively. Although the characterization of Alice Arm circulation was not without controversy, more data were available, and other models of fjord circulation were considered.

3. "Impossible" issues make a scientific resolution unattainable because of unresolvable factual uncertainty and/or differences in value judgements.[6] For these issues, reaching agreement on investigations and on their results is not possible, except to agree to disagree. The objective hence becomes the maximization of agreements and this depends on bringing together people with the appropriate expertise and from the relevant interests. The development of interaction and technical skills and a suitable process are critical determinants of success in attaining and maintaining the maximum agreement possible. Agreement on these issues is particularly vulnerable to weaknesses in both the skills of the people and the design of the process. In 1969-70, during the Utah assessment, an exact delineation of the threat of toxicity likely fell into this "impossible" category: although it was believed that the ICM ore was not a particularly threatening source of bioavailable metals, the exact factors which governed the release of metals were not well understood; the potential pathways within the biological systems of fjords for the bioaccumulation and biomagnification of metals were similarly at an incipient stage of understanding; and given the strongly divergent value positions of various parties, these uncertainties precluded any short-term scientific resolution of the toxicity issue that would be generally acceptable. Without an appropriate process for the relevant interests to even seek an agreement, these issues were impossible to resolve during this period.

It is important to note that the classification of issues changes over time. Some issues move from "difficult" towards "routine" (e.g., fjord circulation in 1970 compared with 1985) or from "impossible" towards "difficult" (e.g., diagenesis in 1978 compared with 1985). Other issues can move at least temporarily from "routine" towards "difficult" (e.g., at Utah fjord circulation was initially appraised as a "routine" problem, when, in fact, as understanding of fjord dynamics improved, it came to be recognized as "difficult"). In general, for projects that raise relatively new issues, it appears that the number of issues increases over time but that many move eventually towards the "routine" end of the spectrum, and that this happens most rapidly in the earlier years of the project's life. Given that political decisions may well be made to proceed with a project even though some "difficult" and "impossible" issues remain, it becomes important to design processes for moving these issues efficiently and quickly towards the "routine" end of the spectrum.

An Analysis of Processes Used to Reach Agreement

Five processes that were utilized in the cases can be used to illustrate some of the ways in which people were brought together during IAMM to resolve issues and reach agreement, even though this may not have been their explicit purpose (Table 3). There were many examples of the first two types of processes..."referrals" and "meetings". The other three processes..."the UBC Independent Agency", "the Waldichuk and Buchanan Review" and the "McInerney Panel"...were "special purpose groups", each with its own specific and unique purposes including, at least implicitly, the resolution of issues and reaching agreements.[7] Each process is analysed in terms of the strengths and weaknesses it demonstrated as it was used. Strengths indicate the best practice that was achieved; weaknesses indicate where there were opportunities to improve practices.[8]

Referrals

Referrals were used by people in government organizations to inform and seek comment from other people in government (Table 3). They are utilized today in all components of IAMM. During the fifteen years spanned by the two cases "referral processes" have become ubiquitous. In the beginning they were relatively informal and simple (e.g., when the federal Department of Fisheries and Forestry was first reviewing the Utah proposal) but today they are labyrinthine and more formalized. This formalization has occurred in the guidelines that specify the information required and the organizations to which applications for various licences, leases and permits required for developments should be referred. Guidelines may exist as a general framework for a category of developments; thus is either mine were being proposed today it would be subject to the provincial Guidelines for Metal Mine Development. Guidelines may also be specific to a particular type of permit that might be required; thus recent consideration of changes in the provincial Waste Management Permit for each of the mines has had to conform with the more specific guidelines. Semi-formal and informal referrals have also been frequently

TABLE 3 IAMM PROCESSES AT UTAH AND AMAX

Referrals

e.g. Utah	Amax
• PCB permit review process (formal and informal) • Review of reports (Monitoring reports; Goyette and Nelson; Waldichuk and Buchanan)	• PCB permit review process (formal and informal) • Federal ad hoc review process (informally to OAS staff) • Alice Arm monitoring design

→ Issues Resolved =Agreement

↓ "Issues Unresolved" ↓

Meetings

e.g. Utah	Amax
• DFF and Utah negotiations • PCB/DFO/EPS coordinating meetings	• PCB and Climax meetings 1974-77 • Internal review of AATDRs • Contingency planning between Amax and federal agencies • Amax technical working group

→ Issues Resolved =Agreement

↓ "Issues Unresolved" ↓

Special Purpose Groups

e.g. Utah	Amax
• University of B.C. Independent Agency • Technical Advisory Committee	• RSCC committee • McInerney Panel

→ Issues Resolved =Agreement

utilized. These may have been used to obtain comments on applications before they were formally submitted and for other purposes, such as the design of a study or the review of a report. While formal referrals would always be transmitted in some written form, the semi-formal and informal referrals might be verbal and often conducted by telephone. Any response to a referral could be verbal. As the response was considered to be of greater importance it became more formalized, ranging through marginal notes on the referred document through to detailed and extensive analyses and position statements. Referrals have been utilized in all these diverse ways throughout the Utah and Amax cases.

Strengths (Reflect best practice achieved at some time)

1. Provided means of informing the many potentially interested people in government.
2. Informed people of proposals and conclusions at an early stage.
3. Allowed the recipient to decide on the priority and magnitude of response.
4. Resulted in valuable information being fed back to the initiator.
5. Semi-formal and informal referrals were cost-effective.

Weaknesses (Reflect opportunities to improve practice)

1. People got left out of referrals.
2. Referrals didn't get made or were late.
3. Inadequate information contained in the referral created problems.
4. Lack of expertise frustrated ability of the recipient to respond.
5. Remote recipients didn't discuss the referral with the initiator.
6. Large numbers of referrals swamped recipients.
7. Formalities constrained initiators and respondents.
8. Unconstructive attitudes of initiators or recipients frustrated responses.

Referrals in their various forms have become centrally important mechanisms for defining issues and seeking agreements in IAMM. The two cases reflect the general growth and improvement in the design of these processes over the last fifteen years. At their best they can be a highly cost-effective means of reaching agreements. However, their success is critically dependent on the way in which individuals use and respond to them. Also, while referrals can be reasonably expected to resolve many "routine" issues, this is unlikely for "difficult" and "impossible" issues. In the case of such issues, resolution will depend on the referral leading to the relevant people coming together promptly for face-to-face and more intensive discussion of the issues. Next we consider four processes that were utilized for doing this in the cases.

Meetings

Meetings were the major type of process used to conduct IAMM. In this section we focus on the myriad forms they took without becoming formalized, the latter are considered next as "special purpose groups" (Table 3). Usually these informal meetings involved only small groups of people. The participants might be members of government agencies, private companies, research organizations or interest groups. The individuals might be from any level of their organization; on occasion ministers, company executives and interest group leaders met, but more commonly individuals were drawn from the middle and lower levels of organizations. They might meet separately (e.g., people from three sections of an agency) or in any variety of combinations (e.g., agency with agency or agency with company). They might meet only once or numerous times, probably on an irregular basis. The meetings were not formalized in that the group had no formal status nor terms of reference; they were for the most part ad hoc. They might, however, be conducted in a relatively formal manner in terms of their use of agendas, the nature of exchanges, decision-making procedures and minutes. While on a few occasions the meetings involved members of the public, they were never conducted in a public forum nor were they intended to report to the public. As illustrated in Table 3, meetings were held for many varied purposes during IAMM at Utah and Amax.

Strengths

1. Brought together relevant interests and expertise.
2. Enabled issues to be identified and defined.
3. Created options for resolving issues.
4. Evaluated the merits of options.
5. Forged agreements to resolve issues.
6. Agreed on procedures for resolving residual disagreements.

Weaknesses

1. Timely meetings were not convened.
2. Key interests were not included.
3. Appropriate expertises were not available.

4. Leadership was lacking.
5. Issues remained poorly identified.
6. Negative and adversarial exchanges frustrated the pursuit of agreements.

Where meetings were timely, involved relevant interests and expertise, and the participants were skilled in interpersonal and group relations, the meetings were highly cost-effective in reaching agreements. Only a small proportion of meetings, however, would score well on all these criteria. Many would score poorly on most of them. The most serious weaknesses resulted from deficiencies in the participants' interpersonal and group relations skills because, without them, the other problems could not be dealt with and tended to be exacerbated. Over the life of the two cases there appeared to be some improvement in these skills and the associated productivity of meetings. Where the issues to be resolved were "routine" these deficiencies reduced the cost-effectiveness of the process but not as greatly as in the case of the "difficult" and "impossible" issues. The three examples of "special purpose groups" that follow illustrate this more specifically. If the deficiencies had not been as serious, however, it is possible that two of the "special purpose groups"...the Waldichuk and Buchanan Review and the McInerney Panel...might have been unnecessary.

UBC Independent Agency and Technical Advisory Committee

The UBC Independent Agency was established in 1971 and continues today as the Technical Advisory Committee. This novel idea in IAMM emerged from discussions between Utah Mines Ltd. and the federal and provincial agencies. The company approached the university to undertake the work. It was agreed that a team of university faculty would advise the company and government agencies on the design of a monitoring program, assist in the training of personnel and conduct of the monitoring, and report to the provincial Pollution Control Branch on the results of the monitoring program. The initial program and disciplines of the faculty involved are shown in Table 4. In 1978 the University of British Columbia did not renew the contract and the company created a Technical Advisory Committee to carry on its responsibilities. This smaller committee included several of the members from the UBC Independent Agency together with some new members.

Strengths

1. Provide a means of harnessing expertise available in universities.

TABLE 4 THE ORIGINAL MONITORING PROGRAM AT UTAH MINES

TABULATION OF SERVICES TO BE PROVIDED WITH RESPECT TO POLLUTION CONTROL PERMIT NO. 379-P SCHEDULE "A"

Item	Description	Services to be provided by	Frequency	Objective	Intended U.B.C. Faculty Member Involved[1]
1. Rupert Inlet Seismic Profile	Determine bottom profile and sediment distribution.	Specialist Contractor (Geomarine Services) and Utah under direction of U.B.C.	March '71, then twice yearly in initial period after production achieved.	To establish extent, buildup rate and nature of mine tailing delta.	Dr. Murray (Geology)
2. Rupert Inlet Bottom Sampling	By obtaining grab and core samples and bottom photography, determine - a) Physical & Chemical properties b) Biological properties Permanent stations within Rupert Inlet and reference stations in adjoining waterways to be maintained.	a) Physical & Chemical - Spec. Contractor (Geomarine) and Utah under direction of U.B.C. b) Biological - Spec. Contractor (Beak Consultants) and Utah under direction of U.B.C.	a) Physical & Chemical - March '71, thence twice yearly. b) Biological - March '71	To establish present Rupert Inlet benthos conditions and monitor possible changes resulting from mine tailing introduction.	Physical:-Dr. Murray Chemical:-Dr. Fletcher (Geology) Biological:- Zooplankton-Dr. Lewis (Ocean) Phytoplankton - Dr. Taylor (Ocean)
3. Rupert Inlet Water Sampling	By approved techniques, determine nature of Rupert Inlet water - a) Physical & Chemical Properties - temp., salinity, pH, alkalinity, dissolved oxygen, "turbidity", sea conditions and weather.	a) Physical & Chemical - Utah under direction of U.B.C.	a) Physical & Chemical - Initially monthly, commencing March '71	To determine natural physical, chemical and biological variations in Rupert Inlet waters and equate these variations with possible modifications resulting from the introduction of Island Copper Mine effluents.	Physical:- Dr. Pickard (Ocean) Chemical:- Dr. Grill (Ocean) Dr. Fletcher (Geology)
	Measurements taken at specific water depths on permanent stations in Rupert Inlet and adjoining waters. b) Biological properties i) Net tows at specified depths on permanent stations ii) Intertidal plates at reference stations iii) Heavy metal contents of resident macrospecies.	b) Biological - Spec. Contractor (Beak) under direction of U.B.C.	b) Biological - i) Tows - monthly, phytoplankton determined by chlorophyll "a" analysis monthly; zooplankton biomass analysed quarterly. ii) Intertidal plates - initially examined monthly and replaced when required. iii) Residual macrospecies analysed as specimens obtained.		Biological:- Zooplankton - Dr. Lewis Phytoplankton - Dr. Taylor Heavy metals - Dr. Fletcher
4. Rupert Inlet Drainage Sampling	By monitoring inflowing streams, determine physical and chemical properties of natural drainage flows.	Utah under direction of U.B.C.	Quarterly, commencing March '71	Determine properties of natural Rupert Inlet drainage inflow, specifically natural heavy metal contents.	Flow rates:- Dr. Quick (Civil) Geochemical:- Dr. Fletcher
5. Effluent	a) By monitoring tailing line, determine rate and nature of mine effluent discharging into Rupert Inlet. b) By analysis of retrievable tailing samples, determine oxidation rate of in situ particulate tailing in Rupert Inlet.	Utah under direction of U.B.C.	a) Tailing line, daily, once production commences. b) Retrievable samples, initially twice yearly, once production is achieved.	Determine nature of mine effluent and monitor heavy metal and flotation reagent distributions and rate of dispersion.	Tailing rate & composition:- Mr. Evans (Mineral Eng.) Retrievable samples:- Dr. Leja (Mineral Eng.) Dr. Poling (Mineral Eng.)
6. Quarterly Report	Collation of above data and preparation of report.	U.B.C.	Quarterly	Fulfill requirement	Mr. Evans (Mineral Eng.)

Source: University of British Columbia, 1974.

1 Subsequently two biologists were added: Dr. D. Ellis, a benthic ecologist from the University of Victoria (1972 on); and Dr. R. Foreman, a nearshore marine ecologist from U.B.C. (1974).

2. Provide expertise to government agencies when they did not have it.
3. Provide company with expertise not available through consultants.
4. Create opportunities for university faculty to develop research and obtain practical experience.
5. Provide opportunities to train graduate students through thesis research.
6. Generated data and analyses from a different viewpoint.
7. Became more efficient over time.

Weaknesses

1. Lack of incentive for faculty participation.
2. Poor communication between disciplines.
3. Lack of challenging across fields of expertise.
4. Unclear whether members were consultants or independent reviewers.
5. Failure to communicate with others interested in the subject.

The UBC Independent Agency was an innovative experiment in bringing together people with expertise relevant to IAMM. It has been instrumental in the development of knowledge about the practice and consequences of marine tailings disposal that has subsequently been of value not only to the development of the Amax mine but also to mines in other countries. In retrospect the difficulties encountered during the earlier years in both conducting transdisciplinary science and meeting diverse expectations should not have been surprising for such a novel venture. In more recent years the Technical Advisory Committee has met regularly with mine staff to discuss current scientific developments, to review the monitoring program and its results, and to advise them on specific issues. The TAC has had greater success in achieving agreement amongst its members. This reflects the skill and expertise of those involved in both defining and resolving issues and practicing transdisciplinary science; these improvements stem from the participants' experience not only with this case but also in other IAMM situations. It also reflects the movement of some issues in the direction of the more "routine" end of the spectrum. However, the TAC still does not have direct contact with regulatory agency staff nor other interests.

Waldichuk and Buchanan Review

The Waldichuk and Buchanan Review was jointly initiated by the federal and provincial governments in 1978 and reported out in 1980. The questions to be addressed were typical of those that arise in IAMM. Its terms of reference were to determine "the facts with respect to: (a) the disposal pattern of tailings from Utah Mines in Rupert Inlet; and (b) the environmental change which is taking place, and its significance" (Qaldichuk and Buchanan, 1980, p.1). The implicit purpose was to resolve differences, primarily between scientists in governmental agencies and the UBC Independent Agency, over the consequences of tailings disposal in Rupert Inlet. As indicated by the terms of reference this purpose was not explicit nor was it assumed by the two reviewers. The assertion that the "implicit purpose" was to resolve conflicts is based on our perception of the events and expectations as revealed by the file records, media coverage and interviews with interested parties.

Dr. Michael Waldichuk is a chemical oceanographer in the federal Department of Fisheries and Oceans with over twenty years experience in water pollution issues not only in coastal British Columbia but also internationally. Dr. R.J. Buchanan is a senior oceanographer in the provincial Ministry of the Environment. Neither had previously had any significant involvement in the case. Over a period of two and a half years they reviewed reports produced since the beginning of the Utah project; conducted 42 face-to-face and 38 telephone interviews with scientists and others with interest in or expertise relevant to the issues; visited the mine and observed the monitoring program being carried out; and produced a report summarizing their conclusions about the consequences of mine tailings disposal into the inlet, the merits of alternative mitigation measures, improvements in the monitoring program, and further research that should be undertaken.

<u>Strengths</u>

1. Reviewed and reported on a diverse body of data, analyses and opinion.
2. Discussed the issues and information with individuals involved and with others who had relevant expertise.
3. Presented the facts as perceived by two previously uninvolved scientists.
4. Proposed changes in impact monitoring and management, and priorities for research.
5. Published a report.

<u>Weaknesses</u>

1. Were unable to interview some key interests who declined to participate.
2. Terms of reference were poorly defined for the implicit task.

3. Did not conduct roundtable discussions.
4. Took two and a half years to report.
5. Conclusions and recommendations were not clearly supported by reasoning and/or references.
6. Interviewees were not given an opportunity to review a draft of the report.

The Waldichuk and Buchanan review was the first attempt to produce a public resolution of the breadth of issues raised by the discharge of mine tailings into Rupert Inlet. Previous reports had not been widely available or were the position papers of a single agency. The review however faced a formidable task in determining "the facts" because of the wide differences of opinion to be reconciled. Recognizing this difficulty, the authors elected to adhere strictly to the terms of reference and to write a report that reflected their opinion on the facts, as opposed to explicitly pointing out the areas of agreement and the disagreement between various groups along with how these differences might be resolved. It is therefore not surprising that while the two reviewers resolved the issues to their satisfaction, many other reviewers of their report found reasons to disagree with it. The disagreements were accentuated by the lack of argumentation and referencing of the basis for the conclusions reached by the authors. The experience with this review clearly demonstrates that authoritative resolution of scientific controversy is not possible when the issues fall in the realms of "difficult" and "impossible" issues. Further, it shows that while face-to-face discussions are essential for "difficult" and "impossible" issues, they will not necessarily resolve disagreements unless they are conducted with the explicit purpose of reaching agreement on the definition of issues and the ways to resolve them. Where this is required it is essential that the terms of reference explicitly state this mandate and that those involved not only be able to bring technical expertise to bear but also the interaction skills that are essential to success.

McInerney Panel

The McInerney Panel was established by the federal Minister of Fisheries and Oceans in February, 1981 and has been intermittently active ever since. Like the Waldichuk and Buchanan Review, it addressed questions typical of those that arise in IAMM. It resulted from extended controversy, particularly between the Nishga and the federal government, over the proposed disposal of tailings from the Amax mine into Alice Arm. Its terms of reference were to assess the adequacy of the proposed regulations, mitigation measures, and monitoring program, and to recommend changes in these, as well as further research. The Panel consisted of three university scientists: Dr. J.E. McInerney (Chairman), a University of Victoria biologist with wide experience in pollution issues, including an appointment as Chairman of the B.C. Pollution Control Board; Dr. R.W. Burling, a UBC specialist in physical oceanography with some knowledge of marine tailings disposal; and Dr. W.K. Oldham, a civil engineer at UBC, with extensive experience in the development of pollution control technology, including an appointment to the provincial pesticide inquiry, but no previous experience with marine disposal of mine tailings. After reviewing the available information, interviews and roundtable discussions were conducted with scientists involved and public meetings were held in Prince Rupert and Vancouver. An interim report was provided to the Minister within one month of the Panel beginning work and the mine starting operations. Three months later the full report was submitted (Burling et al, 1981).

In October, 1981, the Minister decided to retain the Panel in a continuing advisory role to review the results of monitoring and research. As a result the Panel submitted an interim report in August, 1982, followed by a major report in July, 1983 (Burling et al, 1983). The Panel has not reported since then and the mine has been closed down because of poor markets since October, 1982, although the monitoring and research have continued.

Strengths

1. Analysed the available data and discussed interpretations of it with scientists who had produced or assessed it.
2. Panel members constructively challenged each other's analyses.
3. Actively kept interested parties informed and sought their involvement.
4. Conducted public hearings.
5. Published fully documented reports.
6. Explicitly audited earlier conclusions and recommendations.
7. Highly cost-effective operations.

Weaknesses

1. Terms of reference required significant value judgements to be made.
2. There was no process for addressing the social issues.
3. There were no specific provisions for resolving differences.

4. Technical issues discussed in hearings often could not have been understood by lay audiences.
5. The report only implicitly analysed one of the key terms of reference...the fisheries impact.

The McInerney Panel has been successful and cost-effective in fostering agreement among many interests, with the notable exception of the Nishga. In part this success stems from the general increase in understanding of how to conduct such processes but also, in large part, it reflects the experience and skills of the Panel members. In conducting face-to-face discussions both in roundtable meetings and in public hearings, the Panel was able to strike a balance in exploiting the advantages of informality and formality to define opinions on the issues, identify areas of agreement, and propose appropriate studies to address residual disagreements. While their reports, like Waldichuk and Buchanan's, primarily stated their own opinions, they have received much greater acceptance. In part this is because they reflect the consensus that they were able to identify and, in part, because their conclusions were convincingly argued and supported by references. Their continuing existence has enabled them to move some issues towards the "routine" end of the spectrum. They have not however been able to resolve the value differences that currently make some issues "impossible". While their terms of reference called for them to make value judgements that were in the political realm, this did not, in this case, generate particular difficulties even though some significant judgements were made. However, the lack of an explicit process for resolving the social issues has confounded their apparent success in resolving scientific issues.

Conclusions

From the point of view of the particular questions addressed in this paper there are two major conclusions to be drawn from the case studies of IAMM processes used at the Utah and AMax mines. Firstly, interpersonal and group skills were critical to the cost-effectiveness of each type of process; the desire and ability of individuals to communicate their arguments, to consider those put forward by others, to seek resolution of disagreements, and to take a leadership role in bringing people to an agreement, were all fundamental factors in determining the success of referrals, meetings and special purpose groups. Secondly, the cost-effectiveness of IAMM was critically dependent on issues being routed into an appropriate type of process; again, the interpersonal and group skills of individuals were key in achieving this. Figure 3 summarizes what, in general, are likely to be the roles of referrals, meetings and special purpose groups in cost-effective procedures for dealing with "routine", "difficult" and "impossible" issues. It also illustrates the relative importance of political decision-making procedures being an integral part of these processes.[9] The further issues diverge from the "routine" end of the spectrum, the more the cost-effectiveness of the process will depend on integrated procedures for both technical and political decision making.

Improving Impact Assessment, Monitoring and Management

The results of this case study suggest that the cost-effectiveness of IAMM could be greatly increased by improving the ways people interact in resolving issues and seeking agreement. This implies development of personal and group interaction skills, as well as associated changes in technical skills and in the design of IAMM processes.

Development of Personal and Group Interaction Skills

There is an extensive literature on the importance of an individual's skills in determining the effectiveness of any organization (see Bolman and Deal, 1984). So far, however, there has been relatively little application of the principles and techniques developed in this literature to IAMM. The notable exception is the growing experience with environmental dispute resolution (Shrybman, 1983; Bingham, 1985). Based on the results of this case study, three skills are of critical importance:

1. Communicating effectively: Principles and techniques for effective communication are generally well developed (see Stanton, 1982; Arnold et al, 1983). The primary requirement in this context is to develop an appreciation among the participants of first, its importance, and second, how to do it. Major improvements would have resulted in IAMM at Utah and Amax if oral and written communications had been more effective in reaching all the relevant interests, in a timely fashion and in a form that ensured the message was faithfully received.
2. Challenging constructively: The best understanding of both the scientific and social issues will result from the participants challenging the arguments that each puts forward. Mason and Mitroff (1981) develop the argument for this and suggest principles and techniques for doing it that are particularly

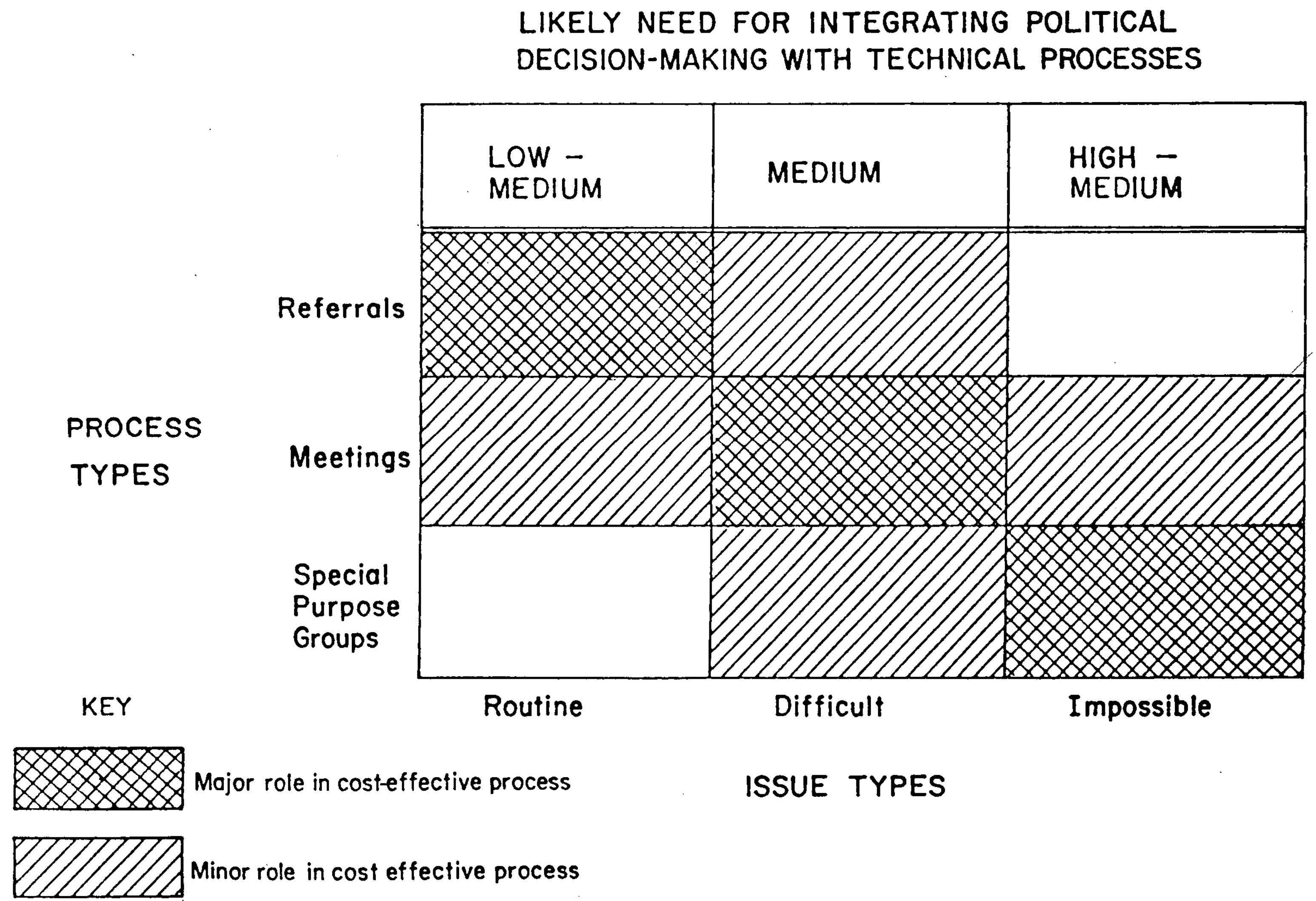


FIGURE 3 MATCHING TYPES OF PROCESSES TO TYPES OF ISSUES

appropriate to IAMM. For the process to be productive it is essential that it be approached in a constructive manner. This means that the goal should be one of furthering the understanding of all parties as opposed to merely seeking to destroy the arguments of others. The case studies revealed not only the high costs and ineffectiveness of failing to challenge and of negative adversarial relations, which often predominated for extended periods, but also the remarkable effectiveness of participants who did challenge constructively.

3. Bargaining successfully: Participants bring competing interests to the resolution of both scientific and social issues, and it will not always be possible to resolve these without some trade-offs. Being able to bargain successfully is therefore an essential skill for all participants in IAMM. Fisher and Ury (1981) analyse the pervasive need for bargaining skills and a set of basic principles that could be employed by any individual. The successful bargainer is one who finds opportunities for maximizing the parties' joint gains, wherever possible, and who reaches agreements that endure. Bargaining was evident throughout the two cases as attempts were made to resolve scientific and social issues but very few participants explicitly recognized this. Frequently the bargaining broke down, many opportunities for joint gains appeared to be missed, and agreements often did not endure. In the instances where bargaining was successful, which often seemed to be a consequence of just one of the participants being adept at bargaining, the increased cost-effectiveness of IAMM was clearly evident.

Implications for Technical Skills

The cases show the novel demands placed on scientific expertise in IAMM if issues are to be resolved and agreements reached. In particular IAMM calls for judgements about existing knowledge and development of new knowledge, in ways and time periods that require technical skills that are at present scarce and poorly developed. Thus, besides improving participants' interpersonal skills, it is essential to increase the number of people with appropriate technical skills.[10] Success in defining issues and reaching agreements depends critically on the participants generating appropriate information. This implies developing three types of skills:

1. Putting theory into practice: Participants in IAMM have to be adept at integrating both social and scientific theory with practice (see Schon, 1982). The case studies revealed that on numerous occasions high costs and ineffec-

tiveness could result from participants not explicitly considering theory in designing their practice or failing to apply existing theory or being unnecessarily concerned with theoretical niceties. In constrast, on other occasions, individuals demonstrated the remarkable effectiveness of the practitioner who can reflect on his or her experience so as to derive appropriate theory. It is significant that on occasion such individuals did not have formal qualifications in the field of application and would as a result frequently be under-appreciated by other participants when formal action was required even though their expertise was valued in the more informal processes.

2. Practicing transdisciplinary science: All IAMM requires the interpretation of several sciences in defining and resolving issues. Integration of natural and social science disciplines is always required and in complex cases, like those considered here, there will be a variety of disciplines within these. Several of the participants in the cases have developed an ability to practice transdisciplinary science, that is, they not only bring their own expertise to IAMM processes but also have developed a knowledge of other relevant disciplines and actively seek to expand their understanding of them.[11] Their contribution to improving the cost-effectiveness of IAMM is clearly evident; for example in the resolution of issues through constructive challenging of other participants' arguments. The conspicuous weakness is in the continuing scarcity of individuals with transdisciplinary skills that integrate the natural and social sciences.

3. Exercising judgement: The constraints and limitations in understanding make it essential that participants be skilled in exercising judgement. They must understand both the need for such judgement and, at the same time, the responsibilities this imposes. Without the judgements of those who are best informed to make them, valuable information will be lost in both defining and resolving issues. The unwillingness of participants to exercise judgement frustrated agreement on both occasions. However, when any judgement is made it is imperative that this be explicit in terms of the assumptions and arguments upon which it is based. Without this evidence, it is impossible for other participants to be aware that judgement has been exercised and to give an informed reaction to its factual and value content. In addition, awareness of judgements is crucial to participants recognizing where political decision-making processes must be integrated with the technical processes. The

neglect of the latter has been the most serious continuing weakness in the two cases; it has bedeviled the resolution of issues at all levels and, in particular, has generated public controversy that overshadows the substantial improvements in IAMM. The major challenge is to design policy frameworks that facilitate judgements and cost-effective mechanisms for accounting for them which are appropriate to the magnitude of the factual and value judgements involved.

Implications for Process Design

As a result of experience worldwide, models of IAMM have been greatly refined since the beginnings of the first case study in 1968 (Munro, this volume). It was in fact the introduction of the National Environmental Policy Act in the United States in 1969 that stimulated the development of IAMM in North America and to a large extent elsewhere. Since then the focus of impact assessment has broadened from the initially narrow concerns with physical-chemical-biological consequences to embrace the socio-economic and institutional changes as well. Progressively it has been recognized that impact management should be designed as an ongoing process. One reason is that some projects, like the mining projects examined here, clearly have an extended life and raise different impact management issues at various stages of their development (Figure 1). A second reason has been the growing appreciation that many management decisions cannot be made in advance of project development or that they are likely to be better informed decisions if postponed until the specific character of the consequences becomes evident. These experiences have led more recently to the recognition that IAMM needs both a policy context and more refined processes.

The need for a policy context for particular projects has been the impetus to the emerging attempts to develop strategic planning for resource regions and sectors. The refinement of IAMM processes has included the addition of screening mechanisms to route projects into appropriate IAMM processes; scoping procedures to determine the nature of the most important scientific and social issues raised by the proposed project, along with the best steps for resolving them; and monitoring procedures for meeting diverse needs including initial assessment, baseline data, determination of effects (one aspect of follow-up), compliance with regulations (one type of audit) and research. Thus, based on the literature today, a model of IAMM would likely include all these refinements in some way (Figure 4; see also Whitney

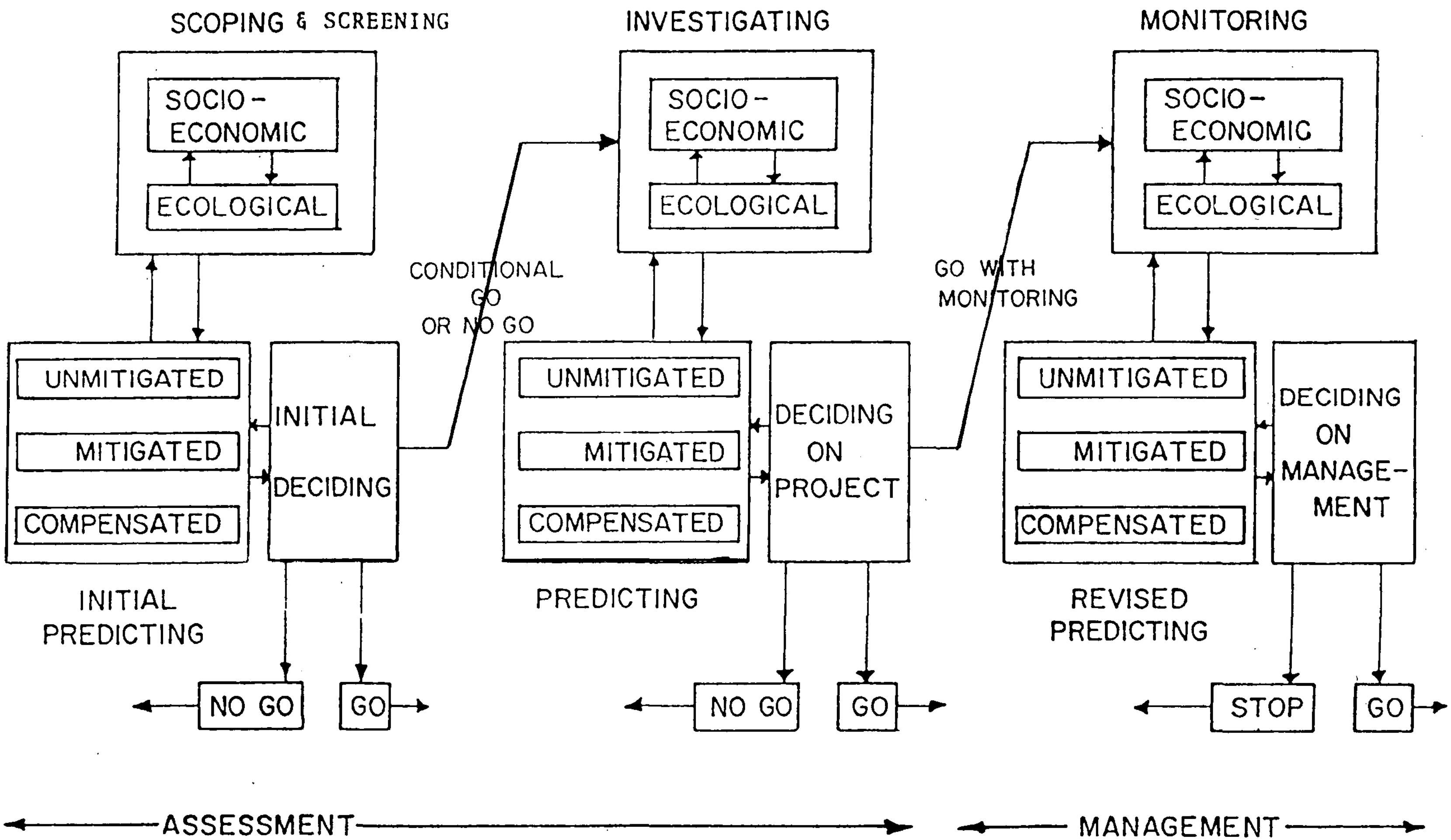
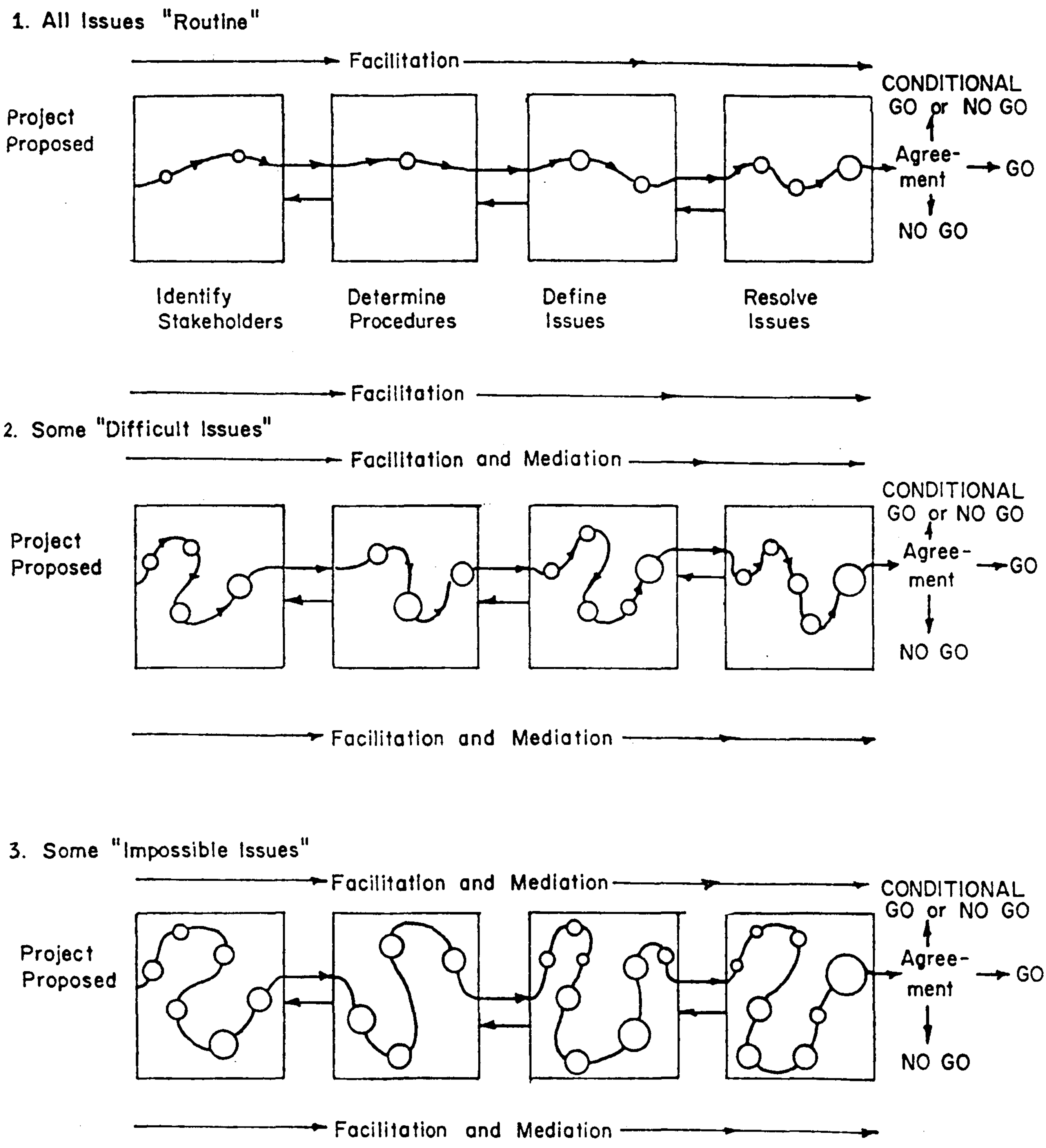


FIGURE 4 THE IAMM MODEL

and MacLaren, 1985). The procedures now in place for reviewing new mine developments in British Columbia in principle include many of these elements, although strategic planning has not yet progressed far in generating the essential policy context (Cornford et al, 1985). However, the results of the case studies of Utah and Amax have important implications for specific aspects of the design of IAMM processes if they are to be effective and not unnecessarily costly in resolving issues and reaching agreements.

Three aspects of the design are critical:

1. Structuring the process: An entirely new perspective on the structure of the process is generated if, as argued in this paper, the objective of IAMM is to define issues and reach agreement on their resolution. It implies that attention should focus on how best to bring together the appropriate expertise and relevant interests in each of the components of IAMM. The merits of alternative configurations of these people need to be tested. Drawing on the above suggestions for improving both interpersonal and technical skills, the new kinds of alternatives that should be evaluated can be suggested. Using the example of scoping and screening, Figure 5 illustrates what this might involve. Comparable examples could be developed for each of the components of IAMM shown in Figure 4, and in particular for the various types of follow-up and audit that might be employed. The objective of the process would be to reach agreement on the scientific and social issues, and their resolution. In doing this, the extent to which the issues are "routine", "difficult", or "impossible" would be determined. For issues which could not be resolved immediately, agreement would be sought on how they might be resolved (e.g., an agreement on the design and conduct of a particular study and/or reference to a specific decision-making process, which could involve an explicit political decision). These agreements would be documented and submitted to the organization responsible for the overall conduct of IAMM. From this perspective the responsible organization needs to excel in facilitating the participation of the relevant interests and appropriate expertise, as well as mediating between them where necessary to assist in reaching agreements. Thus, as shown in the figure, the process would proceed through identification of the stakeholders who should be represented, agreement on the procedures to be followed in scoping and screening, identification of the issues, building consensus on the



NOTE: Sizes of circles indicate the relative magnitude of people involved

FIGURE 5 THE PROCESS DESIGN: SCOPING AND SCREENING issues and ways to resolve residual disagreements, and drafting of an agreement. Experiments should focus on the costs and relative effectiveness of the ways in which people are brought together to do this in scoping and screening, as well as the other components of IAMM, each of which would have its own design requirements. Based on the results of the case study and the literature cited above, it seems likely that each of these would involve much more use of relatively small groups, sometimes bringing together subsets of the interests and/or relevant experts, meeting in carefully orchestrated sequences and several times when necessary, which is more likely for resolving "difficult" and "impossible" issues. Given the large amounts of money being spent already, as indicated below, and the causes of ineffectiveness identified in these case studies, it is reasonable to expect such processes would be more efficient. Susskind and McCreary (1985) describe four examples of successful dispute resolution in U.S. coastal resource management, which have many of the characteristics of the approach being suggested here even though they are not analysed as IAMM processes per se.

2. Financing IAMM. To date the financing of IAMM in Canada has grown in an ad hoc manner. Except for vociferous debates over the need for intervenor funding little attention has been given to how much should be spent, by whom, and to do what. If the cost-effectiveness of IAMM is to be improved then procedures must be developed for giving explicit attention to this. The case studies reveal that very large amounts of money can be involved, but also that while some aspects may be overfunded others may be neglected. Although we have not made specific estimates of the costs incurred, it is evident that the companies have frequently spent between one half and one million dollars a year for monitoring and assessment studies. To this must be added federal and provincial agency costs for monitoring and assessment studies, which have fluctuated in intensity and on occasion have reached the same orders of magnitude. While the companies have been generally concerned to avoid escalation of their monitoring and assessment costs, they have usually expanded their programs as requested; after initial buildup of the program this has usually involved some winding down of one area to expand into another. Both companies have also initiated monitoring and studies over and above those requested by regulatory agencies. Perhaps the greatest difficulties have been encountered in regulatory personnel being able to influence the priorities

of governmental research agencies and in the timely securing of funding to support such research. Financing and the setting of priorities should therefore become an explicit element in the agreements to be negotiated, and evaluation of alternative approaches should be incorporated into the experimentation recommended above for the structuring of IAMM.

3. Creating incentives. Building the incentives for all participants to seek agreement is essential to improving the cost-effectiveness of IAMM. A basic change would be to require agreements to be reached; this would be in sharp contrast to the present system that often tends only to encourage criticism. The nature of the agreements required would likely vary between the components of IAMM.[12] In designing each, attention needs to be given not only to all of the above considerations but also to the incentives required to make them work. Thus, for example, to encourage government and university researchers to develop methods and knowledge appropriate to IAMM, it will be necessary to change the evaluation criteria and rewards of their institutions; the increasing emphasis on primary journal publication as the measure of performance is further increasing the disincentives to contribute to the development of IAMM. Or, to induce governmental personnel to seek agreement it will be necessary to give them policy frameworks and explicit mandates that both give them the confidence to explore possible agreements and at the same time delimit their ability to make commitments; without these provisions governmental personnel often tend to be reluctant to explore possibilities and other participants are uncertain about negotiating agreements that might have no legitimacy. In experimenting with different approaches to IAMM, the effect to creating new incentives can be evaluated.

This paper has focussed on the importance of participants' skills in determining the cost-effectiveness of IAMM. It has suggested a new perspective on the pursuit of excellence that emphasizes the changes required to improve the resolution of social and scientific issues and success in reaching agreements. This has revealed the primary task of the governmental agency responsible for IAMM to be one of facilitation of the process and mediation between the competing interests; a task which is ongoing throughout the life of impact management. The recommendations lead to suggestions for action in two areas. First, in training professionals to undertake IAMM specific attention should be given to the development of their interpersonal and group skills. This should be built into post-secondary education and the organizational development programs for both private and public sector organizations. Secondly, by drawing on available literature and further evaluating experience with the factors determining success in reaching agreement in other cases across Canada, a program to evaluate specific innovations in the design and conduct of IAMM can readily be implemented. Such a strategy would implement the ongoing follow-up and selective auditing that should be an integral part of any national IAMM strategy.

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FOOTNOTES

1. During the seventeen years spanned by the two cases the correspondence files of government agencies and companies have become voluminous and many study reports have been published. Our selective assemblage of these materials alone occupied four file drawers. The approach taken in the study was (i) to review these materials, (ii) to identify the issues, the people involved and the chronology of events, (iii) design interview schedules for major participants, (iv) conduct 3-4 hour structured discussions with 33 selected participants, (v) circulate a draft report and then a draft of this paper for review by all interviewees, other selected participants, and other IAMM researchers. For details of the research design, the literature upon which it is based, the methodologies employed and the bibliography of materials relating to the two case studies, see Dorcey and Martin (1986).

2. The Island Copper Mine processes about 40,000 tonnes of ore and 100,000 of waste rock per day, and the Kitsault Mine was designed to process 11,000 tonnes of ore. Besides these differences in the two operations there are important differences in the procedures for disposal of waste rock. While the two cases were selected because they both involved mine tailings disposal into coastal inlets, there were important differences between them.

3. Diagenesis is a general term pertaining to the overall chemical changes that occur in the sediment column. Two aspects of these phenomena of particular interest to those studying marine tailings disposal are the decomposition of organic material contained in the sediment and the related releases of metals from sediments over long time periods.

4. This plume was never very obvious (it was barely visible to the naked eye) and as a result of improvements to the milling process it has significantly dissipated.

5. This implies the disagreements can be resolved through investigation and, if necessary, subsequent bargaining; irresolvable differences in value judgements put the issue into the "impossible" class.

6. While it may be impossible to separate completely facts and values, much can be done in particular IAMM contexts to usefully understand them separately and their interrelationships (Dorcey and Thompson, 1983; Martin, 1985).

7. Other special purpose groups that were used included the Regional Screening and Coordinating Committee established for the assessment of the Amax proposal, the Pollution Control Branch (PCB) hearing for the Utah proposal, and the hearings conducted by the McInerney Panel. Although small and short in duration, the two sets of hearings are examples of the inquiry processes that have become common in more recent years for projects that raise "difficult" and "impossible" issues.

8. In the book the prevalence of strengths and weaknesses is considered. The summary statements presented here indicate strengths and weaknesses that existed at least part of the time. Thus neither the identified strengths nor

weaknesses were present on all occasions. It is for this reason that the stated strengths and weaknesses may sometimes appear contradictory.

9. Political decision-making procedures are required wherever value judgements are being made. When these are made by people other than politicians then there should be an explicit policy framework and accountability mechanism.

10. Here the term "appropriate" has the same sense as in "appropriate technology" or "intermediate technology". As in the economic development literature from which it is taken, the term implies that expensive and highly refined technologies are often not what would be most useful; rather low cost and simple technologies may be more beneficial at the present stage of development. Although this will not always be the case, there is an analogous need in IAMM to give greater emphasis to the development of the knowledge, methodologies and associated technical skills that meet the pragmatic needs of management and not just the special interests of the disciplinary expert.

11. The concept of transdisciplinary (in contrast to disciplinary, multidisciplinary, pluridisciplinary, crossdisciplinary and interdisciplinary) science has been developed by Jantsch (1971).

12. For an example of how this approach might be implemented by the utilization of contracts instead of permits for pollution control see Barton et al (1984).

WORKSHOP SUMMARY

George Greene
James W. MacLaren
Barry Sadler

Introduction

Workshop sessions from an important part of the proceedings of the International Conference on Audit and Evaluation in Environmental Assessment and Management. The objective was to review the results of papers presented at Banff in order to develop recommendations on effective policies and practices of follow-up. Four themes were selected for discussion. These dealt with:

- impact prediction,
- monitoring and mitigation,
- management procedures, and
- public involvement.

Each of the workshop streams ran concurrently, and they were organized on the basis of small groups of between five and ten participants. All of the groups addressed two basic questions with reference to their respective themes:

- how can audit evaluation and related follow-up activities be used to improve the capabilities of environmental assessment and management processes and practices?
- what are the requirements for effective environmental audit and evaluation?

In addition, a checklist of questions specific to each of the workshop themes was sent out by J.W. MacLaren, the Conference Chairman. For the record, this is outlined in Table 1.

A consolidated set of recommendations and guidelines for their implementation is outlined in this section. It represents a distillation of the more detailed reports submitted by theme chairmen, small group facilitators and rapporteurs (Appendix I). Because there was a degree of overlap, several recommendations represent a synthesis of discussions held in two or more working groups. In some cases, recommendations made by working groups addressing one theme are presented under another theme, more appropriate to the intent of the recommendation.

TABLE 1 QUESTIONS FOR WORKSHOP REVIEW

Theme I - Impact Prediction

1. Are the baseline data adequate?
2. Are the major impacts properly anticipated and are their predictions measurable? Are any missed?
3. Are cumulative impacts foreseen and measured?
4. Does the EIA procedure benefit from past experience?
5. Does EIA serve to minimize environmental degradation?
   (a) Does it provide the basis for the modification of the initial project to meet environmental requirements?
   (b) Does its benefits, both quantifiable and non-quantifiable, outweigh its costs?

Theme II - Mitigation and Monitoring

1. How do mitigation and monitoring techniques proposed actually relate to those employed?
2. Can impacts be separately measured and cumulative effects monitored?
3. Are mitigating and monitoring techniques built on past experience?
4. Do mitigation procedures usually relieve the adverse effects and if not how can they be improved?
5. How have mitigation and/or monitoring and surveillance changed over time in the light of new technical knowledge and changing social perceptions on environmental issues?

Theme III - Public Involvement

1. What are the mechanisms and effectiveness of public involvement and how can they be improved?
2. Are the public informed of the mitigating and monitoring activities and do these processes respond to their concerns?
3. Are problems arising through faulty predictions or unanticipated impacts referred to the public and if so how?
4. What opportunities are there for making technical change to protect social values?
5. What have been the actual costs of public involvement against the project benefits created?

Theme IV - Management Procedures

1. Does project management effectively respond to the requirements of the EIA under the development and operation of the project and what management techniques are employed to effectively translate these requirements?
2. Who is responsible for ensuring this response?
3. Are pre-development impacts frequently invalidated by construction and operational changes?
4. Can project management properly enforce complex ecological protection requirements?
5. How do practitioners, managers and politicians interact in EIA requirements and how might we better increase the effectiveness among these groups?

Why Undertake Environmental Evaluation?

Ex-post evaluation changes environmental assessment from a linear process to an interactive one, in which all participants can learn from experience. There are two fundamental reasons for doing environmental appraisal. The first is to provide a mechanism for establishing continuity between project implementation and the environmental assessment and review process. The second is to ensure the feedback of experience from one project to the next.

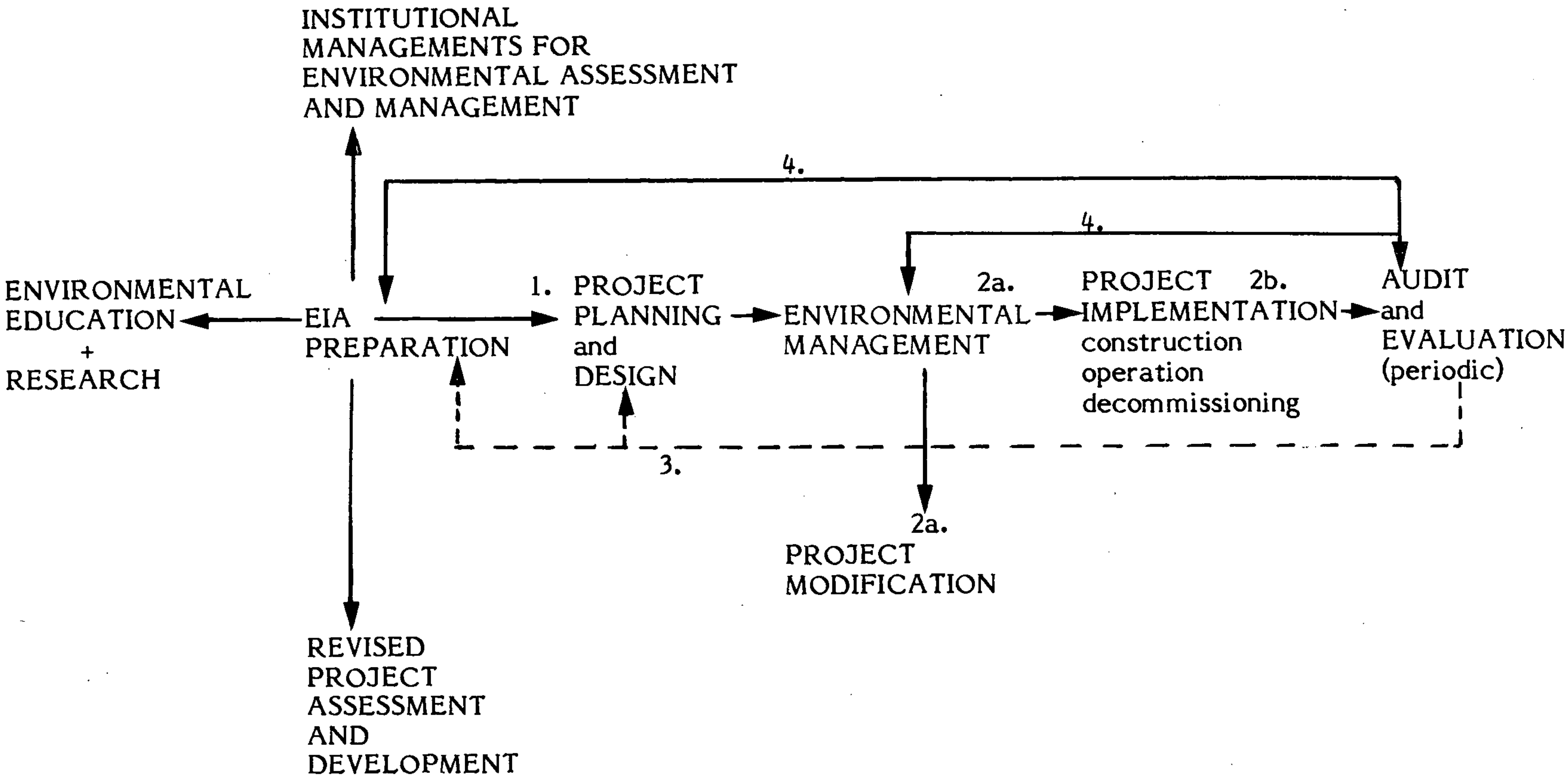
Figure 1 shows evaluation as an integral part of project planning and environmental impact assessment, with results fed back into improvements in both processes. Environmental evaluation makes good management sense. It provides industry and government with the information necessary to make wise decisions in project planning and execution. Evaluation provides information, through feedback mechanisms, to improve impact prediction and assessment capability, and to make environmental assessment and review processes more efficient and effective.

Evaluation and audit can improve environmental management practice by:

- systematically alerting managers to the consequences of project actions, as the occur, and identifying appropriate corrective action during construction, operation and decommissioning;
- identifying and correcting unanticipated impacts;
- making allocation of resources to environmental management activities more appropriate and efficient;
- providing information to allow realistic requirements for monitoring to be set by regulators and allowing resources to be directed from EIA into mitigation and monitoring;
- maintaining proponent accountability for actions taken and determining the degree to which commitments made in EIAs are being met; and
- refining project design, based on appraisal results from previous projects, thereby improving environmental management decisions.

Evaluation and audit can improve EIA processes and practices by:

- reducing time and resource commitments to EIA and the overall regulatory process by allowing all stakeholders to learn from past experience;
- refining predictive capability and assessment methods for use in future EIAs;



Workshop Themes:

1. predictive capability
2a. mitigation
2b. monitoring - compliance
- effects
3. public involvement
4. management procedures

FIGURE 1 THE ROLE OF EVALUATION IN ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

- enhancing the quality of project assessments, thereby leading to environmentally sound projects;
- increasing the effectiveness of the contribution of public involvement to EIAs;
- enhancing credibility or proponents, regulatory agencies, and EIA processes;
- separating impacts of one project from others;
- identifying deficiencies in data and knowledge; and
- developing a data base for future impact assessments to drawn on.

On Definitions

Several terms are used, sometimes interchangeably and seldom consistently, to refer to follow-up studies in EIA. These include: monitoring audit, performance audit, comprehensive audit, environmental appraisal, environmental evaluation. Workshop participants were in general agreement that there is a need for a clear and shared terminology to be used consistently by environmental professionals and that the term "audit" needs to be replaced.

Recommendation 1: Common Terminology

A glossary of terms should be developed by an international body such as the International Association for Impact Assessment (IAIA) or by national bodies such as the Canadian Environmental Assessment Research Council (CEARC). National regulatory or review agencies should clarify their own set of terms. The following discussion of follow-up activities may be helpful in this regard.

"Audit" means a search or verification of records and carries with it a financial accounting connotation. The term "environmental audit", in the narrow sense, involves verification of compliance and collation of monitoring results. In this respect, audit is a part of the more complete function of environmental evaluation or appraisal.

"Environmental evaluation" (or appraisal) incorporates the necessary concepts of interpretation of results and judgement of the value of activities. It has connotations associated with program evaluation, which may concern some environmental practitioners and proponent managers. The term may also be confused with the evaluative component of impact prediction. Ex-post evaluation is thus a more precise term for concepts related to interpretation and testing the value of results or Environmental Assessment and Management processes.

A working definition of environmental evaluation, drawn from the discussions of working groups, reads as follows:

> Environmental evaluation is the examination and interpretation of procedures carried out in project development and of results produced in satisfying environmental objectives and responsibilities. It is undertaken for the purpose of increasing the effectiveness of EIA procedures and environmental management practice. The process incorporates compliance and effects monitoring and auditing.

Selection of Methodologies and Projects for Environmental Evaluation

Papers presented at the conference provided a variety of approaches to the conduct of environmental evaluation, including: interview of key project participants; review of project correspondence; review of project assessment and monitoring reports; and direct measurement of environmental parameters. However, no standard methodologies were evident. Neither did the discussions workshop provide a coherent and consistent set of methods for the conduct of evaluation. While establishment of formal "standards of practice" may not be desirable nor possible, there is a need for practitioners to develop and adopt common, well-defined methodologies for evaluation.

There was general agreement that full environmental evaluation should not be mandatory for all projects which have undergone impact assessment. Rather, this approach should be selectively used for certain projects in order to advance the practice of environmental assessment and impact management. Environmental audits, which are more restricted in scope, could well be conducted by most project proponents, for the purposes of verifying compliance and collating monitoring results.

Criteria for selection of projects for environmental evaluation include:

1. projects with major environmental or social impacts;
2. projects for which there is a considerable degree of uncertainty in the accuracy of impact predictions made or for which there is no clear public policy context;
3. projects where observed impacts deviate from predicted impacts; and
4. projects which offer the greatest possibility for advancement of predictive capability in EIA.

Regardless of regulatory requirements for audit and evaluation, voluntary applications by project operators should be encouraged. The level of detail and comprehensiveness of environmental follow-up will vary, depending on the project circumstances.

Recommendation 2: Demonstration Studies

Several comprehensive demonstration studies should be undertaken to test or determine the capability of audit and evaluation for achieving cost-effective environmental management. The studies should address distinctly different development activities and situations, and should be conducted as joint exercises involving industry, government and the public.

At present there is little documented evidence which demonstrates the utility of evaluation in environmental assessment and management. If demonstration studies show the utility of approach, they should be used to promote voluntary adoption by project operators.

Guidelines for Implementation

1. The pilot studies should focus on impact predictions made, mitigation and monitoring methods and results, public involvement, institutional procedures and evaluation methodology.
2. All case studies should involve real projects which are planned or operational, and which have or will have adequate baseline data, impact predictions and monitoring results.
3. The first pilot study should involve a relatively simple situation, such as evaluation of an existing environmental monitoring program. Subsequent pilot studies could involve all aspects and major industrial projects.
4. One mechanism for implementation is to convince the management of an existing operation to make available relevant records on environmental monitoring and project planning, approvals, construction and operation.
5. Another mechanism is to incorporate the concept and practice of environmental evaluation into a new development agreement for a major industrial or resource extraction project.
6. The Canadian Environmental Assessment Research Council (CEARC) should act as a broker to design the outline for an evaluative pilot study and to find willing project proponents and regulatory and review agencies.
7. Possible sources of funding include Environment Canada, provincial environment and regulatory agencies, including associations, and individual companies, such as provincial and federal crown corporations.

Recommendation 3: Information Availability and Transfer

Mechanisms should be developed to improve the availability of information from environmental evaluations and to promote national and international awareness of and access to results. Each evaluation program should also contain measures to ensure that experience is transferred.

The results of environmental evaluations are seldom reported in the widely-available literature, and usually reside in the "grey literature" of study reports and company and government files. Poor access to these reports and files hinders development of consistency in review documentation and limits the ability of practitioners to learn from experience. All parties involved in environmental assessment and management of projects need to have access to past evaluations in order for the collective experience to be expanded.

Guidelines for Implementation

1. A central clearinghouse or repository of environmental assessment results should be established. It could be established:
   - at the international level by a professional or multilateral organization such as IAIA or UNEP;
   - at the national level by the Federal Environmental Assessment Review Office (FEARO) or under the auspices of the Canadian Council of Resource and Environment Ministers (CCREM); or
   - at the provincial level in the offices of environment ministries.
2. A simpler alternative would be to establish a central referral system, containing computer-accessible listings of document titles and locations.
3. The public must have access to reports listed in these central systems.
4. A requirement for publication of evaluation results could be included in the terms and conditions for project approval.
5. A useful model for such documents is the "as built" reports used in the pipeline industry. These provide information for short-term mitigation of construction impacts, through site restoration, and for improving technical and administrative procedures for future projects.

Impact Prediction

A number of papers presented at the conference showed that many predictions made in EISs are not testable, because they are stated in vague or qualitative form.

Poor predictions result in inadequate design of monitoring programs and mitigation measures, and therefore in poor impact management.

Recommendation 4: Impact Predictions as Testable Hypotheses

Impact predictions should be stated as unambiguous, rigorous, and preferably quantifiable, hypotheses of cause and effect which can be verified or rejected by environmental monitoring and evaluation.

Guidelines for Implementation

1. Impact predictions should be quantified wherever possible and should be based on the level of precision needed for monitoring and appraisal.
2. At the minimum, sound judgement should be used for qualitative predictions, and confidence levels stated for data used to derive predictions. Where the confidence level for predictions is low, more detailed baseline or monitoring studies and conservative design of project elements (application of engineering contingency factors) may be necessary.
3. The rationale and assumptions used to make all predictions in an EIA should be explicitly documented.
4. The probability of occurrence of predicted impacts should be stated in the EIS.
5. Postscript: Accuracy, precision and probability are important scientific concepts, but it is not certain whether they can be applied to impact prediction.

Monitoring and Mitigation

Monitoring and mitigation programs are an important part of environmental evaluation; evaluation is also a means for improving the effectiveness and efficiency of the monitoring and mitigation programs. There is a need to optimize these programs, to make them more effective and to ensure value for money spent.

Recommendation 5: Evaluation of Monitoring and Mitigation Programs

Evaluations of monitoring and mitigation programs should be undertaken in order to make these more adaptable to changing conditions and to make effective use of knowledge gained.

Guidelines for Implementation

1. Two types of evaluation apply to monitoring and mitigation:

- technical appraisals are designed to validate program results and identify necessary changes in project design and execution;
- management appraisals are designed to evaluate the objectives, rationale for and content of monitoring programs in relation to the overall environmental assessment and review process.

2. The objectives and information needs of environmental evaluation must be explicitly considered in the design and conduct of mitigation and monitoring programs.
3. The designs of monitoring programs required by government agencies should be reviewed to ensure that they have clear objectives which are demonstrably related to assessment or reduction of project impacts.
4. Evaluation can be conducted either during or following monitoring or mitigation programs, depending on the objectives of the analysis (during, for technical appraisals; following, for management appraisals).
5. Monitoring programs must be designed on the basis of baseline data collected and the impact predictions made in order to be useful for the conduct of environmental evaluation.
6. Technical appraisals should be the responsibility of the proponent; management appraisals should be the responsibility of government.

Public Involvement

Public consultation has driven many innovations in the procedures and practice of environmental impact assessment, particularly in relation to incorporating social elements into EIA. Evaluation of public participation is a technique for improving the effectiveness of this process in environmental impact assessment, allowing all participants (proponent, regulator, public) to upgrade their skills and knowledge. From a public point of view, such analyses are necessary to establish the credibility of proponent and regulatory agency by demonstrating that issues raised during environmental review have resulted in appropriate terms and conditions being adopted by the proponent or imposed by the regulator.

Recommendation 6: Public Involvement is an Important Part of Environmental Evaluation

Environmental appraisals should incorporate a comprehensive evaluation of public involvement which takes into account the differing interpretations of project effects held by participants in the project review process.

Guidelines for Implementation

1. Each case must be recognized as having unique features because the policy context, project circumstances, individuals involved and objectives of the public involvement process will change from project to project. Experience which is broadly applicable will be slow to build. It will be necessary to conduct a number of evaluations at the outset and to compare their results.
2. A comparison of the different perspectives of the various participants is necessary to determine indicators of success. The goals, interests and roles of the participants are usually disparate.
3. The main methodology for evaluating public involvement in environmental assessment is in-depth interviews with the key participants to extract their views on the process.
4. Existing techniques and expertise from the field of "evaluation research", which is applied to social programs, may prove useful for improving analysis of public involvement in environmental assessment.
5. The public input to environmental assessment reviews often provides specific and precise suggestions for mitigation and other measures; however, review panels and regulatory agencies tend to generalize these in the conditions imposed upon projects. Environmental appraisals must go back to the record of these interventions to determine whether the public involvement has been effective.

Recommendation 7: Socio-Economic Monitoring to Support Evaluation of Public Involvement

Socio-economic monitoring should be conducted to provide necessary data and analyses in support of environmental appraisals and evaluations of public participation programs.

Evaluations are usually done months or years after the fact. Participants forget facts; impressions and subsequent events may colour or change their perceptions. Regular monitoring of changes in perceptions and behaviour over time provides a continuing record in aid of environmental evaluation.

Guidelines for Implementation

1. A socio-economic monitoring program, designed to monitor public involvement, is successful if a number of conditions are met:

a. the publics involved are representative;
b. public involvement is sustained throughout the life of the monitoring program;
c. the publics are involved in the design of the monitoring program; and
d. the issues that are being monitored include those which are relevant to the publics and remain so over time, accommodating desirable changes.

2. The steps and characteristics necessary to achieve these conditions are:
   a. preparation of social profiles to characterize the community and the actors;
   b. hiring an independent broker or intermediary who is or can become knowledgeable about the community and gain the trust of the public;
   c. provision of front-end funding for public involvement in monitoring, through an independent body;
   d. continuity in the position of public involvement coordinator;
   e. flexibility in the monitoring program to accommodate community changes unrelated to the project; and
   f. updating mitigation measures as necessary.

Management Procedures

Under most jurisdictions, the environmental assessment process dies following formal review. There is little formal continuity between environmental assessment and impact management of a project, and between present and future reviews.

Recommendation 8: Establish Feedback Mechanisms

Establish explicit feedback mechanisms linking ex-post evaluation with the environmental assessment process (baseline studies, impact prediction, institutional procedures) and with project planning and execution (design, environmental management).

Guidelines for Implementation

1. Institutional analyses of the project approval process in several Canadian and other jurisdictions should be conducted to identify and recommend appropriate feedback mechanisms. These analyses should include environmental assessment and review, licensing or permit formulation, and surveillance and monitoring procedures.

2. When designing environmental evaluations, explicit responsibilities should be assigned to all participants involved: proponent and operator, review agency and regulator, directly affected and other publics.
3. Linkage should be established among ecological, social, economic and risk assessments conducted for new projects.
4. The regulatory agency and proponent must assign sufficient resources to allow environmental appraisal results to be fed back.

Recommendation 9: Integrate Evaluation into Existing Process

Environmental evaluation should be integrated into existing environmental assessment and review processes. The lead regulatory agency should issue terms of reference for this activity as part of project approval, following the environmental assessment review. All stakeholders should participate in determining the need for and recommending terms of reference for environmental evaluation prior to project construction. This creates the necessary commitment by key participants to ensure follow-up activities are conducted, and helps ensure that appraisal results will meet each interest's needs.

Industry and government alike are wary of creating new legislation for formal adoption of environmental evaluation. On the other hand, some form of institutional structure is necessary to encourage, or in some cases to require, appraisals to be conducted. Integration of environmental appraisal into existing institutional structures provides a reasonable solution to this dichotomy. It will be more effective than *ad hoc* follow-up responses to environmental assessment but at the same time will dispel fears about creation of new agencies and regulatory processes.

Guidelines for Implementation

1. Institutional arrangements and administrative procedures will take different forms in different jurisdictions. Alternative structures for ensuring fair, equitable and effective appraisals comprise:
   a) an independent agency, with resources to conduct evaluation directly or through consultants; or
   b) multilateral stakeholders' committee which sets requirements for and reviews results of evaluation, under the auspices of a lead regulatory agency. Stakeholders may include proponent, regulatory and review agencies, community groups, special interest groups, municipalities and

other affected industries. A government agency or consultant is contracted to do the study.

2. Evaluation should be incorporated into corporate environmental protection policies and procedures. It should be related to generally accepted management practices.
3. Terms of reference for the appraisal, established immediately following the completion of environmental assessment review, should be incorporated into license or permit conditions.
4. The proponent should be responsible for paying for and collecting monitoring data on which the evaluation is based. The regulatory agency should be responsible for paying for the analysis either directly or through the stakeholders' committee.
5. Data collection intended for research purposes (for example to improve predictive capability) is best funded jointly by government and industry.
6. The independent appraisal body or the stakeholders' committee should review the evaluation report, make recommendations on responses and direct these to the company, lead regulatory agency or other relevant government agency for action.
7. The results should be published and disseminated to stakeholders, made available to the public in an understandable language and format, and entered into the central information repository.

Recommendation 10: Monitoring and Evaluation in Place of Impact Predictions

Results from past and existing projects should be used for environmental assessment and review of new projects to reduce the need or limit the scope of impact predictions. The experience gained from evaluation of existing projects may be more useful for impact management (project design changes, contingency plans, operational practice, compensation) than are new predictions. Detailed monitoring programs have produced results which have been fed back into guidelines for management. These are now used directly for new projects, short-circuiting the need for new impact predictions.

Guidelines for Implementation

1. Substitution of monitoring and evaluation for new impact predictions is particularly relevant to:

- project expansions which would normally trigger a requirement for a new EIA and review; and
- analogous new projects, similar in type and scale and in a similar environmental setting to existing projects for which results are available.

2. Proponents of new industrial and resource extraction schemes should prepare project applications, on a trial basis, using the results of evaluation of similar projects, instead of generating new impact predictions. It may be possible for a proponent to bypass a full EIA and directly prepare an environmental management plan, based on site-specific baseline data for the new project and appraisal results from analogous projects. This approach, in sum, may go some distance in ending the constant duplication of effort and information which presently plagues the field of environmental assessment and management.

Appendix I

WORKSHOP FACILITATORS AND RECORDERS

			Facilitator	Recorder
A	Impact Prediction	1	Pat Duffy*	Peter Duinker
		2	Dave Marshall	Marg Crombie
		3	Norm Williams	Paul Rennick
B	Monitoring and Mitigation	1	Bob Everitt*	Terry Antoniuk
		2	Philip Cohen	Bob Walker
		3	John Wiebe	Bill MacDonald
C	Public Involvement	1	Barry Sadler*	Bill Ross
		2	Felicity Edwards	Morley Christie
		3	Dixon Thompson	Metro Dmytrin
D	Management Procedures	1	Steve Janes*	Shirley Conover
		2	George Greene	Klaus Exner
		3	Brian Clarke	Denis O'Gorman

* Theme session Chairman

EDITOR'S POSTSCRIPT

A Research and Development Strategy for Environmental Audit and Evaluation

Barry Sadler

The studies in this and the succeeding volume provide ample testimony to the rapidly emerging interest in environmental audit and evaluation. Until recently, relatively little attention was paid to the ecological and social effects which actually occurred as a result of project development or to the effectiveness of mitigation and management measures which are put into place on the basis of impact predictions. It is now recognized that a lack of follow-up represents a major constraint on the advancement of the practice of environmental assessment. Without the systematic feedback provided by post-audit and evaluation, practitioners and administrators are not in a position to learn from experience. An investment in hindcast research thus has the potential to pay important dividends through improvements to project and process development. Some promising directions are reported in the workshop summary.

In this postscript, a disciplined approach to incorporating audit and evaluation within existing systems of impact assessment/project approval is proposed. The emphasis is on cost-effective strategy for institutionalizing the various research and development initiatives set out in the case studies or brought forward in discussions. Given the political and economic climate, the addition of an ex-post evaluation and review component to government or corporate decision making must yield demonstrable benefits commensurate with the time and resources expended. Monitoring, audit and similar follow-up activities should provide information that is directly useful for impact management and/or relevant to the general development of the field of environmental assessment and management.

A decision protocol, which relates the level of confidence in impact analysis to the terms and conditions of project approval, may prove a useful organizing concept for promoting these ideals. This notion simply makes explicit in principle what is already implicit in practice. What is the advantage of grasping the obvious? It lies in consolidating and focussing existing tendencies into a flexible strategy, one that can be incorporated within different institutional arrangements for environmental assessment and regulation. Only a short statement of approach will be provided;

further details on its rationale and requirements are available elsewhere (Cornford, O'Riordan, and Sadler, 1985; Sadler, 1986; Cornford et al, in press). The purpose here is to stimulate further thinking and discussion about how to build an audit and evaluation capability which supports environmental assessment and management.

The role and contribution that follow-up activities can make to improve practices in the field depends largely on the problems encountered in ecological and social analyses and the quality of information supplied to decision-makers. Generally speaking, the higher the level of confidence in impact prediction, the lower will be the need for monitoring, audit and evaluation. As uncertainty increases, so does the importance of follow-up. Project decision making tends to reflect this inverse relationship; growing complexity and controversy usually means more and stricter terms and conditions being attached to approvals. By formalizing this convention, the process of decision making can itself become the vector for improvements in the practice of environmental assessment. A flexible and self-functioning feedback loop is put in place which responds to the scale of problems encountered, and leads to their resolution through the lessons learned.

Such an approach admittedly involves the systematization of existing procedures. Table 1 summarizes the type of relationships involved in correlating levels of confidence with terms and conditions of project approval. It supports, first of all, the general requirement for reorganization of the scientific basis of impact assessment advocated by Beanlands and Duinker (1983) and others (e.g., Orians et al, 1986). The major steps involved are: data assembly, sorting and rating; developing perspectives on processes of change in ecological and social systems affected by development; and establishing the significance and estimating the probability of effects. While possibly seeming reductionist, the approach is firmly based on the fundamental recognition that many project-induced impacts are difficult to predict before the fact (Holling, 1978). Striving to establish the limits of process knowledge represents a strategy for coping with surprise; it involves the use of science to prepare for the unexpected.

Guidelines for appropriate follow-up are incorporated in the decision criteria set out in Table 1. These range from routine surveillance for compliance, through effects monitoring for fine tuning mitigation and compensation measures, to utilizing large scale projects as research and management experiments to improve functional knowledge. Audit and evaluation protocols should form a conscious design for trial and error, one that operationalizes the adaptive approach to

TABLE 1 A DECISION PROTOCOL FOR EIA DEVELOPMENT: LINKING CONFIDENCE LIMITS AND PROJECT APPROVALS

Confidence Levels	Data Set Ratings	Process Knowledge	Approach Permitted	Approval	Colour Code	Terms and Conditions of Implementation	Follow-up Activities
Objective	Sufficient	Proven cause-effect relationships	Statistical prediction	Unqualified	Green	Normal standards	Surveillance
Subjective	Insufficient	Evidence for hypotheses	Quantitative simulation	Qualified	Yellow	Special regulations	Monitoring Performance audit
Intuitive	Unreliable	Postulated linkages	Conceptual modelling	Conditional	Orange	Stringent controls Projects as experiments	Comprehensive evaluation of research and management findings
Unknown	Non-existent	Speculation	Professional opinion	Deferral	Red	Pilot project Special studies	All above activities

environmental assessment and management. Much remains to be done along these lines. On that note, this postscript serves as a beginning as much as an end.

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LIST OF DELEGATES

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