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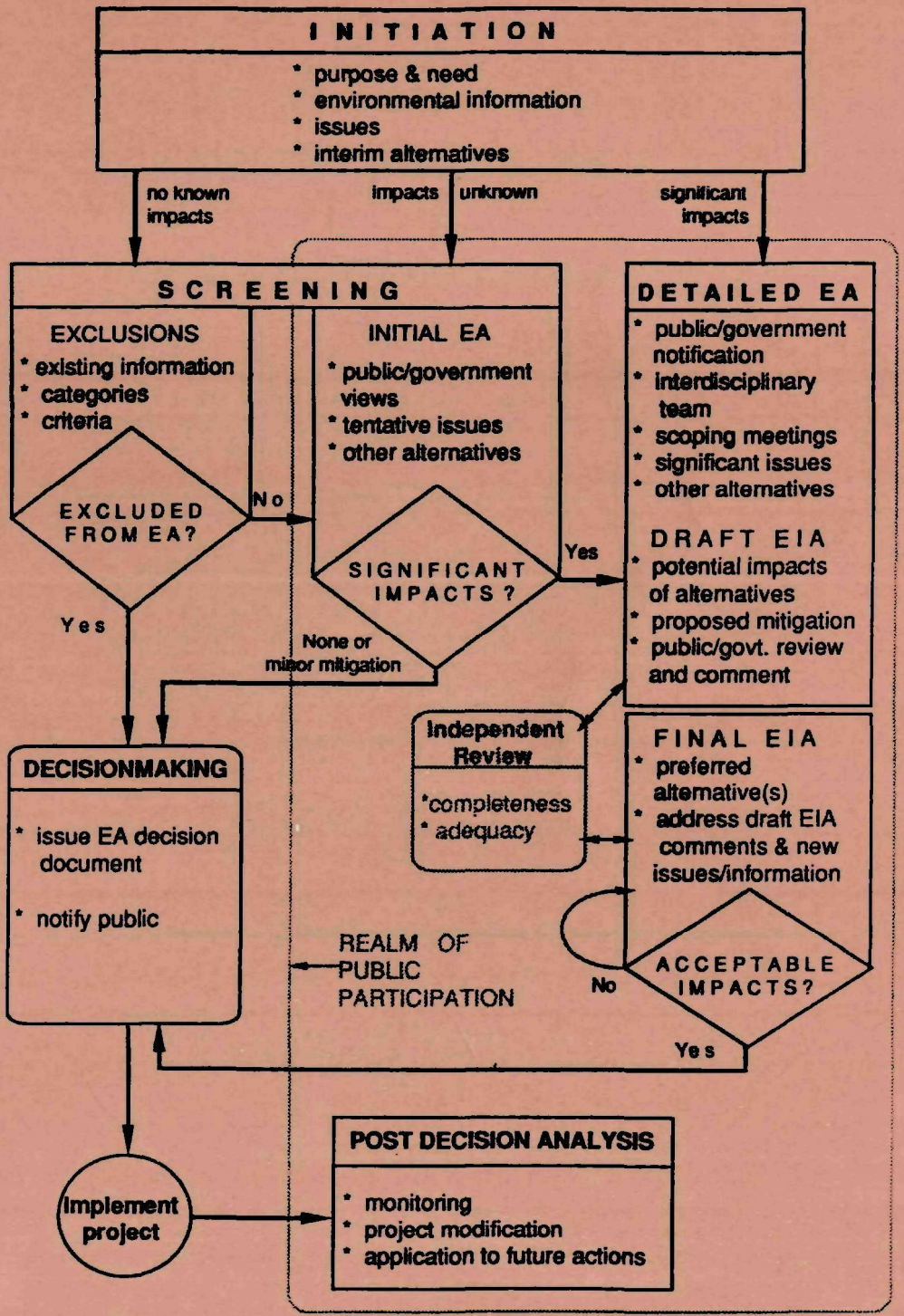

SOURCEBOOK FOR THE ENVIRONMENTAL ASSESSMENT (EA) PROCESS

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SOURCEBOOK FOR THE ENVIRONMENTAL ASSESSMENT (EA) PROCESS

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PREFACE

The United States (U.S.) Environmental Protection Agency (EPA) is increasingly being asked for information on the environmental assessment process (EA) by foreign governments, states, localities and others. This reflects U. S. experience in this area, the increasing number of EPA programs (e.g., the State Revolving Fund) which have encouraged states to have expertise in carrying out EA, and a worldwide interest in the EA process. The Office of Federal Activities, which has responsibility for environmental assessment in EPA under the National Environmental Policy Act (NEPA), decided to develop a sourcebook on EA in order to meet this increased demand for information.

In the sourcebook, EA is used in its broadest sense, that is, as a formal but flexible process (not just a document) for examining proposed activities early in planning for their potential to impact the environment. The term environmental impact assessment (EIA) is used to describe the documentation resulting from the EA process.

The goals of EA are the same regardless of the level of decisionmaking (i.e., project, program or policy). These include the following:

- better decisionmaking,
- public involvement,
- analysis of viable alternatives,
- prediction of impacts,
- mitigation of impacts, and
- follow-up or monitoring and feedback.

A timely interactive EA can:

- minimize adverse impacts on the environment,
- reduce delays in project development,
- reduce cost of the selected alternative,
- promote interagency as well as public involvement and cooperation, and
- promote community acceptance.

Although the sourcebook reflects the U. S. experience in implementing NEPA (and some major international variations) the EA process is applicable to any group charged with the responsibility of providing adequate environmental information to decisionmakers for projects and programs that may directly or indirectly impact the environment. These include private applicants or other non-government entities who are required to provide information or reports to government for grants or permits; proponents of projects and managers and

decisionmakers who are responsible for integrating EA with early planning and the decisionmaking process; and proponents of projects and consultants who are responsible for preparation of EA documents. In addition, the sourcebook may be used by reviewers of environmental documents and decisionmakers to evaluate if environmental effects and values are appropriately identified and presented so that they can be integrated with economic and technical analyses. The sourcebook also includes specific and technical direction in certain areas, particularly document preparation. For these reasons, it is also valuable as a training guide for new employees. However, it is important that users realize that the sourcebook is a guide only and does not address all of the complexities or questions raised by the EA process.

Because the generic elements of the EA process are emphasized, the sourcebook is of use to federal, state, tribal and local agencies, foreign countries, and non-governmental organizations. However, in the U.S., NEPA applies only to federal activities including financial assistance, grants, and permitting. In contrast to other countries, the costs of EA in the U.S. are usually borne by the sponsoring federal agency.

The focus of this sourcebook is generally on EA for project-level decisions because in practice this is where agencies expend most of their EA resources. Historically, there is less experience with the application of EA to policy-and program-level decisionmaking. In theory, however, the EA process is applicable to any level of decisionmaking although the methodologies and the data for broad spectrum analyses are often lacking. Nevertheless, interest is growing in EA of policies as governments realize that their policy-level decisions require assessment of global and international environmental issues (e.g., sustainable development, global warming, biodiversity).

The sourcebook is organized around the major activities that are required for successful EA. These include: initiation, scoping, assessment, decision making, and post-decision analysis. In each of these sections there is a description of the activity followed by subsections that describe the needs, tools, issues, linkages, and references:

- The needs subsections highlight planning, information/data, and resources;
- The tools subsections describe methods and techniques that have proven useful;
- The issues subsections identify important points and concerns and areas where conceptual and analytical uncertainties exist;
- The linkages subsections call attention to the connectedness of EA activities;

- The references subsections provide citations to published information found to be particularly useful.

In addition, there are attachments to each section. These attachments provide information that is often not readily available, particularly to those in foreign countries or those just starting EA programs.

The topics addressed in the sourcebook are mostly broad in scope and inclusive of only some of the many aspects of EA; however, they represent the important aspects of the impact assessment process. It is important for users of the sourcebook to remember that the level of EA should reflect the magnitude of the proposed activity; its potential for environmental impact; and the prevailing environmental policy, regulatory structure, and institutional capabilities.

In the U.S., during the EA process, other environmental review and consultation requirements (e.g., endangered and threatened species, historic and cultural resources) are frequently integrated with the requirements of NEPA. This reduces duplicative effort and the potential for delays. The requirements of such related laws are not addressed in this sourcebook, but brief summaries of the laws are included in Part D. Also included in Part D are the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, the CEQ responses to the forty most asked questions concerning the NEPA regulations, and state requirements for environmental assessment.

The sourcebook is planned to be an easy-to-use reference manual, hence there are some overlaps and repetitions. Its format is designed to facilitate frequent updating or additions of new material. Part F is a computer software supplement to this sourcebook. Comments are invited from users on ways that the sourcebook can better meet their needs.

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ACRONYMS

AHPA	Archeological and Historic Preservation Act
BLM	Bureau of Land Management (U.S.)
CBA	coat-benefit analysis
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COE	Corps of Engineers (U.S. Army)
CZMA	Coastal Zone Management Act
DOE	U.S. Department of Energy
e.g.	for example
EA	environmental assessment (process)
EC	European Communities
ECE	United Nations Economic Commission for Europe
EEC	European Economic Community
EIA	environmental impact assessment (document)
EIS	environmental impact statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
et al.	and others
et seq.	and the following ones
FEARO	Federal Environmental Assessment Review Office (Canada)
FEMA	Federal Emergency Management Agency (U.S.; for Flood Hazard Boundary Maps)
FGDC	Federal Geographic Data Committee
FNSI	finding of no significant impact
FPPA	Farmland Protection Policy Act
FR	Federal Register
FWCA	Fish and Wildlife Coordination Act
FWS	Fish and Wildlife Service (U.S.)
GIS	geographic information system
HEP	habitat evaluation procedure
HUD	Department of Housing and Urban Development (U.S.)
i.e.	that is
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NHPA	National Historic Preservation Act
P.L.	Public Law
PDA	post-decision analysis
ROD	record of decision
SCS	Soil Conservation Service (U.S.)
SEA	strategic environmental assessment
U.S. DOI	United States Department of Interior
U.S.	United States
U.S.C.	United States Code
USGS	U.S. Geological Survey
WA	Wilderness Act
WSRA	Wild and Scenic Rivers Act

PART A

INTRODUCTION

PART A

INTRODUCTION

CHAPTER 1

EVOLUTION OF ENVIRONMENTAL ASSESSMENT

CHAPTER 1

EVOLUTION OF ENVIRONMENTAL ASSESSMENT

In response to a growing awareness of environmental issues in the United States in the 1960s, the public called on Congress to enact an environmental policy with comprehensive goals that transcended the separate pollution and resource management laws of the time. The product of this growing environmental consciousness was the National Environmental Policy Act (NEPA), passed by Congress on December 22, 1969 and signed into law on January 1, 1970 (Part D). The statute is the foundation for consideration of environmental factors in federal decisionmaking. Moreover, it provides for citizen involvement and the opportunity for environmental litigation (Bear 1989).

NEPA ushered in a new era of environmental awareness in the United States by requiring federal agencies to include environmental considerations early in their plans and activities. And it created the environmental impact statement for assessing the likely effects (both beneficial and adverse) of projects with significant environmental impacts that agencies intend to build, finance, or permit. NEPA also provided the interested and affected public with one of its most important tools — the right to bring a case to court. Litigation during the late 1960s and 1970s established that noneconomic interests (i.e., aesthetic, conservational, recreational) were sufficient to establish "standing to sue". Over time, NEPA litigation has declined because there are fewer threshold issues and federal agencies have largely institutionalized NEPA and the results of the early landmark cases in their implementing regulations. Although the effectiveness of NEPA is often questioned, there is growing recognition that NEPA has made a significant difference in federal agency decisionmaking (Wandesford-Smith and Kerbavaz 1988).

In the more than two decades since the passage of NEPA, nations around the world, international lending agencies, and multilateral development assistance organizations have initiated similar requirements for assessing and managing impacts upon the environment of their development activities (see Chapters 10 - 14, 16 and 17 of Wathern 1988). Nevertheless, in Europe and elsewhere, the EA process is essentially reactive (i.e., applied after a decision is made). Requirements for EA, if any, are found in existing statutes and regulations written to address pollution control, safety, and land-use planning. It was not until

publication in 1985 of the Commission of the European Communities' directive on EIA for projects that, at least for the member countries, a proactive approach to environmental assessment was mandated. However, the directive only specifies binding policy objectives; the means for implementing the conditions of the directive are left to each member country. Thus, a wide range of approaches have been adopted (Wathern 1988), mostly set within the context of existing national planning law.

Historically, the emphasis in EA has been on project-level activities in spite of the fact that EA legislation in some countries (e.g., United States, The Netherlands, Canada) includes application to policies, plans, and programs. However, there is growing recognition that EA should reach beyond projects to broader governmental initiatives. In the United States, there is evidence that the government is applying EA to programmatic decisions (e.g., the Department of Army programmatic EIS for the Chemical Stockpile Disposal Program; the Department of Energy (DOE) programmatic EIS for the Nuclear Weapons Complex Reconfiguration; and the DOE programmatic EIS for Environmental Restoration and Waste Management). Following programmatic decisionmaking, more focused documents are prepared for specific projects within a program. The secondary documents are tiered to the programmatic document; they do not duplicate material found in the programmatic document but summarize such information and incorporate it by reference.

In Europe, interest in EA for policies, plans, and programs is increasing (Therivel et al. 1992). Under the auspices of the Senior Advisors on Environmental and Water Problems of the United Nations Economic Commission for Europe (ECE) and the sponsorship of the United States Environmental Protection Agency, an international task force studied the application of the principles of EA to policies, plans, and programs. The task force agreed that the principles of EA as applied to projects are appropriate for policies, plans, and programs (ECE 1992). These include early initiation of assessment, scoping, independent review, public participation, formal documentation, use in decisionmaking, and post-decision analysis. However, the task force recognized that timing and confidentiality might limit public involvement, independent review, and scoping for policy-level decisionmaking. In order to enhance the quality of information used in EA for policies, plans, and programs, the task force agreed that efforts should be pursued to adapt and develop methodologies and databases to promote exchange of information gained from ongoing experiences. In addition, the Commission of the European Communities is currently working on a new directive for strategic environmental assessment (SEA), as it is called, for policies, plans, and programs.

An EA system is easiest to apply within a single jurisdiction. However, there is an increasing need to extend EA to environmental issues that are regional,

international, and sometimes global in scope. Burton et al. (1983) identify two classes of problems associated with international EA:

- the action takes place in one or a few adjacent countries but the impacts can be widespread (e.g., acid rain, nuclear power); and
- the action takes place in many countries and the impacts may be distributed globally (e.g., stratospheric ozone depletion, CO_2 - induced climate change).

In the first case, conventional EA may be appropriate. For the second, new procedures are needed that address state sovereignty, acceptable administrative procedures for EA at the international level, and the determination of significance. The 1991 ECE Convention on Environmental Impact Assessment in a Transboundary Context (signed by 28 countries, including the U.S., and the European Community) obliges signatories to assess the environmental impacts of certain listed activities likely to cause significant adverse transboundary effects. Members are currently working on issues associated with transboundary EA among which are: identification of parameters to determine which activities require EA; criteria for determining the significance of transboundary impacts; and standardization of methods for prediction of environmental impacts.

Obviously, the nature of EA will differ at the various levels of decisionmaking. At the policy level, EA will be more general and less certain. There will be difficulties associated with availability and/or existence of information for assessment and less precise predictions about the consequences of change. Nevertheless, these are not seen as insurmountable problems, because decisionmakers may have lower expectations regarding precision at the policy level (Wathern 1988). The longer lead time associated with policy development should allow feedback between data generation and impact prediction, so that the environmental effects of policies can be more precisely described and the impacts more narrowly defined over time (Wathern 1988).

Currently with the growing interest in policy-level EA, there is increasing recognition that EA should be used to assess the net contribution of a project, program, or policy to sustainable development (Jacobs and Sadler 1990). The 1987 report of the Brundtland Commission, Our Common Future, sounded an urgent call for global environmental strategies for achieving sustainable development based on identification of long-term environmental issues and definition of appropriate efforts to protect and enhance the environment. It went on to state that "The ability to choose policy paths that are sustainable requires that the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial, and other dimensions—on the same agendas and in the same national and international institutions."

A strong case can be made for the use of EA to push decisionmakers along the path of sustainability (Attachment 1.A). There is a clear indication that environmental advisors working in bilateral and multilateral agencies see the potential for modification of existing EA practices to encompass social impact assessment, participatory appraisal procedures, and environmental economics. However, moving from conventional EA to a wider more comprehensive approach encompassing environmental/biological, social and economic elements on an equal basis for developed and developing countries will require time, cooperation, and agreement within and among governments. It has been suggested that EA procedures be developed for issues. For example, focusing on a selected key problem with significant social and economic dimensions as well as environmental implications such as hydropower dams with their associated irrigation schemes, displaced people and refuges. Such an issue - based strategy facilitates an interactive approach, building on lessons learned, and provides a means to test and demonstrate the utility of a modified approach to EA.

The World Bank summarizes the basic operational principles of sustainability as output and input rules:

- output guide. Waste emissions from a project should be within the assimilative capacity of the local environment to absorb without unacceptable degradation of its future waste absorptive capacity or other important services.
- input guide. Harvest rates of renewable resources should be within the regenerative capacity of the natural system that produces them. Depletion rates of nonrenewable resources should be equal to the rate at which renewable substitutes are developed by human invention and investment.

Although not addressed directly, the concept of sustainability has been applied to carrying capacity studies in some 20 EAs prepared for World Bank projects (e.g., for rangeland and power projects; Attachment 1.A). For most animal species, carrying capacity is defined as the maximum population that can be supported indefinitely in a given habitat without permanently impairing the productivity of the ecosystem(s) upon which that population is dependent (Rees 1988). For human society, regional carrying capacity can be defined as the maximum rate of resource consumption and waste discharge that can be sustained indefinitely in a defined planning region without progressively impairing bioproductivity and ecological integrity. Carpenter (1990) presents some practical problems in measuring sustainability and describes ongoing studies that could lead to better measurement of sustainability (Attachment 1.A).

Rees (1988) notes that while the notion of carrying capacity is conceptually simple, various factors make it difficult to put into practice (e.g.,

interregional trade lessens the importer's concern for understanding the carrying capacity of the exporter; cumulative demands for consumption and production must be assessed). Nevertheless, he suggests four initial steps in recreating EA to serve a viable role in sustainable development. They are as follows:

- Extend the scope of EA-like activities to cover the full range of ecologically and socially relevant public and private sector proposals and actions.

- Create a variety of institutional frameworks for EA adapted to the increased diversity of initiatives and activities to be assessed. These mechanisms should be equitable, reduce conflict of interest, and promote political accountability.

- Develop methods for EA that reflect the discontinuous temporal and spatial dynamics and the resilient properties of ecosystems. This requires a balance between predicting the known and adapting socially and politically to the uncertain and unknown in the natural world.

- Implement the foregoing as part of a broader planning and decision-making framework (e.g., community development planning, regional planning) that effectively recognizes ecological functions as limiting factors.

It is also recognized that indicators (i.e., measures) are needed for analysis of sustainability and to guide policymakers in their evaluation of environmental quality (Attachment 1.A). Such indicators will be vital in the development and monitoring of national sustainable development plans. Consider economic planning without GNP or social planning without life expectancy and rates of fertility, yet environmental planning has no comparable measures. New indicators are needed to enable the integration of environmental, economic and social concerns for sustainable development planning.

A mandate for sustainability in environmental planning is found in Section 101 of NEPA (Part D). It states that the ". . . Federal Government . . . will foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans." Furthermore, the regulations that implement NEPA require analyses that address the tenets of sustainability (e.g., the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources).

The challenge for the future is in how well we use the tools we have to fulfill our responsibilities as trustees of the environment for succeeding generations.

REFERENCES

Bear, D. 1989. NEPA at 19: a primer on an "old" law with solutions to new problems. Environmental Law Reporter 19 ERL 10060—10069.

Carpenter, R. A. 1990. Biophysical measurement of sustainable development. The Environmental Professional 12:356-359.

Economic Commission for Europe (ECE). 1992. Application of Environmental Impact Assessment Principles to Policies, Plans and Programmes. ECE/ENVWA/27. United Nations, New York.

Jacobs, P. and B. Sadler (editors). 1990. Sustainable Development and Environmental Assessment: Perspectives on Planning for a Common Future. Canadian Environmental Assessment Research Council, 13th Floor, Fontaine Building, 200 Sacré-Couer Blvd., Hull, Quebec. K1A 0H3.

Rees, W. E. 1988. A role for environmental assessment in achieving sustainable development. Environmental Impact Assessment Review 8:273-291.

Rees, W. E. 1990. Economics, ecology, and the role of environmental assessment in achieving sustainable development. In: Sustainable Development and Environmental Assessment: Perspectives on Planning for a Common Future (eds., P. Jacobs and B. Sadler), Canadian Environmental Assessment Research Council, 13th Floor, Fontaine Building, 200 Sacré-Couer Blvd., Hull, Quebec. K1A 0H3.

Therivel, R., E. Wilson, S. Thompson, D. Hearney, and D. Pritchard. 1992. Strategic Environmental Assessment. Earthscan Publications Ltd., London. 181 pp.

Wandesforde-Smith, G. and J. Kerbavaz. 1988. The co-evolution of politics and policy: elections, enterpreneurship and EIA in the United States. In: Environmental Impact Assessment (ed., P. Wathern), Unwin Hyman, Boston.

Wathern, P. 1988. The EIA directive of the European Community. In: Environmental Impact Assessment (ed., P. Wathern), Unwin Hyman, Boston.

Westman, W. E. 1985. Ecology, Impact Assessment, and Environmental Planning. John Wiley & Sons, New York. 532 pp.

World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, New York. 400 pp.

ATTACHMENT 1.A

EMERGING ISSUES - SUSTAINABLE DEVELOPMENT

- Introduction: Emerging issues - Sustainable development

- **Sustainability and Environmental Assessment.** (Source: Goodland, R., and H. Daly. 1992. Three steps toward global environmental sustainability. World Development 2:64-71)

- Carpenter, R. A. 1990. Biophysical Measurement of Sustainable Development. The Environmental Professional 12:356-359.

References listed below (not attached) are found in the Abstracts and Invited Papers of the Twelfth Annual Meeting of the International Association for Impact Assessment, "Industrial and Third World Environmental Assessment: The Urgent Transition to Sustainability". August 19-22, 1992. The World Bank, Washington, D.C.

— Mikesell, R. F. Environmental assessment and sustainability at the project and program level.

— Dalal-Clayton, B. Modified EIA and indicators of sustainability: first steps toward sustainability analysis.

— Goodland, R., H. Daly, and S. El Serafy. The urgent need for environmental assessment and environmental accounting for sustainability.

Introduction: Emerging Issues - Sustainable Development

It is well recognized that environmental indicators of sustainability are needed to capture trends in ways that policymakers and others can grasp immediately (Mikesell 1992, Dalal-Clayton 1992, Goodland et al. 1992). Such indicators would be tools in assessment of sustainability and monitoring of national sustainable development plans; guide policymakers in their evaluation of environmental quality; and enable integration of environmental, economic and social concerns for sustainable development planning. The relative merits of multiple environmental indicators and a single or "collapsed" indicator are being debated. Nevertheless, there is general agreement that indicators must be simple, practical, and based on data that are readily available in common data sources.

The following tables [excerpted from Dalal - Clayton (1992)] show suggested quantitative (Table 1.A-1) and qualitative (Table 1.A-2) environmental and economic indicators of development. It is suggested (Dalal-Clayton 1992) that the qualitative indicators of sustainability are 1) targets for sustainability and less post-hoc than the quantitative indicators, and 2) more conducive to participatory monitoring by citizen groups. On the other hand, they are probably less useful for integrating changes in the natural resource base in gross national product accounts. The utility of indicators is yet to be tested and it may be that some combination of qualitative and quantitative measures will provide the needed insight to environmental sustainability.

Researchers are also actively evaluating the application of sustainability criteria at various levels of decisionmaking (i.e., policy, program, and project) and various spheres of interest (i.e., global, national, regional and local) (Goodland and Daly 1992).

In addition to debate on what are the appropriate indicators for sustainable development, Carpenter (1990; see attached) discusses uncertainties associated with biophysical measurement and the lack of understanding of ecosystem processes that hamper planning for environmental sustainability. Such uncertainties (e.g., natural variation, succession, reversibility, threshold values) often result in arbitrary management strategies that either overconserve or overexploit natural resources. Nevertheless, Carpenter (1990) sees sustainable development as an experiment, with incremental advances, midcourse correction, and a constant supply of monitoring data.

Table 1.A-1. Some Indicators of Sustainable Development. (Excerpt from Dalal-Clayton 1992)

THE USE OF ENERGY AND MATERIAL

Per capita resources consumption, for a given standard of living, is dropping.

The proportion of non-renewable energy usage in primary production is diminishing, while renewable sources, such as solar or human energy, are increasing: and sectors using non-renewable forms of energy are investing significantly to develop and apply technologies that will use renewable forms.

Passenger kilometers travelled by public transport are increasing in proportion to those travelled by private motorized transport.

There is a progressive increase in both official incentives to use renewable energy and disincentives to use nonrenewable forms.

There is an increasingly free flow of technology, especially to poor countries.

ECOLOGICAL PROCESSES & BIOLOGICAL WEALTH

Development activities seek to maintain ecological processes (soil fertility, waste assimilation, and water and nutrient cycling) and not to exceed the capacity of these processes.

Development increasingly depends upon and conserves a growing range of genetic material, not only the different species but the varieties within species.

Renewable resources are increasingly used and harvested at rates within their capacity for renewal.

More and more areas of high value for their irreplaceable environmental services are not only being set aside, but are being effectively managed, with secure funding.

POLICY, ECONOMICS & INSTITUTIONS

Economies - especially those that depend upon high-volume natural resources data - are diversifying, especially towards high-value information and service industries.

There are growing numbers of formal mechanisms to integrate environmental and development concerns, and to insert environmental values in prevailing systems of economic policy, planning and accounting.

More accurate and representative economic indicators are being introduced to measure sustainable development, so that the currently dominant concerns of consumption, savings, investment and government expenditures are increasingly joined by measures of natural resources productivity and scarcity.

More methods are being introduced for valuing use by future generations, for comparing such use to today's needs and for making equitable trade-offs between generations.

Flows of resources to and from a given country are increasingly stable and equitable, and do not result in severe net depletion of the national resource base.

Both the incidence and the effects of "boom and bust" are diminishing.

There are both regulatory measures that ensure that resource limits are not exceeded, and enabling measures that encourage voluntary improvements in technology to make more sustainable use of resources within those limits.

Environmental monitoring is regularly and effectively carried out, and both policies and operations are adjusted to suit.

Military budgets are decreasing in relation to budgets for work to ensure environmental security and sustainable development.

Table 1.A-1. continued

SOCIETY & CULTURE

The notion of resource limits, and the need for sustainability in production and livelihood systems, is increasingly prevalent in a society's values, embodied in its constitutions and inherent in its education systems.

The community is becoming more diverse in terms of skills and enterprises, and yet remains coherent as a community.

There is a growing body of commonly held knowledge and available technology for maintaining a good quality of life through sustainable activities.

There is a tendency towards full employment, good job security and household stability.

Increasing numbers of people have access to land adequate for sustaining good nutrition and shelter for their families and/or adequate, reliable incomes to pay for these necessities.

The costs and benefits of resource use and environmental conservation are more equitably distributed: consumers increasingly choose to pay for goods and services that are resource-efficient and minimize environmental degradation.

Conflicts over land and resource rights are diminishing.

People who once relied upon unsustainable activities for their livelihood are being supported in their transition to sustainable activities.

Development is increasing people's control over their lives, the range of choices open to them and the knowledge to make the right choices: it is compatible with the culture and values of the people affected by it, and contributes to community identity.

(Source: Holmberg, J., S. Bass, and L. Timberlake. 1991. Defending the Future: A Guide to Sustainable Development. Earthscan Publications Ltd., London)

Table 1.A-2. Some Environmental and Economic Indicators of Development. (Excerpt from Dalal-Clayton 1992)

Countries	1985-90 Population Growth Rate (%)	1985-89 GNP Growth Rate (%)	1991 Human Development Index [a]	1989 Energy Consumption [b] (gigajoules per capita)	1988 Carbon Emissions [c] (metric tons per capita)	Mid-1980s Production of Hazardous Wastes [d] (metric tons)	Annual Rate of Deforestation [c] (hectares)	1989 Protected Areas (% of country)	1990 Water Use (% of available supply)	Soil Erosion (metric tons per hectare per year)
Algeria	3.12	1.7	0.490	27	0.7	X	40,000[f]	0.2	16	X
Botswana	3.51	11.4	0.524	X	0.4	X	20,000[f]	17.7	1	X
Brazil	2.07	3.9	0.759	23	0.4	X	1,380,000	2.4	1	X
China	1.39	7.9	0.614	24	0.6	X	X	0.8	16	X
Costa Rica	2.64	4.6	0.876	15	0.2	X	42,000	12.0	1	X
France	0.36	3.2	0.971	116	1.6	2,000,000	X	8.2	18	X
Haiti	1.88	(0.6)	0.296	2	0.0	X	2,000	0.3	0	X
India	2.08	5.8	0.308	8	0.2	36,000,000	48,000[f]	4.4	18	75[g]
Jamaica	1.52	5.3	0.761	25	0.6	X	2,000	0.0	4	36[h]
Mexico	2.20	0.9	0.838	49	1.0	X	595,000	2.9	15	X
Nigeria	3.43	2.9	0.242	6	0.1	X	300,000	1.1	1	14[g]
Peru	2.51	(0.2)	0.644	15	0.3	X	270,000	4.3	15	15
Rwanda	3.40	(0.4)	0.213	1	0.0	X	3,000	10.5	2	X
Sau. Arabia	3.96	1.5	0.697	186	3.5	X	X	0.4	106	X
Sier. Leone	2.49	2.3	0.048	2	0.0	X	6,000	1.4	0	X
Spain	0.38	5.3	0.951	73	1.3	1,700,000	X	5.1	24	X
Sweden	(0.03)	2.4	0.982	149	1.8	500,000	X	4.1	2	X
Thailand	1.53	10.2	0.713	19	0.3	X	158,000	9.1	18	X
USA	0.82	3.3	0.976	297	5.3	265,000,000	159,000[f]	8.6	19	10[h]
Zimbabwe	3.15	3.6	0.413	20	0.5	X	X	7.1	5	50[g]

Notes: X = Not available. 0 = Zero or less than half the unit of measure.

[a] The Human Development Index, constructed by the UNDP, combines, in one number, a measure of economic, educational, and health deprivation. Countries above 0.8 are considered to have high human development; 0.5 to 0.8, medium development; and below 0.5, low development.

[b] Energy consumption includes traditional fuels.

[c] Figures include carbon from energy consumption and other industrialized sources.

[d] Hazardous wastes are not defined consistently from country to country.

[e] All figures are from the Food and Agricultural Organization of the United Nations for the 1980s, except the following countries, which come from national sources for the years indicated: Brazil, 1990 (legal Amazon only); Costa Rica, 1973-89; India, 1983-87; and Thailand, 1985-88.

[f] These figures include open and closed forests; all others are for closed forests only.

[g] Figures are for seriously affected cropland only.

[h] Figures are for total cropland.

(Source: Mathews, J. T., and D. B. Tunstall. 1991. Moving Toward Eco-Development: Generating Environmental Information for Decisionmakers. Issues and Ideas Paper, World Resources Institute, Washington, D.C.; using data from the United Nations, World Bank, World Conservation Monitoring Centre, World Resources Institute)

Sustainability and Environmental Assessment. (Source: Goodland, R., and H. Daly. 1992. Three steps toward global environmental sustainability.) World Development 2:64-71.

Although sustainability has not been an explicitly defined criterion in EA, a review of some twenty EAs done for World Bank projects revealed some practical ways in which the concept has been applied. For example, in the Uganda Livestock Services Project the EA advocated a carrying capacity study for the rangelands to determine how many cattle could be grazed on the land without reducing the land's capacity to support grazing next year. The main focus of the project was to eliminate the tsetse fly. In a sense the land had been protected from physical degradation by the infestation which had reduced human presence. With the eradication of the tsetse fly human pressure on the land would increase, and the danger of that pressure reaching an unsustainable level was recognized. A study to establish the carrying capacity of the rangelands is a first step in avoiding unsustainable overgrazing. A further study comparing the capacity of the land to support game versus the capacity to support cattle was also recommended along with a study of the market for game meat as a substitute for cattle meat. Also needed of course are institutions and laws that insure that ranchers will not exceed that capacity.

Although the concept of carrying capacity has long been associated with cattle ranching, it is also applicable more generally. For example, in the Java (Suralaya) Thermal Power Project, a 1980 EA established that the site could accommodate up to 3,100 MW of generating capacity. Presumably this reflects environmental limits although the recent EA did not specify how the 1980 EA arrived at that figure. Nevertheless that approximate figure was respected in the current expansion of the Suralaya generating station. It is not clear whether the limiting factor was air quality, cooling water capacity, capacity to dispose of ash, or what. But some regional environmental factor limits the carrying capacity for coal-fired power plants, just as either rainfall, sunlight, or soil nutrients may limit the growth of grass and thus the number of cattle that can sustainably be grazed on the rangelands in Uganda. The concept of environmental carrying capacity logically applies to coal-fired power plants as much as to cattle.

The concept was extended one step further to apply to industrial development in general in the case of the Dahanu Thermal Power Station in India. It was recognized that induced industrial development around the new power station would overwhelm the environmental protection features of the project itself. To avoid exceeding the local environmental carrying capacity for industrial activity in general, part of the surrounding area was declared as an "industrial exclusion zone."

The point of these examples is to show that the above discussion of theoretical input and output guides based on regenerative and assimilative capacities is not impractical abstract theory, but is in fact actually being approximated in rather imaginative ways by project designers even in the absence of guidelines. But sustainability is too critical to be dealt with in ad hoc fashion,

however imaginatively. As emphasized at the beginning of this discussion sustainability is not optional - it is not just one more value to be traded off against others - it is a mandate in the absence of which measured income is not true income and measured rates of return on projects are misleading. To carry out his mandate we must advance sustainability from a vague, but important, concept to a set of operational guidelines.

BIOPHYSICAL MEASUREMENT OF SUSTAINABLE DEVELOPMENT

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Abstract. Sustainability is now an accepted constraint on economic development. Biophysical measurements of the condition of the environment are the essential first step in determining whether a given use or exploitive practice is sustainable. Uncertainties in these measurements and lack of understanding of ecosystem processes hamper the guidance of economic planners and managers. It is especially difficult to detect and predict the shift to unacceptable degradation in a highly productive managed ecosystem, such as intensive agriculture or forestry. Opportunities for improved measurement are to be found in new approaches such as restoration ecology, long-term ecological research, and the concept of keystone species. Economic development enterprises, including international aid agencies, can afford to support research and monitoring to reduce uncertainties about ecological sustainability. An adequate future supply of food and other products of renewable natural systems will depend on more reliable measurement of sustainable development.

INTRODUCTION

Reliance on conventional economics is often blamed for policies and practices leading to unsustainable use of resources (World Commission on Environment and Development, 1987; Goodland, 1989; Daly, 1990; Asian Development Bank, 1990). The implication is that sustainable economic development cannot be achieved at the expense of the environment (Shearman, 1990). Substantial efforts are underway to improve economic theory and analyses, including the valuation of environmental externalities for inclusion in benefit-cost calculations (Carpenter and Dixon, 1985) and the addition of changes in the natural resource base in gross national product accounts (Ahmad *et al.*, 1989). The monetary values used derive from biophysical measurements of the status and trends in natural systems. These quantifications comprise the initial step in ascertaining whether a development activity is ecologically sustainable. The answer may be obvious with no special measurement skills needed if one observes advancing deserts, deep gullies, algal blooms, or salt-crusted soils. Similarly, if natural systems simply are left alone, it is reasonable to predict that they will sustain themselves (although not without changing). The more important and difficult task, however, is to intensify the productivity from natural resources, pressing against thresholds and limits of degradation, striving for that maximum output for the present which does not jeopardize the ability to continue the same productivity in the future.

Science cannot detect dependably, much less predict, the transition from intensive, but sustainable, use to unacceptable degradation. Further, the expectations of scientific certainty by other actors in the development business (particularly decisionmakers) probably are far more than can be delivered. A World Bank report (Ahmad *et al.*, 1989) states:

> We believe that environmental accounting in physical terms is essential, particularly as this would cover collecting data that indicate the direction and rate of change in the quantity or quality of a resource. At the same time, we recognize that 'monetization,' to the extent possible, is important as well....

Recognizing this mismatch of capabilities with expectations and doing something about it must be a part of any attempt to operationalize sustainable development.

Uncertainties about natural systems have at least four consequences on attempts to achieve sustainable development.

- First, it may be difficult to tell whether a given use pattern is sustainable, simply because the natural variations are so great that the effects or noneffects of human intervention cannot be detected. If, as is commonly encountered, the precision of measurement is < 0.5, *i.e.*, the standard deviation is more than twice the difference between the true population mean and the sample mean, then the number of measurements required for the conventional, or prudent, 90-95% confidence in the ability to discriminate becomes large, costly, and perhaps impractical to obtain (Mar *et al.*, 1987). The signal is lost in the noise.

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- Second, uncertainties can be used as an excuse for arbitrary resource management strategies that are either overconserving or overexploiting. To environmentalists, it is intuitive that uncertainty recommends more cautious, even if more expensive, environmental protection. To development advocates, uncertainty about the future environment justifies going ahead to capture obvious short-term economic gains.

- Third, thresholds are postulated to exist in some natural systems beyond which catastrophes or irreversible degradation occur (*e.g.*, extinction of species, contamination of groundwater, loss of soil A-horizon). The uncertainty about threshold values may rule out development options which otherwise are economically attractive.

- Fourth, since ecological and economic calculations of sustainability assume "stationarity," or continuity of fundamental environmental conditions, the likelihood of baseline changes such as climate warming, and the uncertainties about their degree, or even direction, are substantial additional problems for the development analysts and decisionmakers.

If a society is averse to risk, all of these adverse effects of uncertainty are increased. Batie (1989) notes that while econometrics assumes that nature is predictable, the ecological sciences admit the impossibility of prediction in many situations. She describes some of the "belief system" of sustainable development whose advocates: 1)perceive that the biosphere imposes limits on economic growth, 2)express a lack of faith in either science or technology as leading to human betterment, and 3)are extremely averse to environmental risks.

The economic losses associated with erring on the safe side (or compensating for uncertainties) when striving for sustainability may be large. In attempts to design and operate sustainable development systems, the economic optimum may be missed by a wide margin. However, it is not just fine-tuning which is in question, but the very real possibility of not being able to tell whether a system is sustainable. Large investments by industry, government, and international aid agencies are at stake. Therefore, the presumed value of reducing uncertainties should be sufficient to generate substantial support for research and monitoring, including the development of indicators of unsustainability.

EVIDENCE OF CURRENT INADEQUACIES

The following examples of practical problems in measuring sustainability document my thesis.

- The quantification problem is often manageable for single stresses on well-defined resources, such as forests or aquifers, but numerical measures are much more difficult to obtain for characteristics of holistic systems, such as resilience, robustness, or stability (Munn, 1989). Cocklin (1989) asks:

  > Most simply, how do we in fact measure whether a system is sustainable or not? ...It will almost certainly prove impossible to define any single measure of sustainability at a general-system level. This implies, then, that individual components will need to be measured separately.

  How to combine different measures in order for managers to make trade-offs and compare development alternatives becomes a major problem.

- The "Safe Minimum Standard" advocated by Ciriacy-Wantrup (1968) seeks to minimize the chances of catastrophe to the environment by making a social decision to pay a premium of protection costs or foregone production, but only if the premium is not "too large"—a value judgement. In practice, this would require confident prediction of conditions that bring about worst-case consequences, such as species extinction. Furthermore, in the case of extinction, there are large uncertainties about the characteristics of plants and animals that eventually might prove useful to society (Bishop, 1978).

- The conservation of biological diversity is attracting general public support and commitment of funds. At the same time, scientific understanding about disruption from exotic species, critical-link species in food webs, and habitat vs. species preservation is changing rapidly. Westman (1990) notes that some of our current poli[illegible] toward biological conservation appear to be based [illegible] concepts that no longer are widely accepted in the ecological community.

- For some time, fisheries have been managed for maximum sustainable yield, but the impact on harvest from changes elsewhere in the larger system upon which the fish depend can be devastating. Bardach (1990) noted the fluctuations in sardine fisheries of the Southeastern Mediterranean after the Aswan High Dam was built. The Nile stopped delivering nutrients to the sea and the fisheries collapsed, only to revive somewhat later when expansion of irrigated agriculture, also made possible by the dam, again provided some nutrients. A similar example is the crash of shrimp populations in the Eastern Arabian Sea due to an increase in salinity of coastal waters, because dams on the Indus River greatly reduced freshwater flows. Prediction of the timing and magnitude of such chains of events is usually imprecise.

- Development projects based on growing vegetation, such as pastures or fuelwood plantations, usually are not allowed to achieve a mature equilibrium condition; rather, these systems are manipulated constantly to stay at an early successional stage, where primary productivity of biomass is greatest. Establishing the conditions for sustainability in such a dynamic process is much n[illegible] difficult than with systems that are in the climax st[illegible] (Harper *et al.*, 1987).

- Field measurements and laboratory analytical results concerning natural systems in developing countries are notoriously uncertain, due to natural variation and errors in collection, analysis, and interpretation (Blaikie and Brookfield, 1987). A recent report of the Asian Development Bank (1990) concludes:

  > The lack of quantitative environmental information comparable with the statistics available regarding economic parameters is a major obstacle to integrated economic-cum-environmental planning. Statistical information on the environment is scarce, often inaccurate, seldom comparable from country to country, and rarely available in a time series covering a sufficient number of years to indicate trends in a reliable way.

  Statistically reliable data simply are not widely available for such fundamental factors as soil erosion, nutrient transport, and vegetative productivity (Carpenter, 1989). Ludwig (1985) observes that while the results of water analyses reported in developing countries may appear adequate at first glance, all too often they actually contain numerous errors and omissions and scarcely give a competent picture of the water quality.

- Hydrologists have studied the Pearl Harbor aquifer on Oahu, Hawaii, for decades, yet recently decided to reduce the amount of water removed by 13% because of uncertainty about recharge rates and the fear of saltwater intrusion (Hufschmidt, 1990).

- The inability to predict accurately the assimilative capacity of water bodies for organic matter, a so-called free service of nature, has led to the zero-discharge concept in the United States Water Quality Act, thus requiring more expense for sewage treatment and control of nonpoint sources. The value of the renewable resource of assimilation is ignored.

- If the rate of soil building by natural processes (weathering of rock and accumulation of detritus) is greater or equal to the erosion rate in a given farming system, then the practice could be said to be sustainable. Neither rate can be measured with sufficient accuracy, however, to allow certainty in specifying a tolerable amount of erosion (Crosson, 1985).

PROMISING RESEARCH

There are lines of investigation now underway which could lead to better measurement of sustainability. These research approaches could be expedited with increased funding from development interests which are feeling the imposition of a sustainability constraint on their activities.

- Most fertile parts of the world are used to support dense or expanding human populations. Highly productive, intensive, high-input agricultural systems are essential to provide adequate food in the future. Otherwise, marginal lands would have to be brought under cultivation, and such lands are not capable of being farmed sustainably. However, the intensive systems are also suspect; for example, salinization and waterlogging follow excessive irrigation, nitrate fertilizer applied to crops leaches into drinking water supply aquifers, and dependence on chemical pesticides results in resistant strains of insects (York, 1988). Much of the research work at the centers of the Consultative Group on International Agricultural Research (CGIAR) is on the feasibility of agricultural sustainability.

- Promoting sustainable development includes the transformation of currently degraded and unsustainable systems into a productive sustainable state, but not necessarily the same as before degradation. For example, careful research has provided practical means of restoring lakes which have been damaged severely due to pollution by sewage, sedimentation, or lowered water level, and whose damage is irreversible by natural recovery mechanisms. The research involves the entire system of the lake and the surrounding drainage basin. Such measures are called "redevelopment" by Bjork (1988).

- Keystone species are those which play a central role in controlling or determining the relative abundance of other species in an ecosystem. More knowledge of these important plants and animals would allow conservation efforts to be concentrated on their role in, for example, sustained yield management of game species (Westman, 1990). Moreover, the expected global warming will bring stress and breakdown to currently sustainable systems and the health of keystone species could be a key indicator of such changes.

- The actual length of time that a given practice may be sustainable is difficult to predict, because of long-term time lags between human manipulations and ecological responses (Magnuson, 1990). These time lags, sometimes decades long, separate cause and effect and make them difficult to correlate. They may result in costly mistakes by managers of renewable resources. Long-term ecological research is beginning to bring some understanding of these delayed, but profound, changes. So far, such research is mostly in the temperate zone, and extension to the tropics will be necessary to assist the developing countries there.

- The sustainability of an ecosystem often is correlated with the extent of habitat. A minimum viable population (MVP) is that number of some species that has a high probability of survival. For example, in tree species, population sizes decrease with decreasing area, and the risk of extinction due to chance genetic, demographic, or environmental events increases. Although few precise

estimates of MVP are available, future research should allow useful predictions from such relationships (Edgerton, 1990).

- The Environmental Monitoring and Assessment Program of the U.S. Environmental Protection Agency follows the effects of regulating pollution on the condition of the environment. To accomplish this task, indicators of status and change that can be monitored efficiently and continuously are being developed (Hunsaker *et al.*, 1990).

CONCLUSION

Development generally is regarded as acceptable only if it is sustainable socially, economically, and ecologically. In particular, the exploitation of renewable natural resources should not result unknowingly in their degradation. Implementation of this sustainability constraint requires, and presumes, a reasonable certainty about the condition of natural systems under varying degrees of stress.

There is consensus in the environmental science literature that this capability for reliable biophysical measurement is inadequate to meet the expectations of resource managers. Further, there is insufficient awareness of the inherent uncertainties attending descriptions and predictions of natural systems. Despite this management information gap, economic development in a crowded world must proceed with intensified production from forests, fisheries, range lands, farms, and wildlife. Technological inputs to less exploited sites will increase. Damaged ecosystems will be restored. Investments and risks are enormous, but the health and quality of life for billions of persons depend on successful sustainable development.

A second consensus from the environmental science community is that opportunities for improved measurement and prediction are at hand. Research approaches and monitoring techniques which promise practical guidance for development planners are evolving. This work now is funded primarily by pollution control agencies. The sponsorship of environmental science research by development authorities has, so far, been restricted largely to "Green Revolution" agriculture. The analysis presented here justifies a much broader and more direct support, in order to avoid costly mistakes and to increase confidence in decisionmaking. Sustainable development can be considered as an experiment, with incremental advances, midcourse correction, and a constant supply of monitoring data on the condition of the environment as well as its productivity. The payoff for improving biophysical measurements could, in fact, be the achievement of sustainability.

REFERENCES

Ahmad, Y.J., S. El-Serafy, and E. Lutz, eds. 1989. Environmental Accounting for Sustainable Development. The World Bank, Washington, DC.

Asian Development Bank. 1990. Economic Policies for Sustainable Development. Asian Development Bank, Manila, p. 4

Bardach, John. 1990. Sustainable Development of Fisheries. Presented at Globe 90, Vancouver, BC. March.

Batie, Sandra S. 1989. Sustainable Development: Challenges to the Profession of Agricultural Economics. *American Journal of Agricultural Economics* 71(5). December.

Bishop, R.C. 1978. Endangered Species and Uncertainty: The Economics of a Safe Minimum Standard. *American Journal of Agricultural Economics* 60(1): 10-18.

Bjork, Sven. 1988. Redevelopment of Lake Ecosystems: A Case Study Approach. *Ambio* 17(2).

Blaikie, P.M., and H. Brookfield. 1987. *Land Degradation and Society*. Methuen, London and New York.

Carpenter, R.A. 1989. Do We Know What We Are Talking About? *Land Degradation and Rehabilitation* 1:1-3.

Carpenter, R.A., and J.A. Dixon. 1985. Ecology Meets Economics: A Guide to Sustainable Development. *Environment* 27(5): 6-11, 27-32.

Ciriacy-Wantrup, S.V. 1968. *Resource Conservation*, 3rd Edition. University of California Press, Berkeley.

Cocklin, C.R. 1989. Methodological Problems in Evaluating Sustainability. *Environmental Conservation* 16(4). Winter.

Crosson, P. 1985. Impact of Erosion on Land Productivity and Water Quality in the United States. In *Soil Erosion and Conservation*, S.A. El-Swaify, W.C. Moldenhauer, and A. Lo, eds. Soil Conservation Society of America, Ankeny, IA.

Daly, H.E. 1990. Toward Some Operational Principles of Sustainable Development. *Ecological Economics* (2): 1-6.

Edgerton, S.A., K.R. Smith, R.A. Carpenter, T.A. Siddiqi, S.G. Olive, C.P.B. Claudio, V.T. Covello, D.J. Fingleton, K.G. Kim, and B.A. Wilcox. 1990. Priority Topics in the Study of Environmental Risk in Developing Countries: Report on a Works Held at the East-West Center, August, 1988. *Risk Analysis* 10(2).

Goodland, R.J.A. 1989. Environmental Sustainability in Economic Development: A Comment. *Land Degradation and Rehabilitation* (I):311-322.

Harper, D.E., D.B. Botkin, R.A. Carpenter, and B.W. Mar. 1987. Applying Ecology to Land Management in Southeast Asia. Occasional Paper No. 2. East-West Environment and Policy Institute, Honolulu.

Hufschmidt, M. 1990. Personal communication. Consultant, Environment and Policy Institute, East-West Center. Honolulu. July 2.

Hunsaker, C., D. Carpenter, and J. Messer. 1990. Ecological Indicators for Regional Monitoring. *Bulletin of the Ecological Society of America* 71(3): 165-172.

Ludwig, H.F. 1985. Exercise in Checking Validity and Reliability of Typical Water Quality Analysis for a Natural Water. The NEB Newsletter (Bangkok), No. 19. September.

Magnuson, J.J. 1990. Long Term Ecological Research and the Invisible Present. *Bioscience* 40(7).

Mar, B.W., W.S. Mitter, R.N. Palmer, and R.A. Carpenter. 1987. Cost-Effective Data Acquisition. Workshop Report No. 1. East-West Center, Honolulu.

Munn, R.E. 1989. Towards Sustainable Development: An Environmental Perspective. *Development 1989*:2-3, Journal of SID: 70-80.

Shearman, R. 1990. The Meaning and Ethics of Sustainability. *Environmental Management* 14(1): 1-8.

Westman, W.E. 1990. Managing for Biodiversity: Unresolved Science and Policy Questions. *Bioscience* 40(1): 26-36.

World Commission on Environment and Development. 1987. *Common Future*. Oxford University Press, Oxford, UK.

York, E.T., Jr. 1988. Improving Sustainability with Agricultural Research. *Environment* 30(9). November.

PART B

THE EA PROCESS

PART B

THE ENVIRONMENTAL ASSESSMENT PROCESS

THE ENVIRONMENTAL ASSESSMENT PROCESS

The Environmental Assessment (EA) process includes a variety of activities aimed at providing information to decisionmakers to ensure that environmental considerations are a part of decisionmaking (Figure B-1). The scope of these activities will vary depending on the nature of the proposed action, its potential for impacts to the environment, public interest, and the decisionmaking culture of any given industry or government. Nevertheless, there are some basic elements that are recognized as generally essential to successful EA. These include:

- Initiation (including identification of issues and generation of alternatives)
- Scoping
- Assessment
- Decisionmaking
- Post-Decision Analysis

During **initiation**, which is generally an internal process occurring early in project formulation, the proponent evaluates the purpose and need for the proposed action and the required level of EA review and documentation (e.g., in the U.S., categorical exclusion, environmental assessment, or environmental impact statement). Predetermined lists, a screening procedure, or a combination of these approaches can be used to determine the potential impacts of a proposed action. Tentative issues and alternatives are identified during initiation.

Once a decision is made that EA is necessary for a proposed action, a team is assembled and the formal **scoping** process begins. This process usually includes consultation within and between governmental departments and public and government participation in one or more scoping meetings. The purpose of scoping is to identify reasonable alternatives and issues and concerns related to the proposed action; provide early identification of areas (including data gathering and research) that will need attention for evaluation of their significance; and facilitate consideration of alternatives and mitigation. Scoping is an ongoing process, but it is most effective and useful when begun early in the planning process.

Following the formal part of the scoping process, the proponent decides what must be considered in the analysis and **assessment** part of the EA process and what can be eliminated. These early decisions should be documented. Based on guidance from the proponent, an interdisciplinary team divides the analytic and

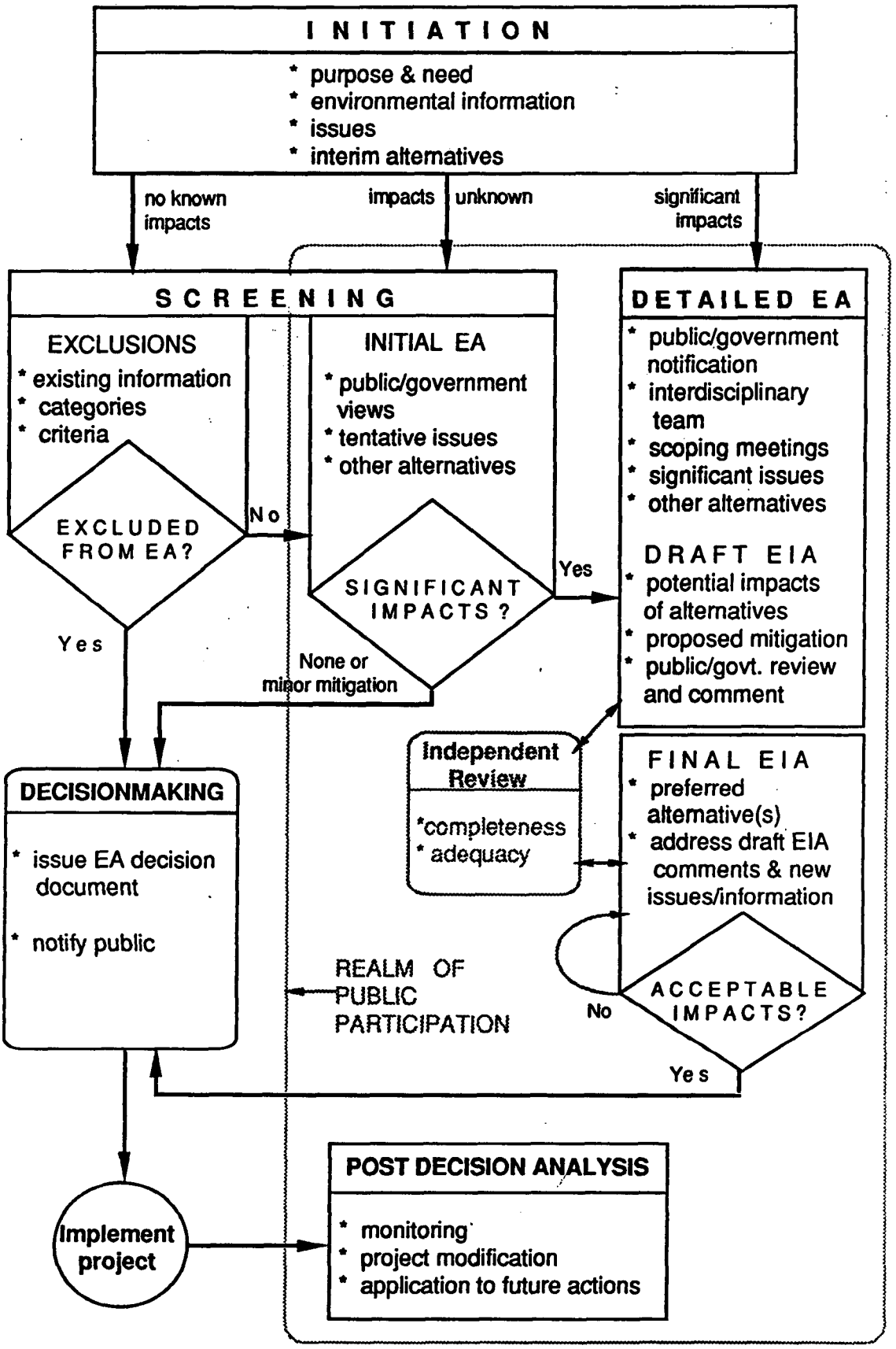


Figure B-1 The Environmental Assessment Process

writing responsibilities and draft and final EA documentation is prepared. For purposes of this sourcebook, an environmental impact assessment (EIA) is the report that documents the detailed EA process. Draft EIAs for proposed actions with potential for significant impacts to the human environment should generally be circulated for review and comment to the public, non-governmental organizations, and government agencies, as appropriate. In the U.S., expert agency comments and public scrutiny are essential to implementing NEPA. Following review of comments, the EA team prepares final documentation which the proponent makes available to all interested and affected entities.

Decisionmaking for major proposed actions follows internal and public review and distribution of the EIA. The result of the decision process is formalized by publication of a "record of decision" or a determination that identifies the alternatives considered, which of them are environmentally preferable, the one chosen to be implemented, and any mitigation measures to reduce or eliminate adverse effects of unavoidable environmental impacts. It also may discuss preferences among alternatives based on economic and technical considerations and statutory constraints. An EIA is written to inform ultimate decisionmakers about the consequences of their choice but decisions are also made during the EA process that influence the choice of alternatives and other aspects of the proposed action (e.g., design and mitigation measures). In practice, the overall influence of an EIA on ultimate decisionmaking is unknown (Culhane et al. 1987) but there is little doubt that EA influences decisions resulting in changes to proposals and environmental management conditions (Hollick 1986). The lack of EA or an inadequate EIA, particularly for major or controversial actions, can result in time consuming and costly litigation that can cause modification, delay, or cancellation of projects.

Post-decision analysis (PDA) is increasingly being recognized as an important element of EA (ECE 1990). Ideally, PDA encompasses evaluation of scientific and technical issues and procedural and administrative matters during and after implementation of a proposed action. The nature of PDA studies depends on the proposed action, but often includes compliance monitoring studies required by regulatory agencies, baseline monitoring (prior to construction and operation), environmental effects monitoring, and mitigation monitoring. The information provided by the PDA studies not only allows for project modifications if needed but also results in a better understanding of impact predictions and the effectiveness of mitigation measures which can be applied to future activities of the same type.

REFERENCES

Culhane, P. J., H. P. Friesema, and J. A. Beecher. 1987. Forecasts and Environmental Decisionmaking. Westview Press. 306 pages

Economic Commission for Europe (ECE). 1990. Post-Project Analysis in Environmental Impact Assessment. ECE/ENVWA/11. United Nations, New York. 54 pages.

Hollick, M. 1986. Environmental impact assessment: an international evaluation. Environmental Management 10:157-178.

THE ENVIRONMENTAL ASSESSMENT PROCESS

- **Environmental Assessment.** (Source: U.S. Environmental Protection Agency. EPA/600/M-91/037 March 1992)

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

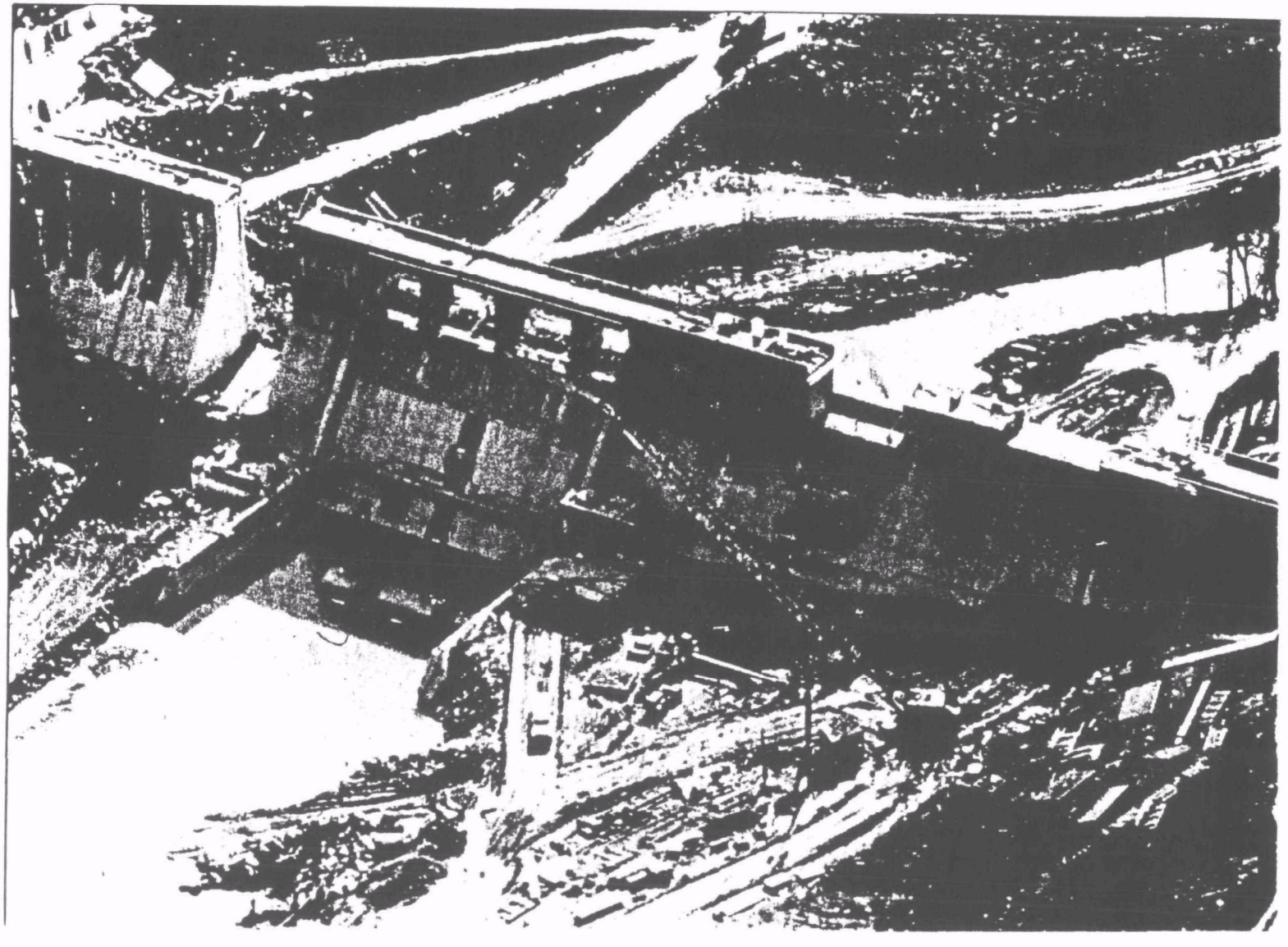
Office of International
Activities
Washington, DC 20460

Office of Enforcement
Washington, DC 20460

EPA/600[redacted]/037
March 1992

EPA

Environmental Assessment



EPA Technical Information Packages

This brochure is part of a series of information packages prepared by the United States Environmental Protection Agency (EPA). Aimed at the international community, the packages focus on key environmental and public health issues being investigated by EPA. The products highlighted within these packages provide a sound technical basis for decisions regarding the development of environmental policy, abatement activities, and pollution prevention. By pooling expertise in the areas of environmental science and technology, significant progress can be anticipated to ensure a habitable environment for all nations.

Environmental Impact Assessments presents information on the components, applicability and benefits of the environmental assessment process. Brochures and associated support material are available on the following topics:

- **Ensuring Safe Drinking Water** EPA/600/M-91/012
- **Mining Waste Management** EPA/600/M-91/027
- **Pesticide Waste Disposal** EPA/600/M-91/028
- **Air Quality Management** EPA/600/M-91/029
- **Solid Waste Disposal** EPA/600/M-91/030
- **Hazardous Waste Management** ..EPA/600/M-91/031
- **Small Community Wastewater Systems** EPA/600/M-91/032
- **Water Quality** EPA/600/M-91/033
- **Risk Assessment** EPA/600/M-91/034
- **Pesticide Usage Guidelines** EPA/600/M-91/035
- **Pollution Prevention** EPA/600/M-91/036
- **Environmental Impact Assessments** EPA/600/M-91/037
- **EPA Information Sources** EPA/600/M-91/038
- **Environmental Management** ...EPA/600/M-91/039

Each complete Technical Information Package (TIP) consists of a cover brochure as well as all of the documents highlighted within the body of the brochure. Generally, the cover brochures contain a section discussing the environmental issue, associated health and environmental effects, guidelines, sampling and analytical methods, as well as treatment and disposal technologies. Following this section, a bibliography is provided to identify other important sources and documents in the field. An attempt has been made to provide references that are readily available in technical libraries. Finally, a number of EPA contacts followed by some additional resources are listed to facilitate consultation and technical assistance. Document ordering information is provided on page 8.

FRONT COVER: Construction of the Stonewall Jackson Dam in West Virginia.

Photo courtesy of the U.S. Army Corps of Engineers.

Environmental Assessment Process

Key Concepts

Environmental Assessment (EA) Process[1]: This generic term denotes a multifaceted decision-making process. The process is structured to anticipate, analyze and disclose the consequences associated with proposed activities[2] with respect to established public policies for protecting and enhancing the natural and man-made environment.

Terms associated with the EA process include:

Assessment: An "assessment" is any documentation describing the consequences associated with a project and the means by which the estimates were derived.

Environmental Assessment: An "EA" is a document containing information in sufficient detail to determine whether a project's environmental consequences will fall above or below thresholds considered to pose significant adverse impact to the environment.[3]

Environmental Impact Assessment: An "EIA" is a document containing an assessment of environmental consequences for projects known, or expected, to exceed thresholds of significant adverse impact to the environment.[4]

The overall purpose for undertaking an environmental assessment is to seek ways to avoid or minimize adverse effects of a proposed project to the extent practicable, and the maintenance, restoration or enhancement of environmental quality as much as possible.

Notes:

[1] "Environmental Review" (ER) process is the legal term used in the United States (U.S.).

[2] "Proposed activities" subject to assessment are not limited to physical projects, but may also include plans, programs, policies and even legislation or regulations if it is determined that their implementation, directly or indirectly, could cause potentially significant environmental impacts to occur. The term "project" is used generically hereafter for any or all of these categories.

[3] In the U.S., EAs are coupled with a decision document termed a "Finding of No Significant Impact."

[4] In the U.S., EIAs consist of an "Environmental Impact Statement" (the "assessment") coupled with a decision document termed a "Record of Decision."

Support documents:

- *Facts About The National Environmental Policy Act*, September 1989, Council on Environmental Quality and U.S. EPA.

The Benefits of an EA Process

An EA process is essentially an early warning process. The primary objectives of an EA process are to alert all interested parties to: the purposes and potential negative impacts associated with a proposed project; and alternatives that optimize positive outcomes while minimizing undesirable effects. The earlier it is initiated the greater the benefits it will provide.

Proposed projects start with an initial planning/design stage, followed by detailed planning/engineering, and ends in implementation or construction. The review for potential environmental impacts should be coupled with the early phases of initial planning and design. If unacceptable impacts are anticipated, changes can be made during early project planning to minimize them less expensively than would be required once engineering or construction work has begun. In some cases, environmentally preferable alternatives may be identified. Therefore, the effectiveness of an EA process is dependent on the following two conditions: first, that the process is an integral part of the plan of action, begun early in the budgeting cycle before irrevocable commitments of resources have been made; and second, that it is linked to the decision-making processes involving location and design studies.

An EA process can greatly influence where and how a project or activity is sited, the size of facilities to be built, the technologies employed, and the area a project is to serve or otherwise affect. Location analysis can help to avoid areas of environmental importance, such as critical habitats of endangered species and highly productive farmland. It can also help to avoid potential catastrophic situations such as diverting developments from areas that are

frequently flooded or potentially hazardous to life and property in other ways.

If critical or sensitive resources or locations cannot entirely be avoided, comparative analysis of alternatives can help identify options that minimize irreparable damage. Similarly, analysis of alternative technologies can identify cost-effective solutions that reduce discharges of air and water pollutants as well as providing collateral savings to the public in terms of reduced maintenance and health costs. Finally the analyses of an EA can influence the extent of project service areas, thereby allowing local communities to exercise control over land-usage and urban growth incompatible with preserving environmental amenities.

Establishing the Framework

Assigning responsibilities[5]: There are several approaches for constructing a framework. They require the following questions to be answered: who will be responsible for (1) preparing the basic format and other assessment requirements to be followed; (2) preparing assessment documents on individual projects; (3) making the final decisions based on project assessments; and (4) evaluating the adequacy of assessments and decisions that flow from them.

For example, a single agency can be designated to be responsible for all four tasks. The benefit to this approach is that it might produce the greatest uniformity of EA application and, incidentally, may preclude the need for evaluating the adequacy of individual assessments. A drawback to this model is that this approach would be the least effective in convincing other agencies about the benefits of the EA process.

Another approach would be to spread the responsibilities for the four tasks among as many agencies as possible. This model would enable the responsibility for the actual production of assessments to be assigned to every agency having jurisdiction over activities affecting development. However this approach would require an independent agency for conducting task four. In the long run, this model could maximize government-wide regard for environmental principles.

There are several other combinations that could be established in between. The most common approach is to require each agency to produce and issue assessments on all projects within their jurisdiction and make final decisions on them, and rely on another agency to undertake the tasks of establishing basic requirements and evaluating the adequacy of assessments.

Note:

[5] The discussion in this and other sections assumes that the process is being conducted by a governmental agency.

Applicability of Projects to Assessment

All projects can benefit from EA even on an individual business level. On a governmental level, triggering mechanisms for subjecting projects to EA are usually defined in the law creating the process. For example, the American federal process requires only projects involving a "federal action" to undergo an EA. Federal actions are generally limited to project sponsors applying for federal financial assistance, a permit or license. Different levels of government may subject different kinds of projects to assessment. When an assessment is required by two different levels of government, requirements of both are usually incorporated into an assessment conducted at the highest level of government.

However, some project actions are so inconsequential that it would be a waste of resources to require them to undergo an EA. Therefore, the EA process usually begins with an initial step for determining whether or not a project should undergo an assessment at all.

To be exempted from the EA process, a project must meet two tests:

Test 1 - the project should be consistent with categories of projects that have been determined not to individually, cumulatively over time, or in conjunction with other projects in the same area, have a significant effect on the quality of the environment (e.g., minor rehabilitation of existing facilities or replacement of equipment); however,

Test 2 - a project meeting the criteria for exemption (test 1) must not be located in or near areas that might affect the protection of sensitive natural or cultural resources (e.g., endangered species, historic sites, etc.).

categories of potentially excluded projects (test 1) are sometimes based on criteria resulting from public policy. More often they result from agency experience indicating that certain project categories rarely result in adverse impacts to the environment. Criteria for not granting an exclusion from EA (test 2) are almost always due to public policy.

Even though, based on the tests above, a decision is made to exclude a project from EA, good practice suggests that the affected public should be notified about these projects as with any other type of assessment. The value of the notice is that local interested parties may know reasons other than those considered by the assessment team, why a particular project should not qualify for exemption.

Experience gained on the federal level in the U.S. indicates that approximately 10-15% of projects covered by the EA process are categorically excluded from further assessment.

Determining the Appropriate Level of Assessment

For project actions not excluded from further assessment, the majority of project actions will fall into a category of assessment whose impacts are unknown. The procedures for undertaking an EA generally begin with an examination of the proposed action to whatever level of detail is required in order to make one of two determinations: either there will be *no* significant impact expected to result; or, there *will* be significant impacts. If at any time during the preparation of an EA information is uncovered that would indicate the project could impact the environment in a significant way, the EA can be immediately terminated and a full-scale EIA begun.

As experience in EA is gained, project actions that have significant impacts associated with them in every case (e.g., power plants, reservoirs and dams) should be identified and categorized. Criteria that may be useful in identifying significant project actions include when a project (1) impacts directly on air and water quality, particularly if there is a possibility that standards may be exceeded or degradation of high quality conditions may occur; (2) adversely affects protected ecological resources, such as endangered species; (3) creates undesirable secondary impacts, such as increased traffic or rapid urban growth; (4) causes release of toxic or hazardous materials or generation of wastes; and (5) in combination with other activities causes adverse cumulative effects.

A majority of project actions result in findings that do not significantly affect the environment, or are easily changed to avoid any undesirable impacts. Only a small percentage of all project actions will require a detailed EIA.

Components of an EA Process

There is not a precise and uniform methodology for EIA. There are, however, four components, each having a core set of activities, that are generally characteristic of EIA as it is practiced throughout much of the world. These four basic components are infinitely adaptable to fit unique environmental, political or cultural conditions. EIA is very much an evolving process, reflecting both the growth in environmental knowledge and increasing experience.

The four basic components to an EIA process, regardless of the complexity of the evaluation to be undertaken, include (1) *Surveying and Information Gathering* - describing the existing environmental/social setting and identifying the project's potential benefits and adverse impacts; (2) *Alternatives Generation and Forecasting* - identifying alternatives and projecting the future environmental and social setting by anticipating the consequences of each alternative; (3) *Screening* - comparing and contrasting the short and long-term effects of each alternative for acceptability of change they cause; and (4) *Communicating* - informing the affected and interested public about the rationale for selecting a "preferred alternative" and soliciting input. There is a fifth component that is not a formal part of an assessment process but is very much related to it. This is: (5) *Monitoring* - ensuring that a project is carried out as approved.

Component 1 - *Surveying and Information Gathering*: project needs and objectives and general solutions are defined; surveys are conducted to collect data descriptive of the existing environmental setting (base line data); meetings with affected and interested parties

are held to identify the environmental issues that need to be addressed (scoping process); and, the nature and intensity of current trends causing changes to the setting are identified. Governmental agencies having jurisdiction over areas that may be affected by the project as well as other groups having special knowledge and information pertinent to the project should be identified and invited to participate in this and succeeding steps. These activities can be best handled by creating an inter-disciplinary team early in this step to work on producing an integrated assessment involving all five steps.

Component 2 - *Generating Alternatives and Forecasting*: First agreement on a set of viable alternatives is reached. Then a "no-action" forecast is made to determine what the future environmental setting might look like without the project being undertaken. Next, modifications to the initial forecast are made to determine the beneficial or negative effects that each alternative under consideration might produce. This step should, if feasible, also take into account: scenarios that identify "areas of uncertainty" for projects expected to have detrimental effects to various segments of the environment; and, should also identify cumulative affects caused by long-term phased projects and/or from other developments in the project area.

Component 3 - *Screening*: The beneficial and adverse short- and long-term impacts of each alternative should be compared and contrasted, and summarized in a way to facilitate discussion and evaluation by the affected public and other interested parties. As a part of this step, the limits of acceptable change and risk should also be identified and explained. The results of this step will be a draft EA document that summarizes the alternatives studied and, whenever possible, identifies the preferred alternative and the reasons for its selection.

Component 4 - *Communicating*: There are numerous benefits to inviting the affected public and other interested parties to comment on all aspects of an assessment, especially on the draft EA. The two principal benefits are that it produces better informed judgements and creates a better climate for public acceptance of a proposed project. Their active participation helps in clarifying the options available and to disclose additional appropriate issues. New issues raised by the public that have not been addressed in the draft EA document should be resolved and included within a final EA document. Whenever necessary, a mitigation plan should be worked out with all interested parties. Finally, a decision document for the public record is prepared focusing on the reasons for the selection of the alternative to be built.

Component 5 - *Monitoring*: This is sometimes considered as one of the major components of an EIA process. In reality, monitoring is generally undertaken during, and following, the implementation or construction of a project. An entity having legal capacity to enforce compliance of restrictions that may have been imposed on the project should be given responsibility for seeing that mitigation measures, when appropriate, are implemented, and environmental safeguards are enforced.

Support documents:

- *Scoping Guidance*, Memorandum of the Council on Environmental Quality, issued April 30, 1981.

The Substance and Content of Assessments

An EA process is an umbrella under which concerns for the protection of impacted natural and cultural resources can be weighed against the benefits derived from the project. Each individual project will raise different issues. One project may require diverse expertise in many socio-economic, ecological and cultural disciplines. Another may have only narrow concerns involving only one or two disciplines. To address this problem, checklists have been developed to quickly assess which potential areas of impact will, or may, be involved. Project managers should consider probable consequences in the following areas (although this is not intended to be an exhaustive list):

- **Human health concerns** include the identification and minimization of undesirable releases of: particulate or hazardous substances to the air; nutrients or hazardous substances to surface water; and solid wastes or hazardous

substances (e.g., pesticides) to soils and groundwater. Assessments should also examine disposal methods for unavoidable contaminants so that environmental problems are not transferred among media. Although the concerns in this area focus on human health, measures taken to prevent contamination of drinking water or waters used for recreation, for example, also will benefit ecological concerns such as fish and wildlife habitats.

- **Other Socio-Economic concerns** include avoiding: the displacement of residents; unaffordable user fees to build, operate and maintain projects; adverse effects on property values and land-use zoning including the uses or misuses of lands in floodplains; overloading community services; and, problems stemming from induced growth in general, including transportation costs and mobility.

- **Ecological concerns** vary widely among geographic and climatological regions of a country or the world. On a national scale, major areas of concern include protection of endangered species of plant and animal life and their aquatic and terrestrial habitats, preservation of wild and scenic rivers and national parks, and other resources considered "critical" (e.g., prime farmland, wetlands, barrier islands and wilderness areas). On a more local level, additional concerns (e.g., preservation of farmlands that produce specialty crops, areas other than prime agricultural land, land of importance to local economies or that which provides open-space relief from otherwise unbroken development) may need to be considered.

- **Cultural concerns** include identifying and determining the worthiness of preserving the artifacts of early cultures and historic settlements (e.g., tools, utensils, furnishings, buildings and other structures). Where and when it becomes impossible to preserve items which have been designated as official historic landmarks, or otherwise considered significant by interested parties, then an effort should be made for experts to study the site and document its attributes and significance prior to its loss by construction activities.

Support documents:

- *Cross-Cutting Environmental Laws: A Guide for Federal/State Project Officers*, January 1991, Office of Federal Activities, U.S. EPA.

(2 model checklists)

- *EPA Reviewers Checklist* and *Guidance for EPA Regional Oversight of State National Environmental Policy Act Delegation.*

Oversight of the EA Process

Oversight of the EA process is necessary to ensure that the intent of an EA process is implemented in a fair and equitable manner.

Establishing Uniform Procedural Requirements

One agency must be relied upon to provide leadership for establishing the basic procedural requirements and guidelines for undertaking the basic components of the EA process. Its primary objective is to establish ground rules to ensure uniform application of legal EIA procedural requirements fashioned to minimize adverse impacts from projects. It should also be responsible for producing guidance documents, as needed, to aid responsible parties in carrying out their duties such as: clarifying requirements of the law; or clarifying how the basic requirements may apply to new assessment situations.

The lead agency should also be responsible for: gathering information on the conditions and trends in environmental quality; evaluating the programs of all responsible parties in light of the goals established in law; developing and promoting national policies to improve environmental quality; and conducting studies, surveys, research and analyses relating to ecosystems and environmental quality. Each year an annual report should be published to inform all responsible parties and the general public on the status of various environmental concerns including the success, or lack thereof, of the EA process.

Responsible Party Adaptation of the EA Process

Once established, the EA process should be applied uniformly across all program areas.

This does not mean that the EA process need to be pursued apart from planning processes established under individual program requirements. It only means that agencies should prepare EAs and EIAs using a common format modified to include all other project planning information needed for an agency to reach its final decision. The format should be such that decisions that result in adverse impact to the environment will clearly highlight the tradeoffs being made between project benefits and impacts. It should also allow for presenting how project benefits outweigh impacts, or, how other priorities may override the environmental ones involved.

Independent Review of Projects

When many agencies are involved in an EA process, there are bound to be differences of opinion on interpreting the significance of impacts, including the acceptability of permissible change to elements of the natural and man-made environment. For this reason several countries, including the U.S., have established an independent evaluation process for all "major" projects (e.g., projects determined to have "significant" impacts). Usually the same agency that establishes the original EIA guidelines is also charged with the independent evaluation of major projects.[6] The function of this reviewing agency is twofold. First it must review individual project EA documentation for adherence to the minimum set of requirements for EIA including public notification and participation in the process. Second it must review for acceptability of the impacts caused, including whether or not the alternative chosen is the most appropriate in minimizing adverse impacts to protected environmental resources. The reviewing agency should also have the responsibility for maintaining a file, available to public inspection, on all major projects evaluated, including a brief description of the action, how well the agency met the requirements of the law and how acceptable the agency's action is in protecting and restoring environmental resources.

Note:

[6] In the U.S. the Council on Environmental Quality originally produced the original requirements and provided the independent evaluation of major project assessments. The independent review is now carried out by the Environmental Protection Agency.

Attachments:

Sect 1502.10, Recommended format; Regulations for Implementing the Provisions of the NEPA, Council on Environmental Quality, 1980.

Additional References

- *Application of Environmental Impact Assessment: Highways & Dams*, United Nations Economic Commission for Europe, Environmental Series ECE/ENV/50.

National Environmental Policy Act [NEPA] of 1969, 42 U.S.C. 4321 *et seq.*

Executive Orders 11514 and 11991; *Council on Environmental Quality Regulations Implementing NEPA*, November 29, 1978 (43 FR 55978).

Environmental Impact Assessment: Theory and Practice, Ed. by Peter Wathern, Unwin Hyman, 1988.

Evaluation of EPA's EIS Program for Wastewater Treatment Facilities, November 1980, Office of Federal Activities, U.S. EPA.

Procedures for Implementing the Requirements of the Council on Environmental Quality on The National Environmental Policy Act, 40 CFR Part 6, U.S. EPA.

Environmental Impact Assessment, Larry W. Canter, McGraw-Hill Book Co., 1977.

Environmental Impact Assessment, Proponent Sponsored Engineer Corps Training, U.S. Corps of Engineers, CE Training Management Div., 1991.

Environmental Assessment Contact List

Technical Area	Contact	FAX Number
Basic Principles & Processes	John Gerba	202-260-0129
Cultural Assessments	Bob Hargrove	212-264-6693
Current Issues	William Dickerson	202-260-0129
Ecological Assessments	Heinz Mueller	404-257-5206
Methods for Identifying & Forecasting Impacts	Larry Canter	405-325-7596
Policy & Plan Assessment	Joseph Montgomery	202-260-0129
Post Assessment Effectiveness	Gene Wojcik	312-886-0168
Public Participation	David Ketchum	202-205-1708
Recommended Formats & Evaluating Documentation	Anne N. Miller	202-260-0129
U.S. Experience	Nicholas C. Yoast	202-887-0689
U.S. National Environmental Policy Act (NEPA)	Dinah Bear	202-395-3744

Training Contacts

The following U.S. federal government agencies provide open enrollment workshops:

CE Registrar
U.S. Army Corps of Engineers
Engineering Division, Huntsville
ATTN: CECND-TD-RG
Huntsville, AL 35807-4302

Group Leader for Training and Support
Environmental Coordination Staff
Forest Service
U.S. Department of Agriculture
P.O. Box 96090
Washington, D.C. 20090-6090

Ordering Technical Documents

The EPA documents mentioned in the Technical Information Package brochures can be ordered at no charge (while supplies are available) from the Center for Environmental Research Information (CERI). Once the CERI inventory is exhausted, clients will be directed to the National Technical Information Service (NTIS) where documents may be purchased. Orders can be placed by mail, phone, or FAX. To order documents, have the document number or the EXACT title ready. The journal articles listed in the *Additional References* section may be ordered from the U.S. National Focal Point of INFOTERRA.

CENTER FOR ENVIRONMENTAL RESEARCH INFORMATION (CERI)
U.S. EPA, P. O. BOX 19963
CINCINNATI, OH 45219-0963
513-569-7562 PHONE 989-296-(US EPA UD) TELEX
513-569-7566 FAX
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SPRINGFIELD, VA 22161
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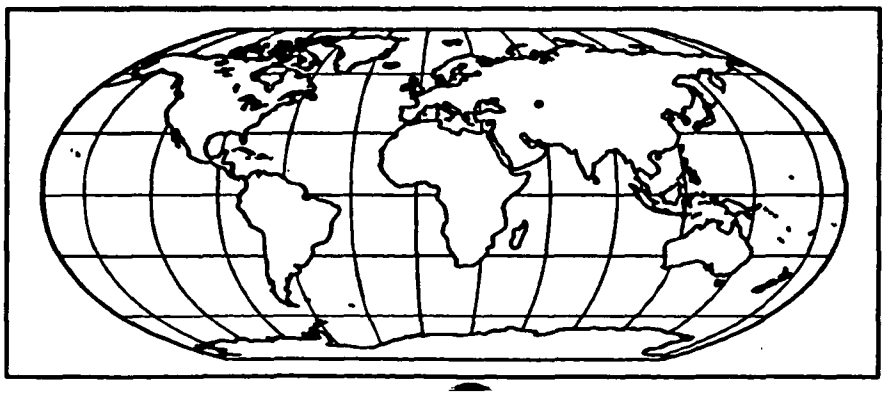

CHAPTER 2

INITIATION

CHAPTER 2

INITIATION

Initiation is generally an internal agency process preceding interagency and public involvement that defines the purpose and need for the proposed activity, generates tentative alternatives, and determines the appropriate level of environmental review and documentation (e.g. in the U.S., categorical exclusion, environmental assessment or environmental impact statement). Predetermined lists, a screening procedure or a combination of these approaches can be used to determine the potential impacts of a proposed action. Management commitment to and support of the EA process must be established early in the planning process and continue throughout the process in order for EA to influence decisionmaking. Although proposals are generated by government decisionmakers, government and public applicants for permits or funding, court orders, and legislative commands, the proponent (i.e., the agency) has the responsibility for developing an interdisciplinary approach to EA that is integrated with planning and decisionmaking.

NEEDS

The initiation phase requires a clearly stated proposal, succinct statements of purpose and need (Attachment 2.A), environmental information for screening to determine the appropriate level of EA, formation of an EA team, and determination of responsibility for coordination, record keeping and public involvement.

- **Environmental Information.** The EA process begins when a proposal is sufficiently well-developed that an environmental information packet can be prepared. The proponent (agency, applicant, grantee, or permitee as the case may be) assembles the packet, generally from existing information and comparison to similar activities. (Activities that can be categorically excluded from detailed EA rarely require information beyond that found in existing sources; activities that require EA may require additional or new information.) The information is used by the proponent to determine the level of EA required for a proposed activity and also it can be used as the basis for public information for scoping.

The packet should describe the potential environmental impacts of the proposed action and be of sufficient scope that it can be used to determine if and how the proposal should be pursued. At the initiation stage, knowledge and understanding of the EA requirements and procedures, management support, good communication, sufficient information, and logic are required. Above all, the content and extent of the environmental information, and all subsequent EA documentation, must be in proportion to the environmental issues and to the relative importance of those issues to decisionmaking. A checklist may be helpful at this stage to identify basic issues related to proposed projects (Attachment 2.B).

To the extent possible and as relevant to the proposed activity, the environmental information packet should include discussion/description of the following items:

- Need for the proposed activity
- The proposed activity
  - description of the proposed activity in appropriate detail
  - current management or other activities in the area
  - known potential impacts of the proposed activity
  - important elements of the existing environment (physical, biological, and social characteristics)
  - known public use/interest in the area
  - reasons for bounding the study area
  - possible concerns
- Purpose (objectives) of the proposed activity
- Decisions to be made
  - reference to any higher-level policy or planning or existing environmental documents that might influence the decisions to be made
- Preliminary alternatives to the proposed action
  - including the no-action alternative (which provides the baseline information for assessment)
- Anticipated level of EA documentation including rationale
- Activities to be considered in the EA (scope)
  - connected, cumulative, or similar activities
  - mitigation measures
- Environmental laws
  - associated review, consultation, or permit requirements
- Federal, state, or local government agencies with jurisdiction by law or expertise

  - names of agencies and point of contact with addresses and telephone numbers
  - tentative roles of agencies
  - formal/informal agreements needed and responsible persons
- Background information documents (e.g., prefeasibility studies, environmental studies)
- Schedule
  - EA milestones, comment periods, and approval dates
  - proposed implementation dates
  - role of the decisionmaker in the assessment process and the review of EA documentation
- Budget
- Responsibility
  - proponent point-of-contact (oversight)
  - team leader
  - team members
  - other expertise as needed
  - editing, graphics
- Public involvement
  - proposed public involvement strategy
  - known affected or interested persons, agencies, organizations

Screening. Once the environmental information is available, the proposed activity can be reviewed in order to determine the appropriate level of environmental assessment. This internal procedure is often referred to as "screening".

There are two approaches to screening, categorical and discretionary, and most EA requirements [e.g., the CEQ regulations implementing NEPA (Part D) and the EC Directive on EIA, 85/337/EEC (1985)] provide for a combination of approaches.

- Under the categorical approach, the proposed activity is compared to pre-determined lists of specific categories of activities that 1) can be excluded from EA or will 2) always be subject to EA. Often the applicability of the exclusion list is determined by eligibility criteria (e.g., if the proposed activity has the potential to affect a valued wetland or other sensitive area, it will be subject to EA even if it is on the exclusion list). The categorical approach reduces uncertainty

and delay in determining which proposed activities will be subject to detailed EA.

- Under the discretionary approach, if the proposed activity cannot be categorically excluded, the proponent decides on the appropriate level of EA. An (EA) document is prepared to assess the environmental significance of the proposed activity.
  - If it is determined that the proposed activity may significantly affect the quality of the human environment, then a full environmental assessment is required, starting with the scoping process and culminating in an environmental impact assessment (EIA) that documents for the decisionmaker the information needed to decide between the proposed activity or one of its alternatives.
  - If it is determined that the proposed activity will not significantly affect the quality of the human environment and/or that potentially less significant impacts can be easily mitigated, then the proponent prepares a brief document that explains why the project will not significantly affect the environment, and if applicable, describes the mitigation measures.

Public involvement in the EA process usually begins when the decision is made that an EIA is required.

Interdisciplinary EA Teams. When the screening process results in a decision that an EIA is required, the proponent is responsible for preparation of the document. Quality EA and documentation is dependent on an experienced EA team leader with a general understanding of all of the issues and an interdisciplinary team of technical and scientific specialists chosen to match the issues associated with the proposed action and its alternatives (Canter 1991). The U.S. CEQ regulations require this interdisciplinary approach (Part D). Furthermore, the regulations require that the professional qualifications of the team members (i.e., their expertise, experience, and professional disciplines) be included in an EIA.

Teams are assembled from staff members, other government agencies or are hired consultants [e.g., non-governmental organizations (NGOs), universities]. Occasionally, team membership can only be determined after completion of the scoping process. Generally, three types of members are selected:

- a team leader, who is responsible for the overall analysis, document preparation, and coordination with the proponent's point-of-contact;
- the core team members, who are responsible for analysis of specific issues; and
- extended team members, who provide information as needed.

The team is responsible for thorough and correct analyses that provide a basis for decisionmaking by the proponent. A team is most likely to produce a competent assessment when it has a thorough understanding of the EA process and prior experience with similar environmental and project issues. Attachment 2.C outlines the characteristics and responsibilities of an EA team leader, the team members, and the extended team members.

- **Proponent Responsibilities.** Successful EA depends not only on adequate environmental information and technical expertise, but also on good planning, management-support, and coordination with the decisionmaker. The proponent must provide the team with:

  - a clear and concise statement of work including the expected technical and procedural standards to be met;
  - available background information (e.g., the environmental information packet);
  - EA document standards (e.g., word processing, format, graphics, number of pages, printing, distribution);
  - a single point-of-contact selected by the decisionmaker who understands the issues and possible decisions and who has been delegated the authority to make interim decisions;
  - a reasonable schedule for deliverables;
  - budgetary allocations; and
  - procedures for review and comment, to include consolidation and clarification of comments by the point-of-contact before delivery to the EA team.

  The proponent is responsible for the quality and accuracy of the information and analyses in an EA document, as well as the conduct of the EA process (i.e., interagency coordination, scoping, public hearings, document review, and general oversight).

- **Public Involvement Strategy.** Public involvement in the EA process, other than being required by law, is also a good management practice. It helps the proponent understand the expectations and concerns of the interested and affected publics,

identify the potential for controversy, and obtain additional information relevant to the proposed activity. It also enhances the proponent's credibility and lessens the chances for public grievances, appeals, litigation, and media attacks. The proponent must encourage and facilitate public involvement by providing public notice of hearings, meetings, and availability of EA documents. Moreover, the public must be given an opportunity to comment on EA documents. In turn, the proponent must remain flexible and ready to respond to public comments and suggested alternatives and issues related to the proposed activity.

Development of a public involvement strategy should start as soon as a decision is reached on the level of EA. The proponent should consider:

- Who might be interested or affected by the proposed activity?
- Who might have information or expertise needed for the EA?
- What information is needed from each person, government agency, and NGO on the list?
- What is the most effective way of obtaining the information?

There are a number of techniques for communicating with the public (Table 2-1); however, each letter, notice, or meeting must be planned to suit the specific proposed activity.

- **Planning Records.** Because records documenting the EA procedures may be required by law, it is important that a plan for record keeping is established early in the planning process. When the EA decision document is signed, the files should be closed. However, the records must be available upon request except for classified information or information on specific locations of endangered species or cultural resources which may be exempt from the law. Such classified information should be kept in a separate and locked file. The contents of a planning record are outlined in Attachment 2.D.

  The planning record is a critical part of a proponent's defense should a lawsuit occur. The object is to be able to document that the procedural requirements of EA were followed in good faith and that a reasonable decision was made based on the information obtained using the procedures. Depending on the size of the project, a data base index might be useful in tracking documents, letters, etc. Fields could be: date, author, agency, organization, addressee, document type, and issue.

Table 2-1. Techniques for communicating with the public. Adapted from Bishop, 1973. (Source: Federal Environmental Assessment Review Office (FEARO). 1986. Initial Assessment Guide. Federal Environmental Assessment Review Office, Ottawa K1A 0H3)

Communication Characteristics				Public Information and Participation Objectives					
Level of Public Contact Achieved	Ability to Handle Specific Interest	Degree of 2-way Communication	Public Participation/Communication Techniques	Inform/Educate	Identify Problems/ Values	Gel Ideas/Solve Problems	Feedback	Evaluate	Resolve Conflict/ Consensus
2	1	1	Public Hearings		X		X		
2	1	2	Public Meetings	X	X		X		
1	2	3	Informal Small Group Meetings	X	X	X	X	X	X
2	1	2	General Public Information Meetings	X					
1	2	2	Presentations to Community Organization	X	X		X		
1	3	3	Information Coordination Seminars	X			X		
1	2	1	Operating Field Offices		X	X	X	X	
1	3	3	Local Planning Visits		X		X	X	
2	2	1	Information Brochures and Pamphlets	X					
1	3	3	Field Trips and Site Visits	X	X				
1	1	2	Public Displays	X		X	X		
2	1	2	Model Demonstration Projects	X			X	X	X
3	1	1	Material for Mass Media	X					
1	3	2	Response to Public Inquiries	X					
3	1	1	Press Releases Inviting Comments	X			X		
1	3	1	Letter Requests for Comments			X	X		
1	3	3	Workshops		X	X	X	X	X
1	3	3	Advisory Committees		X	X	X	X	
1	3	3	Task Forces		X	X		X	
1	3	3	Employment of Community Residents		X	X			X
1	3	3	Community Interest Advocates			X		X	X
1	3	3	Ombudsman or Representative		X	X	X	X	X
2	3	1	Public Review of Initial Assessment Decision Document	X	X	X	X	X	X

1 = low, 2 = medium, 3 = high

X = Capability

The following suggestions for organizing planning records are excerpted from the U.S. Forest Service Litigation Support Handbook:

- Establish the organizational structure, put it in writing, and delegate authority to one person for maintaining the record.
- Use a format based on subject (not date or EIA chapter) so that someone not familiar with the project or with the EA process can retrieve documents easily. Use headings such as:
  - External Agency Communications
  - Internal Agency Communications
  - Public Involvement
  - Resource References and Reports
  - Maps and Other Visuals
  - Data and Inventories
  - NEPA Documents
  - Decision Documents
- Format all documents to a standard size and place in 3-ring binders or similar folders.
- Signatures must be original, carbon copy, or electronic copy ("/s/" is not admissible in U.S. courts).
- Margins should be no less than 1".
- Attach all slides and photographs (including photos of oversized maps and visuals) to standard size paper.
- Replace double-sided document with single-sided copies; remove all paper clips, post-it notes and staples; copy all documents clearly, correctly, and completely; retype all illegible documents, mark them as duplicates, and include the original and the duplicate in the record.
- Documents should be ordered chronologically within each subdivision.
- Pages in the planning record should be clearly numbered consecutively, with page 1 being the first page of the oldest document.

TOOLS

- **Regulations, Guidelines.** United States government agencies are required to formally adopt procedures to implement the federal regulations. Among other things, the procedures must specify criteria for and identification of categories of action that normally:

  - do not require environmental impact statements (EISs);
  - do not require an EIS or an environmental assessment (EA) document (these are categorical exclusions); or
  - require EAs but not necessarily EISs.

These categories of action are used in the screening process to determine the appropriate level of EA for a proposed activity. The list of categorical exclusions includes actions that do not individually or cumulatively have significant effects based on agency experience.

In addition, agencies should prepare written procedures/guidelines/ handbooks that describe their particular EA process and establish offices with responsibility for document review and oversight.

ISSUES

- **EA and Planning.** Environmental assessment must be integrated with other planning at the earliest possible time so that the EA documentation will be completed and ready to be included in every report or recommendation on proposals submitted to the decisionmaker

  A "proposal" originates when an agency has a goal and is actively preparing to make a decision on one or more means of accomplishing it, and the effects of that decision can be meaningfully evaluated. EA documents should not be prepared until prospective proposals are more concrete than mere contemplation. However, EA document preparation should not be put off so as to delay underlying actions. The initiation of EA should coincide with the feasibility analysis stage of projects and the EA documentation should be available before the project has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

  All government agencies should adopt procedures to integrate EA with their planning processes so that projects are better sited and better designed and proposals that have unacceptable environmental impacts will be modified or canceled. However, the extent that EA is integrated into decisionmaking will vary from agency to agency and sometimes from project to project (Bear 1987). Some agency officials resist the application of EA, citing conflicting purposes between EA and their "real" mission. Other agency decisionmakers believe the primary value of compliance is to avoid litigation. While in some agencies, the EA process is a vital part of their decisionmaking process. How an agency views and implements the EA process will depend on the commitment of the decisionmaker(s), high-level staff in environmental review or compliance offices, and the solicitator's or general counsel's office.

- **Coordination with Other Laws.** Environmental impact assessments should be prepared "concurrently with and integrated with" other environmental analyses and reviews to reduce duplication between federal, regional and local EA activities. In addition to the U.S.

federal laws listed in Part D, other federal laws contain provisions that affect the content and scope of EA under certain circumstances. Laws on water pollution control, clean air, and surface mining control and reclamation are good examples. Permits or licenses may also require baseline data. There is no one way of accomplishing this integration because of differences in agencies' projects and differences in regional and local procedures. However, the EA process lends itself to a unifying role because it deals with every aspect of the environment, and thus provides a focus for multiple approval processes (Yost 1989). The key to success lies with early planning and some flexibility in project scheduling.

The proponent must:

- establish contact with the relevant agencies to learn their concerns and requirements;
- determine how cooperation can best be achieved;
- prepare a project schedule that coordinates agency requirements and EA milestones, and
- maintain contact to ensure that cooperation continues.

LINKAGES

Initiation may be the most important element of the EA process. At this time, commitments are made to support (philosophically and financially) consideration of the environment in decisionmaking. Tentative alternatives are generated and the level of EA is determined. These activities influence the makeup of the EA team, the assessment effort, and the documentation required. Integration of the early stages of EA with the feasibility discussions and planning for proposed actions results in more effective compliance with environmental standards; improvements in the design and siting of construction projects; savings in capital and operating costs; speedier approval of development applications; and the avoidance of costly adaptations to projects once in operation (Lee 1988).

REFERENCES

Bear, D. 1987. Does NEPA make a difference. In: Environmental Impact Assessment, Proceedings of a Conference on the Preparation and Review of Environmental Impact Statements, West Point, New York. New York State Bar Association, One Elk Street, Albany, New York 12207. 329 pp.

Canter, L. W. 1991. Interdisciplinary teams in environmental impact assessment. Environmental Impact Assessment Review 11: 375-387.

Environmental Law Institute. 1989. NEPA Deskbook. Environmental Law Institute, Washington, D.C. 438 pp.

European Economic Community. 1985. Council Directive on the Assessment of the Effects of Certain Public and Private Projects on the Environment. 85/337/EEC. Official Journal of the European Communities, No. L 175, S.7.85. pp. 40-48.

Kirsch, P. J., and C. M. Rippy. 1991. Defining the scope of alternative in an EIS after Citizens Against Burlington. Environmental Law Reporter 12 ERL 10701-10710.

Lee, N. 1988. Training requirements for environmental impact assessment. In: Environmental Impact Assessment. Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Stein-Hudson, K.E. 1987. How local and regional public participation affect the EIS process. In: Environmental Impact Assessment, Proceedings of a Conference on the Preparation and Review of Environmental Impact Statements, West Point, New York. New York State Bar Association, One Elk Street, Albany, New York 12207. 329 pp.

U.S. Forest Service. 1989. Litigation Support Handbook 1509.21, Region 2, Supplement 3. Denver, Colorado.

Yost, N. C. 1987. One project-one process: an applicant's perspective on coordinating the EIS process at the federal and state level. In: Environmental Impact Assessment, Proceedings of a Conference on the Preparation and Review of Environmental Impact Statements, West Point, New York. New York State Bar Association, One Elk Street, Albany, New York 12207. 329 pp.

Identification of Issues

Issues are unresolved concerns or questions, often about the environmental consequences of proposed activities, that have societal significance. They are usually raised during scoping and document review by interested or affected individuals, groups, organizations or agencies that value a certain resource. The identification of issues early in the planning process helps to limit the scope of EA to potentially significant impacts, relevant concerns, and workable, acceptable solutions to problems that are useful to the decisionmaker and the project planner. To be meaningful and effective, EA must be relevant to regulatory needs and public concerns as well as scientifically valid.

Although issues are mostly project-specific, public concerns with environmental matters generally fit into the following categories (FEARO 1986, Beanlands 1988):

- impacts on human health and safety;
- threats to livelihood (e.g., loss of important commercial species or commercially available production; concern for habitat losses which represent a foreclosure on future production);
- life-style modifications (e.g., loss of home or changes in life style due to visitors or new residents with different values);
- threats to valued resources (e.g. recreational, aesthetic, educational, scientific and historic features, and the preservation and conservation of biological populations, communities, and natural areas);
- land-use conflicts (especially when available land is limited and the proposed uses are mutually exclusive); and
- supply and demand (i.e., when there are perceived imbalances between supply and demand of resources and their development within a local, regional or national context).

NEEDS

- Clear purpose and need statements (Attachment 2.A), project descriptions, tentative alternatives, and known potential environmental impacts and mitigation measures, so that the publics and agencies understand the proposed action and can participate in scoping and document review in a meaningful way.
- Distribution of project information to interested/affected publics and agencies.
- Public and agency participation in scoping meetings.
- Identification early in the EA process of the valued environmental components so that the assessment is focused on the important issues and the assessment endpoints necessary for impact analysis can be determined.

TOOLS

- The use of checklists can help the proponent and the EA team identify potential impacts and issues associated with a proposed activity (Attachment 2.B; also Chapter 4.1 and 4.2).
- Public involvement is necessary to determine the social relevance of environmental issues (i.e., the value placed on the change by different affected groups). If a component has little public value, it may not warrant extensive effort in the assessment. However, there can also be issues of interest to other governmental agencies or issues of scientific and ecological/environmental importance that must be resolved but which may not elicit public interest.
- In addition to techniques for communicating with the public listed in Table 2-1, the proponent should solicit input from appropriate professionals and other government agencies. Surveys, questionnaires, and brainstorming sessions can provide opportunities for identification of issues.
- Use of the following questions will help to focus the issues and impacts:
  - Who is interested in the issue and what are the chief concerns?
  - What is the threshold of concern (i.e., the point at which an impact becomes unacceptable)?
- If possible, determine the threshold of concern (i.e., a maximum or minimum number or other value for an environmental impact or resource use which, if exceeded, causes it to take on new importance) in terms of the following criteria:
  - magnitude [the probable severity of each potential impact (e.g., degree, extent, or scale)];

- prevalence (relation to cumulative impacts);
- duration and frequency (long-term, short-term, recovery during inactive periods);
- risks (probability of environmental effects); and
- precedent (does the project create a precedent that is likely to be duplicated or extended elsewhere?).

ISSUES

- Lack of public understanding of the proposed action and its potential environmental impacts.
- Care should be taken that issues identified during scoping are not:
  - too broad to be useful for analytical purposes (e.g., cultural impacts - what does this mean? What are the impacts that should be examined?);
  - causes rather than issues (e.g., oil and gas development is a cause that fails to go beyond the obvious to the specific effects that are of concern); and
  - outside of agency control (e.g., mandated by legislation).
- Once issues are identified, the proponent must refine broad general topics and specify which issues need analysis and evaluation, eliminate from detailed study those issues that are not significant, and identify those issues that have been covered by prior environmental review.
- Often an issue is not clearly stated and it is difficult to determine the underlying concern or question. As a result the document may not address a relevant issue and the adequacy of the document is open to challenge.
- Characterization and analysis of issues is often difficult because baseline data are lacking and the degree of uncertainty is high.

LINKAGES

Early identification of important issues during initiation and scoping gives direction to EA and allows more focused efforts. However, the potential exists for new or additional information to become available throughout the EA process (i.e., assessment, decisionmaking, and post-decision analysis); thus, new issues may need to be addressed at any time.

REFERENCES

Bardwell, L. V. 1991. Problem-framing: a perspective on environmental problem-solving. Environmental Management 15:603-617.

Beanlands, G. 1988. Scoping methods and baseline studies in EIA. In: Environmental Impact Assessment: Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston 332 pp.

FEARO (Federal Environmental Assessment and Review Process). 1986. Initial Assessment Guide. Federal Environmental Assessment Review Office, Ottowa, Canada. 36 pp.

Generation of Alternatives

United States federal regulations require analysis of reasonable alternatives to a proposed action, including the option of not proceeding with any action at all (the "no action" alternative) (Part D). This is considered the heart of EA because it organizes and clarifies choices available to the decisionmaker and presents the consequences of each choice. The description of the no action alternative provides a baseline of information on the present and future environment for comparing and contrasting the impacts of the proposed action among other alternatives (see Chapter 4.1 for baseline information).

Preliminary alternatives are generated at the initiation stage by the proponent. These are included in the environmental information packet that is prepared for distribution at scoping meetings and elsewhere. Additional alternatives may be generated by the public, NGOs and other governmental agencies during scoping and at other stages of the EA process (e.g., document review). Alternatives can be different ways of accomplishing the purpose and need (i.e., alternatives to a project such as conservation, recycling, new or different technologies) or different ways of accomplishing the proposed action (i.e., alternatives within a project such as options for siting, scaling, phasing, timing of construction and operation; mitigation, use of resources, management of residuals).

NEEDS

- A clear description of the purpose and need for the proposed action in order to identify and bound reasonable alternatives (Attachment 2.A).
- A description of the proposed action, its potential impacts, and any known related issues.
- Relationship of the proposed action to other known or reasonably foreseeable actions (projects, programs, policies) including possible cumulative effects.
- Any policy, programmatic, legal, regulatory or other constraint to the proposed action.
- A list of the alternatives considered during the preparation of the proposal.

TOOLS

- A no action alternative as a benchmark against which to compare and contrast the anticipated effects of the proposed action among other alternatives.
- Intra-agency consultation to generate preliminary alternatives.
- Scoping meetings and interagency consultation to generate other alternatives.
- A screening procedure to reduce alternatives to a reasonable number that are practical, feasible and representative of the complete array of viable alternatives.

ISSUES

- Generation of preliminary alternatives should occur as soon as the purpose and need are established so that planning to select the proposed action does not bias the choice of alternatives.
- Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the proponent.
- Reasonable alternatives are not limited to the jurisdiction of the proponent.
- The alternatives should offer substantive choices.
- All reasonable alternatives, including the preferred alternative, should be given equal treatment in EA documentation. Identification of a preferred alternative provides a focal point for commentary by other organizations and the public. Moreover, it is required by U.S. federal regulations (Part D).

LINKAGES

The generation of preliminary alternatives starts during the initiation stage of a proposed action. Additional alternatives are generated during scoping and may even be identified during the analysis and decisionmaking stages of EA. In general, after scoping there is agreement on the alternatives to be evaluated in the EA document. Documentation is prepared for those alternatives eliminated from detailed study, including the reasons for their elimination.

ATTACHMENT 2.A

PURPOSE AND NEED

- Introduction: Defining the Purpose of and Need for a Proposed Action

- Schmidt, O. L. 1988. The statement of underlying need defines the range of alternatives in environmental documents. Environmental Law 18:371-381.

- Kirsch, P. J., and C. M. Rippy. 1991. Defining the scope of alternatives in an EIS after *Citizens Against Burlington*. Environmental Law Reporter 21:10701-10710.

Introduction: Defining the Purpose of and Need for a Proposed Action

In the United States, an EIS must briefly specify the underlying purpose and need to which an agency is responding in proposing alternatives, including the proposed action. The less detailed U.S. NEPA document (i.e., an environmental assessment) must have a statement of underlying need, but need not have a statement of purposes.

Webster defines need as the lack of something requisite, desirable, or useful or a condition requiring relief. Purpose is defined as an object or end to be achieved. Consequently, the two terms should be seen as complimentary. The EIS discussion of purpose and need should demonstrate that the purpose of a proposed action is to attain or achieve at least part of the underlying need for the proposed action (Kirsch and Rippy 1991).

The CEQ regulations and most U.S. agencies do not distinguish between purpose and need and the terms are used together and separately in NEPA documents. Such flexibility is considered desirable because of the widely disparate nature of agency activities to which the CEQ regulations apply. However, lack of distinction in agency statements of purpose and need can lead to litigation (Attachment 2.A).

Both the CEQ regulations and case law recognize that it is the statement of need that defines the scope of alternatives in an EIS (Kirsch and Rippy 1991). If the need for an action is defined too broadly, the number of alternatives that might require analysis could be limitless. For example, a Department of Interior EIS defined the underlying need for the issuance of oil and gas leases in the Gulf of Mexico as the need to meet the Nation's energy crisis. Subsequently, as a result of *Natural Resources Defense Council, Inc. v. Morton*, the court required the agency to consider all reasonable ways to meet the energy crisis in their EIS (including eliminating oil import quotas, developing oil shale, tar sands and geothermal resources, desulfurizing coal, and coal liquefaction and gasification) even though the agency did not have the authority to implement all of the alternatives.

On the other hand, it is inappropriate in most situations, to define the underlying need so narrowly that only the proposed action is applicable. For example, if a site needs to perform laboratory analyses within 24 hours of water sampling in order to meet quality assurance procedures, an inappropriate statement of need would be that the agency needs to construct a new onsite laboratory. A new onsite laboratory is but one way of meeting the agency's need; other alternatives might include expansion of existing onsite facilities or use of nearby off site facilities.

In general, it is useful to think of the purpose of the proposed action as one way to satisfy the underlying need for the action. The statement of need should be an objective description of the reason that the proposed action is being pursued (Kirsch and Rippy 1991). The statement of purpose follows from the statement of need. It can be a subjective statement

that refers to the agency's mission, reflects the limits on the agency's statutory authority, explains how the proposed action satisfies the need, and justifies the decision to choose the preferred alternative (Kirsch and Rippy 1991).

THE STATEMENT OF UNDERLYING NEED DEFINES THE RANGE OF ALTERNATIVES IN ENVIRONMENTAL DOCUMENTS

BY
OWEN L. SCHMIDT*

I. INTRODUCTION

We propose to build a dam because we need a dam. We propose to cut trees because we need to cut trees. We propose to drill wells because we need to drill wells. We propose action because we need action.

This simple logic may satisfy the unenquiring, but probing minds want to know the underlying reason action is proposed. Without knowing why action is needed, we cannot know what other ways we might have to meet those needs, or what would happen if we did not meet those needs. We cannot know if any action at all is really needed.

When Federal agencies propose to take action, we expect an explanation of what action is proposed, what need would be met by taking that action, what alternative actions would also meet that need, and we expect to see a comparison of the alternatives alongside the proposed action. In short, this is the decision making process that was perhaps envisioned by the National Environmental Policy Act (NEPA)[1] and its implementing regulations.[2] Are Federal agencies fulfilling this vision?

II. THE UNDERLYING PURPOSE AND NEED

Environmental impact statements (EISs) must include a brief statement of "the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action."[3] These few words have great impact on the contents of an EIS, but the Council on Environmental Quality (CEQ) does not elaborate on what it meant by the words "underlying purpose and need."

Maybe CEQ meant a single statement of "purpose and need," using two words to express the concept when one might have been enough, or maybe CEQ meant two statements, one for "purpose" and one for "need." CEQ does not say what it meant.[4]

The two words have different meanings. A "need" is the lack of something requisite, desirable, or useful, or a condition requiring supply or relief.[5] Purposes, on the other hand, are goals, or ends to be attained.[6] Thus if we give these two words their literal meanings, a statement of underlying purpose and need will actually have two parts: *needs* (lack of something wanted, presence of something not wanted), and *purposes* (goals, ends to be attained).

The words are not synonyms. A need is not a purpose, and a purpose is not a need. If use of both words was intentional, then Federal agencies must write a "purpose and need" statement in two parts. If use of both words was in any way unintentional, then Federal agencies may have more latitude in how they prepare this section of an EIS.

I suggest that whether or not use of two words was intentional, purposes and needs are different elements of an EIS. Federal agencies *should* write a statement of needs, and a statement of purposes. Each has its place in the decision making process. If agencies do that, their EISs will take on a structure like that presented in this article.

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1. 42 U.S.C. §§ 4321-4370 (1982).
2. 40 C.F.R. §§ 1500-1508 (1987).
3. 40 C.F.R. § 1502.13 (1987).
4. *See* CEQ, Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18,026 (1981) [hereinafter Forty Questions]. This document's title is self-explanatory; however, it does not address or explain the "underlying purpose and need" requirement.
5. "Needs" is defined as "2a: a want of something requisite, desirable, or useful;" and "3: a condition requiring supply or relief." A "need" can be seen as the lack of something wanted, or the presence of something unwanted. WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY (1971).
6. "Purposes" is defined as "an object to be attained: an end or aim to be kept in view in any plan, measure, exertion, or operation." *Id.* Thus a "purpose" can be seen as a goal to be attained, perhaps while seeking to satisfy an underlying need.

III. A Proposal for Action to Meet an Underlying Need

The NEPA process starts with a proposal for action.[7] A proposal for action starts with an underlying need.

The CEQ's regulation on underlying need seems to suggest that needs come first—"the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." Agencies respond to needs. Needs come first, then agencies respond to them by proposing action.

What action? Action that somehow meets the underlying need. Action that supplies something that is lacking, or takes away something that is not wanted.

There is no rule that the action must completely meet the underlying need,[8] or be the only way to meet the underlying need, or even be the best way. The rule is that there must be some sort of relationship between the proposed action and the underlying need.

For example, a Federal agency proposes to build a dam. Why? Flood control, power, and recreation. Is this the correct statement of underlying needs? It may be. If it is established that there are floods, then there may be a condition requiring relief. That would be the correct definition of an underlying need. Whether there is also a need for power and recreation requires further proof. If it can be established that there is a need for power, then the proposal to build a dam meets two underlying needs—flood control and power. And for recreation, if there is a condition requiring relief, building a dam may meet three needs. But if there is no "need" for power or recreation, the needs may become "purposes"—goals to be attained while building a dam to meet the need for flood control.

7. "An agency shall commence preparation of an environmental impact statement as close as possible to the time the agency is developing or is presented with a proposal . . . so that preparation can be completed in time for the final statement to be included in any recommendation or report on the proposal." 40 C.F.R. § 1502.5 (1987).

8. "[T]he EIS must nevertheless consider such alternatives to the proposed action as may partially or completely meet the proposal's goal and it must evaluate their comparative merits." Natural Resources Defense Council v. Callaway, 524 F.2d 79, 93 (2d Cir. 1975). The case uses the word "goal" rather than "underlying need," but the concept is the same.

Thus there is established a structure for preparing EISs: a *proposed action* (build a dam), to meet an *underlying need* (flood control), while achieving other *purposes* (power and recreation in this example).

IV. Alternative Ways to Meet the Need

Nothing better characterizes the NEPA process than the development of alternatives. But which alternatives? The proper alternatives in an EIS are alternative ways to meet the underlying need.[9]

Take the above example of a proposal to build a dam to meet the underlying need for flood control. What are other ways to meet the underlying need? Perhaps an upstream program of levees, weirs, and vegetation management would also control floods. Perhaps a number of smaller upstream dams would work. There may be other ways.

But what if there were also a need for power? Then would any of these alternatives still work? Probably not. Levees and upstream vegetation management are not alternative ways to meet the underlying need for power. Thus a Federal agency defines the range of alternatives in an EIS by defining the underlying need. When the underlying need is for both flood control and power, only a dam will meet that need and the range of alternatives may become very narrow.

Take the case of *City of New York v. United States Department of Transportation*.[10] The Department of Transportation (DOT) proposed to regulate the highway transport of radioactive materials. The underlying need to which DOT was responding

9. The "rule of reason" for the range of alternatives is well known. *See, e.g.*, Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, 435 U.S. 519, 551 (1978). Thus only "reasonable" alternatives are required. CEQ defines the kinds of alternatives required within the scope of an EIS as the no action alternative, other reasonable courses of action, and mitigation measures not in the proposed action. 40 C.F.R. § 1508.25(b) (1987). These rules are entirely consistent with each other. The "no action alternative" is defined in this article as "the alternative of not meeting the need." "Other reasonable causes of action" are other reasonable ways of meeting the underlying need. "Mitigation measures" are a special class of alternatives and can be added to an EIS without conflicting with the range of alternatives responding to the underlying need.

10. 715 F.2d 732 (2d Cir. 1983), *cert. denied*, 465 U.S. 1055 (1984).

was the need for Federal regulation for safe highway routing of radioactive materials. The City of New York criticized DOT's rulemaking and urged DOT to consider barging radioactive materials around the city as an alternative to highway transport.[11] Is barging an alternative to highway transport? Yes, of course it is. But is barging an alternative way to meet the underlying need? No:

> The scope of alternatives to be considered is a function of how narrowly or broadly one views the objective of an agency's proposed action. In this case, for example, if DOT's objective is to improve the safety of highway transportation of radioactive materials, relevant alternatives might include a choice of routes, a choice of equipment, and a choice of driver qualifications. If DOT is concerned more broadly with all transportation of these materials, it might consider alternative modes of transportation. If the objective is viewed still more broadly as reducing the hazards of radiation exposure, the Department might consider alternative sources of power that could reduce the generation of spent nuclear fuel.[12]

The court used the word "objective" rather than "underlying need," but the concept is the same--the range of alternatives is defined by the statement of underlying need. Barging is not an alternative to highway safety, although it would be an alternative to highway transport. DOT need not have considered barging radioactive materials around New York as an alternative in its environmental document[13] because it was responding to the need for safe highway transport of radioactive materials, not to the need for transportation of some kind.

There are very few cases making this point. In *Natural Resources Defense Council, Inc. v. Morton*,[14] the Secretary of the

11. "Throughout the rule-making process, the City of New York was a vocal critic of DOT's proposals and repeatedly urged DOT to broaden the scope of its inquiry and to consider barging as an alternate means of transporting large-quantity shipments of radioactive materials around urban centers that lack circumferential highways." City of New York v. United States Dep't. of Transp., 715 F.2d at 739.

12. *Id.* at 743.

13. It is not relevant here that DOT had prepared an Environmental Assessment (EA) rather than an EIS. The court was not construing 40 C.F.R. § 1502.13, which pertains only to EISs. The point is the same whether agencies prepare EAs or EISs.

14. 458 F.2d 827 (D.C. Cir. 1982).

Interior prepared an EIS prior to issuing Gulf of Mexico oil and gas leases. The underlying need to which the Secretary was responding stemmed from the problem of the energy crisis of the early 1970s. Other ways to meet the need included eliminating oil import quotas, developing oil shale, tar sands, and geothermal resources, desulfurizing coal, and coal liquefaction and gasification.[15] Even though it was beyond the Secretary's jurisdiction to change the oil import quota or implement the other alternatives, the court required these alternatives in the Secretary's EIS, noting that the level of detail needed for some kinds of alternatives might be affected by "the needs to which the underlying proposal is addressed."[16] Once Interior had defined the underlying need as the need to meet the nation's energy crisis, all reasonable ways to meet the energy crisis had to go into the EIS. Those that were less reasonable could perhaps be described in less detail.

In *Izaak Walton League of America v. Marsh*,[17] an EIS on a Corps of Engineers' proposed replacement lock and dam was held adequate even though it did not include a rehabilitation alternative because that alternative would not meet the underlying need for expanding the lock and dam, did not include a railroad alternative because that alternative would not meet the need for more safety at the lock and dam, and did not include the alternative of controlling congestion at the existing lock and dam because that alternative would not meet the need for expanding the capacity of the waterways system.[18] "It would certainly be a waste of agency resources to test the efficiency of an alternative which is not only beyond the agency's power, but also incapable of either fully solving the problem at hand or fulfilling the mandate of Congress."[19]

15. *Id.* at 834, 836-37.

16. *Id.* at 837-38.

17. 655 F.2d 346 (D.C. Cir.), *cert. denied sub. nom.* Atchison, T. & S.F. Ry. v. Marsh, 454 U.S. 1092 (1981).

18. *Id.*, 644 F.2d at 372-74.

19. *Id.* at 374. The court is apparently adding three criteria to the proper range of alternatives: (1) the alternative must be within the agency's power, (2) the alternative must be "fully capable of solving the problem at hand," and (3) the alternative must fulfill the mandate of Congress. Even partial solutions may be a reasonable alternative. *See* Natural Resources Defense Council v. Callaway, 524 F.2d 79, 93 (2d Cir. 1975) ("[T]he EIS must nevertheless consider such alternatives to the proposed action as may partially or completely meet the proposal's goal and it must evaluate their comparative merits."). As to being within the agency's power and fulfilling the mandate of Congress, EISs must include alterna-

In *Trout Unlimited v. Morton*,[20] the court upheld the range of alternatives in an EIS on a proposed dam project. Of the need for flood control, the alternative of levees was considered. Of the need for irrigation water, the alternative of groundwater pumping was considered. "The range of alternatives that must be considered need not extend beyond those reasonably related to the purposes of the project."[21] The court used the term "purposes" of the project rather than "underlying needs," but the concept is the same.

Thus the structure of an EIS continues with the added twist that it is not alternatives to the proposed action that must be analyzed in an EIS, but alternative ways to meet the underlying need. If a particular alternative does not meet the need very well, or is otherwise not very reasonable, it might be analyzed in less detail.

V. No Action—Not to Meet the Need

A "no action" alternative is required in EISs.[22] Many EISs treat the no action alternative literally as "not taking the proposed action." If the proposed action is to build a dam, the no action alternative may be treated simply as not building a dam. The impacts of not building a dam are then treated as not flooding farmland, not relocating displaced landowners, not building access roads, etc.

A more insightful approach would be to treat the no action alternative as not meeting the need. In our example, there is a need to control floods. What would happen if the need were not met? Continued floods! What is the impact of continued floods?

tives outside the mandate of Congress and agency's statutory authority. *See* Natural Resources Defense Council v. Morton, 458 F.2d 827, 835 (D.C. Cir. 1972) ("While the Department of Interior does not have the authority to eliminate or reduce oil import quotas, such action is within the purview of both Congress and the President, to whom the impact statement goes"). The better rule would be that none of these criteria are valid reasons to leave an alternative out of an EIS entirely, but these factors may affect the level of detail to which the alternatives are analyzed.

20. 509 F.2d 1276 (9th Cir. 1974).

21. *Id.* at 1286.

22. 40 C.F.R. § 1508.25(b)(2) (1987). CEQ does provide guidance on this in Question [illegible] of its "Forty Most Asked Questions." *See* Forty Questions, *supra* note 4, at 18[illegible]

And what is the impact of the proposed dam? With this analysis, decision makers, and the public, would have before them the true difference between building and not building the dam.

One court has acknowledged this approach. In *Trout Unlimited v. Morton*, above, the Ninth Circuit upheld an EIS which "considered the alternatives of (1) no development whatsoever (the alternative of not accomplishing the project's purposes),"[23] but the court did not elaborate. CEQ has also acknowledged this approach. " 'No action' . . . would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward."[24] Following CEQ's advice, an agency would analyze the impacts of not meeting the need rather than simply not taking the proposed action.

VI. Purposes Become Decision Factors

A troublesome part of this model is to distinguish "needs" from "purposes." A handy rule of thumb is that needs have alternatives and purposes do not. In other words, agencies develop reasonable alternative ways to meet needs, but not purposes.

Purposes are those collateral decision factors that help sort out the alternatives. For example, if an agency presented four alternatives in an EIS—each equal in every respect except that one was cheapest—and if one of the agency's purposes was to save money, then the cheapest alternative would be favored by that decision factor. In our earlier example, the underlying need was to control floods. Alternatives included levees and vegetation management. If one of the agency's purposes were to provide recreation, then the alternative that had the best recreation benefit would be favored by that factor in the decision making process. In our example, building the dam would probably provide the best recreation benefits and the proposed action would thus be favored by this purpose.

Purposes appear in two places in the decision making process: in the "purpose and needs" section of the EIS[25] and again in

23. 509 F.2d at 1286.

24. 46 Fed. Reg. 18027, March 23, 1981.

25. 40 C.F.R. § 1502.13 (1987).

the Record of Decision (ROD).[26] The CEQ regulations do not say that purposes appear in a ROD, but decision factors must be disclosed:

> An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.[27]

The logic for tying "purposes" in an EIS to "decision factors" in the ROD is threefold. First, the ROD should be based on the record before the agency. In many agency proceedings, the EIS is perhaps the only record created prior to the decision, and so the EIS is the best place if not the only place to put matters that are relevant to the decision. Second, there may be acute public awareness of and interest in the pending decision. Disclosure of all relevant decision factors in the EIS—long before they are disclosed in the ROD—serves as public notice and invites comments on decision factors that may affect the public. Third, putting these factors into the EIS paves the way for those who follow to write the ROD. The eleventh decision making hour, when ROD writers are hard at work, is not the best time to start listing the relevant decision making factors.

Thus the structure of an EIS continues with the decision factors—as they will ultimately be used in the ROD—being disclosed in the purpose and need section.

VII. Special Rules for Environmental Assessments (EAs)

EAs must have a statement of underlying need, but need not have a statement of purposes: "Environmental Assessment . . . [s]hall include brief discussions of the need for the proposal . . ."[28] Why did CEQ leave "purposes" out of EAs? A simple explanation, consistent with the model described above, is that for EISs, purposes are only relevant at the time of preparing the ROD. Because EAs are not followed by RODs,[29] there is no rea-

26. 40 C.F.R. § 1505.2 (1987).
27. 40 C.F.R. § 1505.2(b) (1987).
28. 40 C.F.R. § 1508.9(b) (1987).
29. CEQ regulations only require RODs in cases where EISs are prepared. 40 C.F.R. § 1505.2 (1987) ("At the time of its decision . . . each agency shall prepare a concise public record of decision"). This section only applies to cases where an EIS is prepared.

son to put purposes into EAs. In other words, purposes are relevant at the time of decision as decision factors. Decision factors must be disclosed in RODs. RODs are not required in cases where EISs are not prepared. Thus the reason purposes are required in EISs is simply not present when an EA is prepared.

Agencies may choose to prepare RODs following EAs, and thus should put purposes into EAs as well as EISs. In any event, at the time of decision, when decision makers are balancing all relevant factors, the record should disclose somewhere what decision factors—underlying purposes—the agency was responding to.

VIII. A Checklist for the Purpose and Need Statement

The statement of proposed action and underlying need can never be the same. "We propose to build a dam because we need a dam" is not a proper statement of underlying need; it is just a repetition of the proposal, and in any event it is not analytic.

The reasonable alternatives to be presented in an EIS are the reasonable ways to meet the underlying need. Alternatives that do not meet the need can in some cases be eliminated from study and in other cases be analyzed in less detail. The proper question is not "What alternatives are there to this *proposal*," but "What alternatives are there to meet this *underlying need*."

Needs are distinguished from purposes by the fact that needs have alternative solutions, but purposes do not. For example, saving money is nearly always an agency objective. But agencies do not usually engage in decision making processes for the sole purpose of saving money. Normally agencies apply the factor of cost savings when deciding between alternative ways to meet an underlying need.

Purposes are goals to be attained while meeting the underlying need, and become decision factors at the time of making the decision. Decision factors conveniently fall into three categories: economic, technical, and environmental. The choice between alternatives often requires a balance between these factors.

"No action" means not to meet the need. There is very little

analysis in defining the no action alternative simply as not to take action. A better perspective comes from analyzing the alternative of not meeting the need.

Agencies are free to define the underlying need to which they are responding, subject to judicial review under an as-yet-undefined standard. The law in this area has not yet developed. Agencies should expect, however, not to define arbitrarily or capriciously an underlying need, and to show a rational connection between proposed action, other alternative courses of action, and the underlying need.

NEWS & ANALYSIS

ARTICLES

Defining the Scope of Alternatives in an EIS After *Citizens Against Burlington*

by Peter J. Kirsch and Conrad M. Rippy

Editors' Summary: NEPA requires federal agencies to prepare EISs for major federal actions that significantly affect the quality of the human environment. EISs must discuss all reasonable alternatives to the proposed action. The discussion of alternatives is the heart of an EIS. In Citizens Against Burlington, Inc. v. Busey, *the D.C. Circuit appears to have narrowed the scope of alternatives that a federal agency must consider when it issues a permit or other federal approval. This Article analyzes the case and proposes an interpretation that would reconcile* Citizens Against Burlington *with CEQ regulations and NEPA case law on the scope of alternatives.*

In the recent case of *Citizens Against Burlington, Inc. v. Busey*,[1] the D.C. Circuit interpreted the National Environmental Policy Act (NEPA)[2] and its requirement that federal agencies, when preparing an environmental impact statement (EIS), must consider all reasonable "alternatives to the proposed action."[3] On its surface, the opinion by Circuit Court Judge Clarence Thomas[4] appears to reject both NEPA regulations and longstanding case law on the proper scope of alternatives that an agency must consider in an EIS. The opinion seems to sanction a narrower scope of alternatives when a federal agency issues a permit or other federal approval than when a federal agency is the principal proponent of a project. This Article explores the court's reasoning and proposes an interpretation of the case that reconciles the apparent conflict between *Citizens Against Burlington* and 20 years of case law defining the proper scope of alternatives in an EIS.

NEPA requires that federal agencies prepare an EIS on "major Federal actions significantly affecting the quality of the human environment."[5] The regulations of the Council on Environmental Quality (CEQ), which form the foundation for all other federal regulations under

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1. 938 F.2d 190, 21 ELR 21142 (D.C. Cir. 1991).
2. 42 U.S.C. §§4321-4370a, ELR STAT. NEPA 001-012.
3. NEPA §102(2)(C)(iii), 42 U.S.C. §4332(2)(C)(iii), ELR STAT. NEPA 003.
4. On October 15, 1991, the Senate confirmed Clarence Thomas as an Associate Justice of the U.S. Supreme Court.

   Judge Thomas has not taken an overly friendly view of environmental concerns in the past. For example, in Cross-Sound Ferry Services, Inc. v. Interstate Commerce Comm'n, 934 F.2d 327 (D.C. Cir. 1991), Judge Thomas concurred in a judgment denying a NEPA claim. Moreover, he would have denied standing to the plaintiff, arguing, contrary to the majority, that the national transportation policy set forth at 49 U.S.C. §10101 could not be interpreted to encompass environmental factors. Judge Thomas contended that statutory language mandating efficient transportation "surely did not mean to . . . promote ecological consciousness-raising" or any factors other than "the economics of transportation." *Id.* at 338. Judge Thomas thus seems unwilling to consider environmental protection as an element of a cost-benefit equation.

   Although he has not written any other significant environmental opinions, Judge Thomas' basic indifference towards environmental claims appears in other environmental cases in which he has sided with the majority in denying claims based on federal environmental laws. *See, e.g.*, National Wildlife Fed'n v. United States Envtl. Protection Agency, 925 F.2d 470, 21 ELR 20565 (D.C. Cir. 1991) (denying petition for review of a decision by EPA allowing states, for limited time periods, not to comply with the Safe Drinking Water Act); Tongass Conservation Soc'y v. Cheney, 924 F.2d 1137, 21 ELR 20558 (D.C. Cir. 1991) (upholding as adequate the consideration of a range of alternatives in an EIS prepared by the Department of Defense for siting of a submarine base); Macht v. Skinner, 916 F.2d 13, 21 ELR 20,004 (D.C. Cir. 1990) (holding that neither federal funding for an EIS for a light rail vehicle project otherwise entirely funded by the state of Maryland nor Army Corps of Engineers issuance of a wetlands permit for a "negligible" part of the project constitutes major federal action for the purposes of NEPA or §4(f) of the Transportation Act); Hazardous Waste Treatment Council v. United States Envtl. Protection Agency, 910 F.2d 974, 20 ELR 21359 (D.C. Cir. 1990) (denying a petition for review of a Resource Conservation and Recovery Act "no migration" hazardous waste disposal exemption). *But see* Linemaster Switch Corp. v. United States Envtl. Protection Agency, 938 F.2d 1299, 21 ELR 21359 (D.C. Cir. 1991) (denying plaintiffs' petition for review of decision by EPA to add hazardous waste sites owned by plaintiffs to the national priorities list under the Comprehensive Environmental Response, Compensation, and Liability Act).
5. NEPA §102(2)(C), §4332(2)(C), ELR STAT. NEPA 003.

NEPA,[6] require that an EIS contain, among other elements, a statement of the purpose of and need for the action,[7] and a discussion of alternatives to the proposed action.[8] It is these two requirements that were at issue in *Citizens Against Burlington.*

The requirement to analyze alternatives to a proposed project is the heart of NEPA. It is absolutely essential that an EIS contain "detailed and careful" analysis of the relative merits and demerits of the proposed action and proposed alternatives, a requirement which courts have characterized as the "linchpin" of an EIS.[9]

Citizens Against Burlington v. Busey

Background of Toledo Airport Expansion EIS

Citizens Against Burlington arose from the approval by the Federal Aviation Administration (FAA) of plans to expand Toledo Express Airport near Toledo, Ohio. The Toledo-Lucas County Port Authority sought to expand Toledo Express Airport to accommodate plans by Burlington Air Express to move its air cargo operation to Toledo from Fort Wayne, Indiana. Toledo predicted that Burlington's move would bring more than 1,000 jobs to the city's depressed economy. As an incentive to attract Burlington, the Port Authority proposed to enhance Toledo Express Airport by constructing new facilities and lengthening a runway and taxiways at the airport, all of which required FAA approval. The Port Authority also sought FAA funding for the expansion project.

One of the first steps in seeking FAA approval or funding is the preparation of the required NEPA documentation on the proposal. As required by FAA regulations,[10] the Toledo Port Authority prepared an environmental assessment,[11] which the FAA converted into an environmental impact statement.[12] The draft EIS generated considerable controversy from both the public and the Environmental Protection Agency.[13] In its final EIS, under a subhead entitled "Need for the Proposed Federal Action," the FAA explained that:

> The purpose and need for this action lies in FAA's responsibility to review the airport design and runway configuration with respect to its safety, efficiency and utility within the national airspace system and its environmental impact on the surrounding area.
>
> The key item in this regard is the need for extending Runway 7-25 to provide safe and adequate length . . . .
>
> Another purpose and need for the proposed Federal action is that FAA has a statutory mandate to facilitate the establishment of air cargo hubs . . . .[14]

The FAA reviewed and dismissed several alternatives before concluding that it had to consider in depth the environmental impacts of only two alternatives: the approval of the airport expansion plan as proposed by Burlington and the Port Authority, and the no-action alternative. The FAA explained that

> [w]ith respect to this proposal for establishment of an air cargo hub at Toledo Express Airport, the role of the FAA in selecting alternatives is limited. . . . The FAA has verified the need for the proposed project . . . . The FAA has further reviewed the site selection process that Burlington began in 1987 . . .[15]

Following issuance of the EIS, the FAA approved the proposed airport expansion in July 1990.[16]

Judge Thomas's Opinion on Review of the EIS

The petitioners in *Citizens Against Burlington* sought review of the FAA's decision approving the Toledo expansion plan on the grounds that the EIS impermissibly discussed only the alternatives of approving the plan as proposed by the Port Authority and the no-action alternative. Petitioners argued that the FAA should have considered other alternatives in detail, including the alternative of expanding Burlington Air Express operations at its existing Fort Wayne, Indiana, facility.[17] Petitioners also raised a number of issues relating to the adequacy of the EIS discussion of noise impacts, to the scope of analysis required for compliance with §4(f) of the Department of Transportation Act[18] and §509(b)(5) of the Airport and Airway Improvement Act of 1982,[19] and relating to NEPA conflict-of-interest rules,[20] which are beyond the scope of this Article.

6. 40 C.F.R. §1507.1 (requiring all federal agencies to comply with CEQ regulations).

7. *Id.* §1502.13.

8. *Id.* §1502.14.

9. Natural Resources Defense Council, Inc. v. Callaway, 524 F.2d 79, 92, 5 ELR 20640, 20647 (2d Cir. 1975) (quoting Monroe County Conservation Soc'y, Inc. v. Volpe, 472 F.2d 693, 697-98, 3 ELR 20006, 20007 (2d Cir. 1972)).

10. *See* FED. AVIATION ADMIN., U.S DEP'T OF TRANSP., ORDER 5050.4A, AIRPORT ENVIRONMENTAL HANDBOOK (1985) [hereinafter FAA ORDER 5050.4A]; FED. AVIATION ADMIN., U.S. DEP'T OF TRANSP., ORDER 1050.1D, POLICIES AND PROCEDURES FOR CONSIDERING ENVIRONMENTAL IMPACTS (1986).

11. FAA ORDER 5050.4A, *supra* note 10, para. 43 *et seq.*

12. *Id.* at para. 72 *et seq.*

13. *See* 55 Fed. Reg. 8983 (Mar. 9, 1990) (EPA comments finding that draft environmental impact statement was "inadequate to fully assess all environmental impacts and therefore does not meet the purpose and intent of NEPA" and that the project was "environmentally unsatisfactory"). EPA comments on the draft EIS resulted in so much interagency controversy that EPA was able to pressure the FAA into signing a letter agreement over the manner in which impacts for future airport expansions would be analyzed. Letter from Barry Lambert Harris, Deputy Administrator, Federal Aviation Administration, to F. Henry Habicht III, Deputy Administrator, Environmental Protection Agency (June 15, 1990).

14. FED. AVIATION ADMIN., U.S. DEP'T OF TRANSP., FINAL ENVIRONMENTAL IMPACT STATEMENT ON ESTABLISHMENT OF AIR CARGO HUB, TOLEDO EXPRESS AIRPORT, TOLEDO, OHIO, at 1-3 (May 11, 1990) [hereinafter TOLEDO EIS].

15. *Id.* at 2-1.

16. FED. AVIATION ADMIN., GREAT LAKES REGION, U.S. DEP'T OF TRANSP., RECORD OF DECISION FOR TOLEDO EXPRESS AIRPORT, TOLEDO OHIO (July 12, 1990).

17. Brief for Petitioners, On Petition for review of a Decision of the Federal Aviation Administration at 1, Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 21 ELR 21142 (D.C. Cir. 1991) [hereinafter Pet. Br.].

18. Section 4(f) of the Transportation Act of 1966 prohibits the FAA from approving any project that uses protected parks, recreation or wildlife areas, or historic structures unless there is no prudent and feasible alternative to using the land and the project includes all possible planning to mitigate for harm to protected lands. 49 U.S.C. §303(c).

19. The Airport and Airway Improvement Act is similar in language to §4(f) of the Transportation Act but broader in scope in that it prohibits FAA funding of a airport expansion project that "may have a significant impact" on any environmental factor unless no feasible

For the present discussion, it is important to understand the issues on review as articulated in petitioners' brief. The principal issue was the scope of alternatives in the EIS:

> Whether the FAA has violated NEPA by relying on an environmental impact statement which (a) fails to analyze the continuation of Burlington's operations in Ft. Wayne even though this is a feasible and reasonable alternative . . . [21]

Petitioners argued at length that the FAA should have considered the alternative that the Burlington Air Express facility would remain at Ft. Wayne, Indiana, [22] and criticized the agency's assertion that legally it was limited in its action to accepting or rejecting Toledo's application. [23]

The D.C. Circuit panel, with Judge James Buckley dissenting, upheld the scope of alternatives in the EIS. Writing for the majority, Judge Clarence Thomas undertook a wide-ranging discussion of an agency's obligations under NEPA to consider alternatives in an EIS. [24] Noting that the term "alternatives" as used in NEPA is not self-defining, [25] Judge Thomas observed that "[i]f . . . the consideration of alternatives is to inform both the public and the agency decisionmaker, the discussion must be moored to 'some notion of feasibility.'" [26] Judge Thomas explained that an alternative is reasonable—and must, therefore, be analyzed in an EIS—"if it will bring about the ends of the federal action." [27] In other words, he concluded, "[t]he *goals* of an action delimit the universe of the action's reasonable alternatives." [28]

Court's Definition of Goals of Federal Action

The court started by explaining its standard of review: "the agency . . . bears the responsibility for defining at the outset the objectives of an action," [29] and the court will "uphold an agency's definition of objectives so long as the objectives that the agency chooses are reasonable." [30] Nevertheless,

> an agency may not define the objectives of its action in terms so unreasonably narrow that only one alternative . . . would accomplish the goals of the agency's action. . . . Nor may an agency frame its goals in terms so unreasonably broad that an infinite number of alternatives would accomplish those goals . . . [31]

Paraphrasing the EIS, the court explained how an agency should determine its "goals" and "objectives" when the agency is asked to approve an application by a nonfederal party: an "agency should take into account the needs and goals of the parties involved in the application." [32] The court did not explain the relationship between an applicant's "needs and goals" and the corresponding federal "goals" and "objectives," though the context suggests that the court used the terms interchangeably.

The court next turned to an examination of how the FAA set its "goals" for the Toledo airport expansion. Observing that Congress has told the FAA to "nurture aspiring cargo hubs," [33] Judge Thomas concluded that it was proper for the FAA to define its goal with reference to "the Port Authority's reasons for wanting a cargo hub in Toledo," [34] among which was the Port Authority's hope that a cargo hub "will lead to a renaissance in the Toledo metropolitan region." [35] Consequently, the court found that

> the FAA defined the goal for its action as helping to launch a new cargo hub in Toledo and thereby helping to fuel the Toledo economy. The agency then eliminated from detailed discussion the alternatives that would not accomplish this goal. [36]

The court held that the FAA acted properly in its decision to evaluate the "environmental impacts of the only proposal that might reasonably accomplish that goal—approving the construction and operation of a cargo hub at Toledo Express." [37] Although the court found that an essential "goal" was the FAA's desire to help "fuel the Toledo economy," the source of this finding is troubling. Neither the FAA nor the parties in their briefs articulated economic growth as a consideration. The only discussion of economic growth in the EIS was as a beneficial impact of the proposed action. [38]

Although the court discussed at length the FAA's "goals" and its "objectives" (and apparently uses both terms interchangeably), neither term is used in the EIS. Nor did the EIS anywhere explain that the goal of the project was either a new cargo hub at Toledo Express Airport or the rejuvenation of the Toledo economy. For example, the EIS refers to the "purpose and need for this action," to the "need for extending" a runway, to the statutory mandate as setting "[a]nother purpose and need for the proposed Federal action," and to the proposed federal action as "fulfilling the mandate." [39] Notwithstanding his view that it would be improper for the court itself to define the agency's goal, Judge Thomas did precisely that in order to conclude

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and prudent alternatives exist and "all reasonable steps have been taken to minimize" environmental impacts. 49 U.S.C. app. §2208(b)(5). This statute effectively requires the FAA to implement all mitigation measures articulated in an EIS.

20. *See* 40 C.F.R. §1506.5(c) (regulations regarding conflict-of-interest by preparer of EISs).
21. Pet. Br., *supra* note 17, at 1.
22. *Id.* at 23-25.
23. *Id.* at 26-27.
24. *See supra* note 4.
25. 938 F.2d 190, 194, 21 ELR 21142, 21144 (D.C. Cir. 1991) (quoting Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519, 8 ELR 20288 (1978)).
26. *Id.* at 195, 21 ELR at 21145 (footnote and citation omitted).
27. *Id.*
28. *Id.* (emphasis added).
29. *Id.* at 195-96, 21 ELR at 21145.
30. *Id.* at 196, 21 ELR at 21145.
31. *Id.* (citing City of New York v. United States Dep't of Transp., 715 F.2d 732, 13 ELR 20823 (2d Cir. 1983), *cert. denied*, 465 U.S. (1984)).
32. 938 F.2d at 196, 21 ELR at 21145; Toledo EIS, *supra* no 2-1 ("the Federal government's consideration of alternati accord substantial weight to the preferences of the applica sponsor").
33. 938 F.2d at 197, 21 ELR at 21146 (citing 49 U.S.C. app. §2201 (11)).
34. *Id.*
35. *Id.* at 198, 21 ELR at 21146.
36. *Id.*.
37. *Id.*
38. TOLEDO EIS, *supra* note 14, at 1-4, 2-17.
39. *Id.* at 1-3, 1-4.
40. 938 F.2d at 199, 21 ELR at 21147.

the FAA's goal in Toledo was to help fuel the Toledo economy by launching a cargo hub at its airport.[41]

Adequacy of Discussion of Alternatives

Having determined the agency's goals, the court proceeded to explore whether the scope of alternatives in the EIS appropriately reflected those goals. It concluded that the FAA acted properly by evaluating the impacts only of the proposal submitted by the Port Authority and by excluding any other potential alternative. Strictly relying on the language found in NEPA,[42] the court explained that an agency need examine only alternatives to the *federal action*, not alternatives to the entire proposed project.[43] Because a federal permitting agency like the FAA often is limited simply to granting or denying a permit, and has no substantive role in shaping the applicant's project, Judge Thomas concluded that an EIS need not examine alternatives to an applicant's proposal that lie outside the purview of the federal involvement.[44]

Citing *Van Abbema v. Fornell*,[45] the petitioners argued that the scope of alternatives must be defined as "alternative means to accomplish the *general* goal of an action; it is not an evaluation of the alternative means by which a particular applicant can reach his goals."[46] The court explicitly rejected the *Van Abbema* reference to "general goals," because of the difficulty of determining "how to distinguish general goals from specific ones and just who does the distinguishing."[47] Arguing that *Van Abbema* implies that the court should do this distinguishing, Judge Thomas disagreed that this is a proper role for either the court *or the permitting agency*:

> An agency cannot redefine the goals of the proposal that arouses the call for action; it must evaluate alternative ways of achieving *its* goals, shaped by the application at issue and by the function that the agency plays in the decisional process. Congress did expect agencies to consider an applicant's wants when the agency formulates the goals of its own proposed action.[48]

Without citing any authority for the proposition, Judge Thomas concluded that the scope of alternatives in an EIS—just like the definition of the agency's goals—properly should depend on the "function that the agency plays in the decisional process."[49] With respect to such airport expansions as proposed at Toledo, the FAA's function generally is to "nurture aspiring cargo hubs" but not to "determine the siting of the nation's airports."[50] Consequently, the court concluded that the FAA had no business examining alternative airport locations for the Burlington Air Express cargo hub, once Burlington made clear its preference for the Toledo location.

Judge Buckley's Dissent

Judge James Buckley dissented in part from the majority opinion, on the grounds that the FAA impermissibly had limited the alternatives in the EIS to the single alternative in which Burlington Air Express had expressed an interest. He saw a disparity between the majority view that "would limit consideration of alternatives to those available" to the Toledo Port Authority,[51] and the FAA's view that it had to consider any reasonable alternative that was available to *either* the Port Authority or Burlington Air Express, the real beneficiary of the project.[52] The dissent faulted the FAA and the majority for their unquestioning acceptance of assertions by both the Toledo Port Authority and Burlington Air Express that Toledo Express Airport was the only airport suitable for the project. Instead of testing these assertions, the FAA "simply accepted Burlington's 'Toledo-or-bust' position,"[53] notwithstanding its obligation under NEPA to "exercise a degree of skepticism in dealing with self-serving statements from a prime beneficiary of the project."[54]

As Judge Buckley explained, the majority opinion leaves the scope of an EIS in the hands of the beneficiary of a federally permitted project. If the beneficiary claims that one and only one project alternative is acceptable, then the agency's EIS need only examine that proposal and the no-action alternative.[55]

Implications of the *Citizens Against Burlington* Case

The plain language of *Citizens Against Burlington* suggests two potentially far-reaching consequences. First, the court appears to have held that an agency may accept the "needs and goals" of a nonfederal applicant as the defining criteria for its own "goals" or "objectives." Second, since the court says that the range of alternatives properly is defined by the federal agency's "goals" or "objectives," the scope of alternatives in an EIS also should be defined by the applicant's desires and the nature of the agency's role in the decisionmaking process.

If these two propositions were accepted as the holdings of *Citizens Against Burlington*, they would portend a situation in which any applicant for a federal permit could limit NEPA analysis to consideration of only the project and no-project alternatives, merely by informing the permitting agency that it would not consider modifications to its project. Either proposition effectively eviscerates

41. *See id.* at 198, 21 ELR at 21146.

42. NEPA §102(2)(C), 42 U.S.C. §4332(2)(C), ELR STAT. NEPA 003 (an agency must examine "alternatives to the proposed action").

43. 938 F.2d at 199, 21 ELR at 21147.

44. *Id.*

45. 807 F.2d 633, 17 ELR 20429 (7th Cir. 1986).

46. *Id.* at 638, 17 ELR at 20432 (emphasis in original); Pet. Br., *supra* note 17, at 21-22.

47. 938 F.2d at 199, 21 ELR at 21147.

48. *Id.* (emphasis in original).

49. *Id.*

50. *Id.* at 197, 21 ELR at 21146.

51. *Id.* at 207, 21 ELR at 21151.

52. *Id.* at 208, 21 ELR at 21152 ("Burlington makes the demands that define the project; Toledo enjoys the benefits that result").

53. *Id.*

54. *Id.* at 209, 21 ELR at 21153. *See* Van Abbema v. Fornell, 807 F.2d 633, 642, 17 ELR 20429, 20434 (7th Cir. 1986) (criticizing agency for its "blind reliance" on information submitted by an applicant); Trinity Episcopal School Corp. v. Romney, 523 F.2d 88, 94, 5 ELR 20497, 20500 (2d Cir. 1975) (agency must determine for itself the availability of alternatives).

55. 938 F.2d at 209, 21 ELR at 21153.

the alternatives requirement in any EIS for a federally permitted action.[56]

Acceptance of either proposition means throwing to the wind almost 20 years of NEPA case law and CEQ guidance in three fundamental respects. First, NEPA requires an agency to examine all "reasonable" alternatives, without reference to the agency's jurisdiction to implement the alternative.[57] Second, both CEQ and the case law consistently have held that the scope of alternatives in an EIS must reflect only technical, economic, and common sense practicability.[58] Third, both the regulations and case law are highly critical of any EIS that relies on information and analysis provided by an applicant and that has not been evaluated independently by the federal agency.[59]

It is possible to reconcile *Citizens Against Burlington*, however, with both CEQ regulations and guidance[60] and other NEPA cases addressing the scope of alternatives. To do so requires examination of the meaning of the terms "purpose" and "need" as they are used in the NEPA context and an understanding of the contexts in which courts have addressed the alternatives requirement of NEPA.

Importance of Defining Purpose and Need

This discussion must begin with four basic definitions and propositions. First, although it has been widely used by courts in many circuits, Judge Thomas's term "goal" is not defined in NEPA, used in the CEQ regulations, nor explained in CEQ guidance documents. Because there is, furthermore, no generally accepted definition, the term goal has variously been used to refer to the need for a proposed action, the purpose of a federal action, or the mission or mandate of a federal agency. (Incidentally, while the term does appear in some EISs, the FAA did not use the term in the Toledo EIS. The description of the agency's goals in *Citizens Against Burlington* is Judge Thomas's interpretation of the EIS.)

Second, while NEPA requires an EIS to include discussion of "alternatives to the proposed action," the statute itself does not indicate whether "the proposed action" for this purpose is identical to the "major Federal action" referred to in an earlier clause of the statute. Contrary to Judge Thomas's unsupported assertions, CEQ regulations and guidance have interpreted the phrase "alternatives to the proposed action" to be broader than alternatives to the *federal* action alone.[61] The CEQ requires that the foundation for consideration of alternatives be the entire underlying project, including those elements in which there is no federal participation.[62]

Third, the CEQ requirement that the scope of alternatives not be limited by the agency's jurisdiction is reinforced by the definition of the project or proposed action for NEPA purposes. If a federal action (e.g., a license or permit) is a necessary precondition to other parts of a project (e.g., construction of a new runway or taxiways), the entire project—not just the federal element—becomes the proposed

56. Because the evaluation of alternatives is the "heart" of any environmental impact statement, 40 C.F.R. §1502.14, and is the "linchpin" of its authority, Monroe County Conservation Council, Inc. v. Volpe, 472 F.2d 693, 697-98, 3 ELR 20006, 20007 (2d Cir. 1972), it is unclear how NEPA is to continue to fulfill its mission as described by Congress: to "assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings." NEPA §101(b)(2), 42 U.S.C. §4331(b)(2), ELR STAT. 003.

57. 40 C.F.R. §1502.14(c) (an EIS must include "reasonable alternatives not within the jurisdiction of the lead agency"); CEQ, MEMORANDUM: QUESTIONS AND ANSWERS ABOUT THE NEPA REGULATIONS, 46 Fed. Reg. 18026 (Mar. 23, 1981), ELR ADMIN. MATERIALS 35020, at Q. 2a (Mar. 17, 1981) [hereinafter FORTY QUESTIONS]. ("In determining the scope of alternatives to be considered, the emphasis is on what is 'reasonable' rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative"). *See* Methow Valley Citizens Council v. Regional Forester, 833 F.2d 810, 815-16, 18 ELR 20163, 20165 (9th Cir. 1987) (exclusion of any viable but unexamined alternative renders an environmental impact statement inadequate), *rev'd on other grounds sub nom.* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 19 ELR 20743 (1989); *Van Abbema*, 807 F.2d at 638, 17 ELR at 20432 (alternatives evaluation must be based on the general agency goal for the action, not on the goals of the applicant); Natural Resources Defense Council v. Morton, 458 F.2d 827, 836, 2 ELR 20029, 20033 (D.C. Cir. 1972) (consideration of alternatives must "permit a reasoned choice . . . so far as environmental aspects are concerned," and must include even solutions that do not fully solve the problem before the agency); Sierra Club v. Marsh, 714 F. Supp. 539, 577-78, 20 ELR 20216, 20235 (D. Me. 1989) (simply because an applicant "desires" certain features of a project does not mean that an agency may exclude otherwise reasonable alternatives from its NEPA analysis; instead, the agency must look to the core goals of the project to define reasonable alternatives); California ex rel. Van de Kamp v. Marsh, 687 F. Supp. 495, 499, 19 ELR 20165, 20166 (N.D. Cal. 1988) (failure to consider any alternative other than that submitted by the applicant excludes from consideration some reasonable alternatives and thus violates NEPA); Residents in Protest—I-35E v. Dole, 583 F. Supp. 653, 660 (D. Minn. 1984) (agency goals should not be so tailored to an applicant's wishes that the agency goal is preordained).

58. *See* FORTY QUESTIONS, *supra* note 57, at Q. 2a ("Reasonable alternatives include those that are *practical* or *feasible* from the technical and economic standpoint and using common sense, rather than simply *desirable* from the standpoint of the applicant.") (emphasis added); Sierra Club v. Marsh, 714 F. Supp. at 577, 20 ELR at 20235 (a consideration of reasonable alternatives must have as its basis "a rational relationship to the technical and economic integrity of the project" beyond the desires of an applicant).

59. *See, e.g., Van Abbema*, 807 F.2d at 642, 17 ELR at 20432-33 (agency failure to conduct an independent investigation of information submitted by an applicant in formulating an agency goal amounts to "blind reliance" on such material and a violation of NEPA); *Johnson v. Davis*, 698 F.2d 1088, 1095 (10th Cir. 1983) (an agency may not rely on information provided by another party without doing its own research if there is a chance that such reliance would cause the EIS to be misleading); *Trinity Episcopal School Corp. v. Romney*, 523 F.2d 88, 93-94, 5 ELR 20497, 20500 (2d Cir. 1975) (an agency may not accept an applicant's "self-serving statements" that alternatives are limited; instead, the agency must examine all reasonable alternatives and "study, develop and describe each alternative for appropriate consideration").

60. In addition to its regulations, 40 C.F.R. pt. 1500, CEQ has published several memoranda setting forth its interpretation of the statute and the regulations. CEQ guidance and interpretation of NEPA is entitled to great deference. Andrus v. Sierra Club, 442 U.S. 347, 358, 9 ELR 20390, 20393 (1979).

61. 40 C.F.R. §1502.14. *See also* FORTY QUESTIONS, *supra* note 57, at Q. 2a, 2b (agency is required to analyze alternatives both outside its jurisdiction and outside the capability of the applicant if such alternatives are practical and feasible, rather than simply desirable); CEQ, MEMORANDUM: GUIDANCE REGARDING NEPA REGULATIONS, 48 Fed. Reg. 34263 (July 28, 1983), ELR ADMIN. MATERIALS 35045, 35048 (July 23, 1983) [hereinafter CEQ MEMORANDUM ON GUIDANCE] (there is no inherent distinction in scope of alternatives for "traditional" federal actions and federally permitted actions).

62. 40 C.F.R. §1502.14; *Van Abbema*, 807 F.2d at 638, 17 ELR at 20432 (EIS alternatives analysis must look at the general goal of an action, not "alternative means by which a particular applicant can reach his goal"); Sierra Club v. Marsh, 714 F. Supp. at 575, 20 ELR at 20234 (consideration of alternatives is to examine general objectives, not specific goals).

action for NEPA purposes; alternatives to the entire project must be examined.[63]

Fourth, while the strict language of NEPA does not offer a benchmark for determining "reasonable alternatives," CEQ regulations and guidance set forth such standards. Reasonable alternatives are those that are "practical or feasible from the technical and economic standpoint and using common sense."[64] Because an agency's responsibilities are bounded by some notion of feasibility, an agency need not discuss "purely conjectural possibilities."[65]

These four definitions set the foundation for a theory on how the elements of an EIS are interconnected. The CEQ requires that the framework for the scope of alternatives be the purpose and need for the proposed action. An EIS must contain a statement of the purpose and need:

> The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action.[66]

Just as practicality and feasibility determine whether an alternative is reasonable, both CEQ regulations and case law recognize that the statement of need defines the scope of alternatives in an EIS.[67] In other words, the broader the statement of need, the greater the range of alternatives. Beyond this, neither the statute nor the CEQ regulations provides much assistance.

A careful distinction between "purpose" and "need" will avoid much of the confusing terminology which cases like *Citizens Against Burlington* have fostered.[68] A need is the lack of something requisite, desirable, or useful or a condition requiring relief.[69] Purpose is defined as an object or end to be achieved.[70] Consequently, the two terms should be interpreted as complementary. The EIS discussion of purpose and need should demonstrate that the purpose of a proposed federal action is to attain or achieve at least part of the underlying need for the proposed action.

The statements of purpose and need for the proposed action each play a different role. The statement of need should be an objective description of the reason that the project (not necessarily the *federal* action) is being pursued.[71] An EIS must include alternative methods of satisfying the need, including any reasonable alternative means that lie outside the jurisdiction of the federal agency. An adequate discussion of alternatives will respond fully to the statement of need.[72]

The statement of purpose follows from the statement of need. It should be seen as the tool for understanding why the federal agency has selected the preferred alternative from among the alternative ways of meeting the need. Unlike the objective statement of need, the statement of purpose can be subjective, should refer to an agency's mission, and should reflect the limits on an agency's statutory authority. The statement of purpose further should explain how the proposed federal action satisfies the need and should justify the decision to choose the preferred alternative. Since an EIS must be prepared only for a major federal action, the statement of purpose should explain the nature of the federal action and the relationship between the project and the federal action.

This theory of the meaning of purpose and need suggests that need must be defined first, framing and delimiting the discussion of alternatives in an EIS. When need and purpose are fused into a single statement—as in the past they frequently have been—it becomes possible for an agency to define the need for a project as the agency's purpose.

An example proves the point. Suppose an area lacks adequate electricity capacity, and an applicant wishes to build a nuclear reactor to provide this capacity, for which a federal license is required. One of the benefits of the project might be the jobs and economic growth it would generate for the region. A proper statement of need for the federal action would relate to the provision of electricity capacity; the EIS on the project must examine alternative ways of increasing regional electricity capacity. A proper statement of purpose would relate to the licensing of a nuclear power plant. The federal action is the granting of a license or permit necessary to construct the additional electricity capacity. Were the regulatory agency improperly to equate purpose and need in a single statement, it might define the "purpose and need" as providing electricity capacity and encouraging development of the nuclear industry while also stimulating economic growth in the region. The scope of alternatives is fundamentally different when the statement of need is fused into a single statement of purpose and need. The latter, limited, definition of need allows no alternatives other than that proposed by the applicant, effectively short-circuiting the alternatives requirement of NEPA.

Judge Thomas sees a strikingly similar "goal" (combining need and purpose) behind the expansion of Toledo Express Airport.[73] The FAA could have devised several different statements of need for the Toledo project that could have required its EIS to examine not only alternative

63. *See* National Forest Preservation Group v. Butz, 485 F.2d 408, 3 ELR 20783 (9th Cir. 1973) (a private project that is enabled by a federal action becomes the proposed action for NEPA purposes); Friends of the Earth, Inc. v. Coleman, 518 F.2d 323, 5 ELR 20428 (9th Cir. 1975) (nonfederal project elements that are "closely interwoven" with the federal action must be considered as part of the proposed action).

64. *See* 40 C.F.R. §1502.14; FORTY QUESTIONS, *supra* note 57, at Q. 2a.

65. CEQ MEMORANDUM ON GUIDANCE, *supra* note 61, 48 Fed. Reg. at 34267, ELR ADMIN. MATERIALS at 35048.

66. 40 C.F.R. §1502.13.

67. *Id.* §1502.14; *see* Roosevelt Campobello Int'l Park Comm'n v. U.S. EPA, 684 F.2d 1041, 1047, 12 ELR 20903, 20905 (1st Cir. 1982). *See also* City of New York v. Dept. of Transportation, 715 F.2d 732, 743, 13 ELR 20823, 20827 (2d Cir. 1983) ("[t]he scope of alternatives to be considered is a function of how narrowly or broadly one views the objective of an agency's proposed action"); Trout Unlimited v. Morton, 509 F.2d 1276, 1286, 5 ELR 20151, 20155 (9th Cir. 1974) (alternatives must be "reasonably related" to statement of purpose).

68. For a general discussion of the distinction between "purpose" and "need" in the NEPA context, *see* Schmitt, *The Statement of Underlying Need Defines the Range of Alternatives in Environmental Documents*, 18 ENVTL. L. 371 (1988).

69. WEBSTER'S NINTH NEW COLLEGIATE DICTIONARY.

70. *Id.*

71. Coalition for Canyon Preservation v. Bowers, 632 F.2d 774, 11 ELR 20053 (9th Cir. 1980). *See also* Concerned About Trident v. Rumsford, 555 F.2d 817, 831 n.2, 6 ELR 20787, 20795 n.2 (D.C. Cir. 1977) (an agency should produce an EIS that observes "objective reasonableness" when evaluating the "concept" behind the action).

72. 40 C.F.R. §1502.14; *see also* Natural Resources Defense Council v. Morton, 458 F.2d 827, 836, 2 ELR 20029, 20032 (D.C. Cir. 1972) (alternatives analysis must include reasonable actions to satisfy the need even if they lie beyond agency's jurisdiction).

73. 938 F.2d 190, 196, 21 ELR 21142, 21146 (D.C. Cir. 1991).

locations for a Burlington air cargo hub, but also alternatives to air cargo services altogether. At the other extreme, the FAA could have defined the need for the project so narrowly that the only practical and feasible alternative was the construction of a cargo hub at Toledo Express precisely as proposed by Burlington. Judge Thomas believes that the FAA properly adopted this latter approach.

Judicial Review of the Statements of Purpose and Need

The principal utility of this paradigm separating the statements of purpose and need is to define a clearer standard of judicial review. In the past, in those few cases in which the definition of purpose or need has been at issue, courts have not articulated a clear standard of review.[74] It can be argued, however, that the standard of judicial review should not be the same for the two statements.

Because the underlying need for a federal action is supposed to be examined objectively,[75] without regard to the agency's policy aims or statutory mission, the adequacy of its definition is easily susceptible to judicial review under the well-established "rule of reason" standard by scrutinizing the scope of alternatives.[76] Precisely the opposite standard should apply to the statement of purpose. Since this statement should reflect an agency's policy decision on how, when, and to what degree it will satisfy the need, the adequacy of a statement of purpose is largely a discretionary, administrative determination, and should be subject to judicial review under a much more deferential standard.[77] A statement of purpose should be reviewed only to determine whether it violates an agency's statutory authority or mission.

This distinction between the statements of purpose and need should alleviate the difficulties of judicial review exemplified by *Citizens Against Burlington*. As Judge Thomas's discussion implies, courts are loath to second guess an agency's decision when a court cannot distinguish between an agency's policy preferences and the objective facts underlying that decision. Joint statements of purpose and need, therefore, are likely to be upheld not because a court finds that they meet the requirements of NEPA, but because of reluctance to impose judicially established policy preferences on federal agencies.

Although courts frequently have confused or combined the concepts of purpose and need, at least one court has successfully drawn the distinction. In *Druid Hills Civic Association v. Federal Highway Administration*,[78] the Eleventh Circuit confronted the plaintiffs' claim that the Federal Highway Administration, when considering alternatives to the purpose for its proposed parkway construction, "did not provide a full and fair discussion of the traffic and safety justifications for the road because information was omitted that did not support the perceived need for the project."[79] The court drew a clear separation between the need for the project ("[t]he proposed Parkway is premised on the need for transportation improvements in the east-west corridor")[80] and the purpose for the granting of construction permits ("providing an alternative east-west route," thus decreasing traffic volumes on the existing road, and "improv[ing] safety conditions in the corridor" by reducing traffic overflow onto local streets).[81] The court went on to examine the discussion of alternatives to the need, and held that although the EIS did not "contain what some may feel is a detailed and careful analysis" of all potential alternatives, the analysis was adequate.[82]

Druid Hills stands as an unusual example of a clearly differentiated need and purpose for a project. The general, objective need for improved traffic flow on the east-west corridor was addressed not only by the preferred alternative and the purpose of the federal action, but also by a consideration in the EIS of subway, light rail, and other potential solutions.[83] The court found no fault with the subjective determination of the purpose for the action and held that the discussion of alternatives reasonably fit the need.[84]

Necessity for Alternatives to Reflect Need

This lengthy discussion of the statements of purpose and need is critical to understanding *Citizens Against Burlington* and earlier cases that have examined whether the discussion of alternatives in an EIS is adequate. As has been seen, the foundation for an adequate discussion of alternatives is the statement of need. If a litigant does not challenge the propriety of an agency's statement of need, then the reviewing court is limited to examining whether the scope of alternatives closely matches the statement of need. In the principal cases in which courts have upheld the discussion of alternatives, the statement of need generally parallels closely the range of alternatives.[85] Where courts have found the

74. *See, e.g.*, Roosevelt Campobello Int'l Park Comm'n v. U.S. EPA, 684 F.2d 1041, 1046, 12 ELR 20903, 20905 (1st Cir. 1982) ("need" for a project not required to be updated "in order to accommodate the most recent data and federal policy shifts"); Izaak Walton League of America v. Marsh, 655 F.2d 346, 372, 11 ELR 20707, 20721 (D.C. Cir. 1981), *cert. denied*, 454 U.S. 1092 (1981) (congressional passage of a statute specifically authorizing a project narrows the breadth of the investigation of alternatives (defined by the need and purpose of the project)).

75. *See supra* note 71.

76. *See Natural Resources Defense Council*, 458 F.2d at 835, 2 ELR at 20031 (articulating the "rule of reason" standard for judicial review). *See also Roosevelt Campobello*, 684 F.2d at 1047, 12 ELR at 20905 (court "measures federal agency compliance with NEPA's procedural requirements" by adhering to a "rule of reason"); California v. Block, 690 F.2d 753, 767, 13 ELR 20092, 20098 (9th Cir. 1982) (alternatives discussed provide the basis for the "rule of reason" under which the agency decisionmaking process is reviewed by the courts); *Izaak Walton League*, 655 F.2d at 371-72, 11 ELR at 20721 ("rule of reason" complied with as "long as the agency's conclusions have a substantial basis in fact"); Concerned About Trident v. Rumsford, 555 F.2d 817, 827, 6 ELR 20787, 20792 (D.C. Cir. 1977) ("[i]n determining [NEPA compliance], we are governed by the rule of reason" (citations omitted)).

77. *See* 938 F.2d at 196, 21 ELR at 21145.

78. 772 F.2d 700, 15 ELR 21082 (11th Cir. 1985).

79. *Id.* at 710, 15 ELR at 21086.

80. *Id.* at 709, 15 ELR at 21086.

81. *Id.* at 710, 15 ELR at 21086.

82. *Id.* at 713, 15 ELR at 21088.

83. *Id.*

84. *Id.*

85. *See, e.g.*, Roosevelt Campobello Int'l Park Comm'n v. U.S. EPA, 684 F.2d 1041, 1047, 12 ELR 20903, 20905 (1st Cir. 1982) (approving a limitation of the range of alternatives based on the need for a deepwater port); Izaak Walton League of America v. Marsh, 655 F.2d 346, 372, 11 ELR 20707, 20721 (D.C. Cir. 1981) (where need has been statutorily narrowly defined, the discussion of alternatives is similarly "relatively narrow"); North Slope Borough v. Andrus, 642 F.2d 589, 601, 10 ELR 20832, 20838 (D.C. Cir. 1980) (agencies have discretion to treat the discussion of alternatives

discussion of alternatives to be objectionable, it generally is because the EIS has omitted reasonable alternatives that would meet the need.[86]

For example, in *Natural Resources Defense Council, Inc. v. Morton*,[87] the D.C. Circuit examined the adequacy of an EIS on oil and gas leases issued under the Outer Continental Shelf leasing program. The court held that the Department of Interior improperly limited its discussion of alternatives to those that lay within its jurisdiction. The need for the project was set forth in a message to Congress by President Nixon in which the President proposed a coordinated plan to deal with research and development toward the goal of clean energy.[88] The EIS, however, improperly omitted reasonable alternatives that did not fulfill the entire need, the agency did not have authority to implement, or would have required legislative implementation.[89] The court explained that the scope of alternatives must match the need for the action:

> When the proposed action is an integral part of a coordinated plan to deal with a broad problem, the range of alternatives that must be evaluated must be broadened. While the Department of Interior does not have the authority [to implement all alternatives] such action is within the purview of both Congress and the President, to whom the impact statement goes.[90]

The opposite result prevailed where Congress enacted legislation specifically directing the construction of a project. In *Izaak Walton League of America v. Marsh*, an EIS was prepared on construction of new locks and dams on the Mississippi River. Plaintiffs alleged that the Army Corps of Engineers should have examined rehabilitation of existing facilities, alternative modes of transportation, and improved congestion control as alternatives to the proposed new locks and dams.[91] The D.C. Circuit held that the agency did not have to examine those alternatives because the need for the project was set by congressional mandate to build new locks and dams; the agency properly examined all reasonable alternative means of satisfying that mandate.[92]

One of the clearest examples of the necessity for the range of alternatives to respond to the statement of need appears in *Sierra Club v. Marsh*.[93] In that case, the district court found that the Army Corps of Engineers had omitted reasonable alternatives in its EIS for a federal permit to construct a marine cargo terminal on the coast of Sears Island, Maine. The federal agency argued that any alternative that would not satisfy the applicant's stated goals or needs is inherently not reasonable. The court disagreed. Quoting CEQ guidance, the court held that, while the agency properly should not disregard the applicant's desires, those desires alone are not enough to define the need for a project.[94] The court examined the record in detail to discern both the applicant's "primary project objective" and the federal agency's "general goals" for the project.[95] The court next reviewed each potential alternative proffered by the plaintiff to determine whether it would satisfy the need for the project. It then held that several omitted off-site alternatives were not reasonable in the circumstances but that omitted on-site alternatives should have been examined.[96] The court explained the relationship among the statement of need, the applicant's desires, and the scope of alternatives:

> The central project goals identifiable in the present FEIS contemplate an efficient marine dry cargo . . . terminal in the Searsport area . . . . Although [the applicant] amply demonstrates that it "desires" a terminal facility capable of expansion to six berths, unless its preferences bear a rational relationship to the technical and economic integrity of the project, they would not warrant exclusion of some otherwise "reasonable alternative" from analysis under NEPA. A project's principal goals must override the stated preferences of the applicant for purposes of NEPA's "reasonable alternatives" analysis.[97]

Surprisingly, there are few cases in which the adequacy of the agency's statement of *purpose* has been at issue. There are several possible explanations for the absence of such case law. First, agencies frequently prepare a single statement of "purpose and need," thereby making it difficult if not impossible to distinguish between the purpose and need.[98] Some agencies—including the FAA in the case of the Toledo airport EIS—prepare a single statement that intersperses the terms "purpose" and "need" with intended synonyms such as "goal," "objective," "mission," or similar words that blur the distinction. This fusing of purpose and need makes it nearly impossible for potential challengers (and the reviewing court) to determine whether the agency has examined a reasonable range of alternatives to meet the need.[99]

specially with respect to the goal of the project); Trout Unlimited v. Morton, 509 F.2d 1276, 1286, 5 ELR 20151, 20155 (9th Cir. 1974) (finding consideration of alternatives adequate as long as all "those reasonably related to the purposes of the project" are included).

86. *See, e.g.*, Van Abbema v. Fornell, 807 F.2d 633, 638, 17 ELR 20429, 20432 (7th Cir. 1986) (discussion of alternatives must "be an evaluation of alternative means to accomplish the *generic* goal of an action . . . not an evaluation of the alternative means by which a particular applicant can reach his goal"; discussion did not respond to broad need and therefore inadequate); California v. Block, 690 F.2d 753, 767, 13 ELR 20092, 20098 (9th Cir. 1982) (where the need to be addressed is "how to allocate a scarce resource—wilderness—between the two competing and mutually exclusive demands of wilderness use and development," it is unreasonable to fail to examine any alternative that develops less than 37 percent of the wilderness); Sierra Club v. Marsh, 714 F. Supp. 539, 577, 20 ELR 20216, 20235 (D. Me. 1989) (striking down EIS as inadequate because discussion of alternatives focussed too narrowly on the applicant's desires rather than the broader need for an expanded deep-water port capacity); California ex rel. Van de Kamp v. Marsh, 687 F. Supp. 495, 495-99, 19 ELR 20165, 20166 (N.D. Cal. 1988) (obvious alternative of resolving need for an expanded airport by locating part of the project at another airport not discussed; hence discussion inadequate).

87. 458 F.2d 827, 2 ELR 20029 (D.C. Cir. 1972).

88. *Id.* at 835, 2 ELR at 20030.

89. *Id.* at 837, 2 ELR at 20033-34.

90. *Id.* at 835, 2 ELR at 20033.

91. 655 F.2d 346, 372, 11 ELR 20707, 20721 (D.C. Cir. 1981).

92. *Id.* at 372-74, 11 ELR at 20721-22.

93. 714 F. Supp. 539, 20 ELR 20216 (D. Me. 1989).

94. *Id.* at 573-74, 20 ELR at 20233 (citations omitted).

95. *Id.* at 575-76, 20 ELR at 20234-35.

96. *Id.* at 577-82, 20 ELR at 20235-37.

97. *Id.* at 577, 20 ELR at 20235 (citations omitted).

98. This difficulty is exemplified by the *Van Abbema* opinion. There, the court attempted to distinguish between the "general" and the "specific" agency goals, a distinction which Judge Thomas in *Citizens Against Burlington* correctly criticizes as unworkable. 938 F.2d 190, 199, 21 ELR 21142, 21147 (D.C. Cir. 1991).

99. No alternative may be rejected on the grounds that it does not fully

A good illustration of this problem is the First Circuit's opinion in *Roosevelt Campobello International Park Commission v. Environmental Protection Agency.*[100] The plaintiffs specifically challenged the adequacy of the agency's statement of need for a deepwater port at Eastport, Maine, as "totally outdated and of no present use."[101] The court used such phrases as "justification for the project," and the applicant's "primary objectives" that blurred the distinction between the need for the project and the agency's purpose in reviewing an applicant's proposals.[102] While the court appeared to view the need to be the "longstanding federal policy of encouraging the construction of domestic refining capacity in order to promote national security," the court also opined that the need to which the agency was responding was more limited:

> [E]valuation of alternatives was explicitly based on the premise that [the agency's] role in reviewing privately sponsored projects "is to determine whether the proposed site is environmentally acceptable . . . ."[103]

It is noteworthy that the very next year, the CEQ criticized the implication in *Roosevelt Campobello* that an agency's role (i.e., the purpose of the federal action) properly defined the scope of alternatives.[104]

Other courts have used terminology that makes it nearly impossible to distinguish between purpose and need. For example, in *Residents in Protest—I-35E v. Dole,*[105] the court used the phrases "purposes of the project," "goals and objectives," and "underlying goals of the project," synonymously with the phrase "need which [the project] was designed to serve."[106] In *Natural Resources Defense Council, Inc. v. Callaway,*[107] the court stated that the content and scope of alternatives is a function of the "nature of the proposal"; an EIS must discuss alternatives that "meet the proposal's goals."[108]

Both Judge Thomas and the FAA fell into the same trap in *Citizens Against Burlington.* First, neither Judge Thomas nor the FAA uses the terms carefully; Judge Thomas's "goals" and "objectives" appear to be a combination of the agency's purpose and the need for the project. The EIS itself contains no clearly articulated statement of purpose and need, either separately or jointly.[109] The EIS does not even purport to include a statement of purpose; the section of the EIS that was labeled as the agency's statement of need contains a jumbled discussion of purpose, need, description of the project and benefits of the proposed federal action.[110] It appears that the FAA believed that the need for the proposed action was

> to facilitate [Toledo-Lucas County Port Authority's] construction of facilities at the airport for an air cargo hub that will serve as Burlington's permanent hub . . . [and to provide for] extending Runway 7-25 to provide safe and adequate length to permit Burlington Air Express to operate fully loaded DC-8-63F aircraft to west coast market destinations.[111]

Instead of setting forth a clear statement of purpose, the EIS sets forth the factors that the FAA says it considered in meeting the need, including the agency's "statutory mandate to facilitate the establishment of air cargo hubs," and the FAA's

> responsibility to review the airport design and runway configuration with respect to safety, efficiency and utility within the national airspace system and its environmental impact on the surrounding area.[112]

Although he claims that the court defers to the agency's definition of the purpose and need for the project, Judge Thomas does nothing of the sort. He weaves of whole cloth the explanation in *Citizens Against Burlington* that the purpose or need for the Toledo project was both construction of a cargo hub for Burlington and the economic revitalization of the Toledo economy. The court's explanation is troubling not only because it is a court-imposed definition, but also because it fuses purpose, need and beneficial impacts of the project. Even if one accepted the court's implicit conclusion that it is permissible to equate purpose and need, this statement neither reflects the objective necessity for the Toledo project (the need) nor bears any relationship to the federal action that, by statute, is limited to the approval (and possible funding) of the layout plan for the expansion of Toledo Express Airport (the purpose). Consequently, even under the court's assertion that the purpose and need should reflect the nature of the agency's role, the court's definition fails to pass muster.

The holding in *Citizens Against Burlington* is not, however, dependent on Judge Thomas's redefinition of the purpose and need for the project. If one were to construct separate statements of purpose and need for the Toledo EIS, it appears that the FAA believed that the need for the Toledo project was to provide a permanent air cargo hub at Toledo Express Airport for Burlington. The purpose for the federal action was to design a safe and efficient facility that meets federal aviation standards.

Under this refined statement of purpose and need, it appears that the FAA's decision to evaluate only two alternatives was unobjectionable. Because the parties focussed strictly on whether the FAA had omitted discussion of reasonable alternative ways of meeting the need, moreover, the court did not need to examine the adequacy of the statement of need.

Arguably, therefore, Judge Thomas's discussion of the agency's goals and objectives is little more than dicta.[113]

accomplish every goal of the originally proposed action. *See* Town of Matthews v. United States Dep't of Transp., 527 F. Supp. 1055, 1058, 12 ELR 20345, 20346 (W.D. N.C. 1981).

100. 684 F.2d 1041, 12 ELR 20903 (1st Cir. 1982).

101. *Id.* at 1046, 12 ELR at 20905.

102. *Id.* at 1046-47, 12 ELR at 20905.

103. *Id.* at 1046, 12 ELR at 20905.

104. CEQ MEMORANDUM ON GUIDANCE, *supra* note 61, 48 Fed. Reg. at 34267, ELR ADMIN. MATERIALS at 35048.

105. 583 F. Supp. 653, 660-61 (D. Minn. 1984).

106. *Id.* at 659-60.

107. 524 F.2d 79, 93, 5 ELR 20640, 20647 (2d Cir. 1975).

108. *Id.*

109. Toledo EIS, *supra* note 14, at 1-3 (subhead for section discussing the purpose and need for the project is entitled "Need for the Federal Action").

110. *Id.* at 1-3, 1-4.

111. *Id.* at 1-3.

112. *Id.*

113. Similarly, his supposed holding that the scope of alternatives is defined by the agency's role is contradicted by a binding D.C. Circuit precedent. Natural Resources Defense Council v. Morton, 458 F.2d 827, 834-37, 2 ELR 20029, 20032-33 (D.C. Cir. 1972). It is sig-

The only issue presented to the D.C. Circuit was whether the EIS discussed all reasonable alternative ways to provide a permanent air cargo hub at Toledo for Burlington. If one accepts either the FAA's or Judge Thomas's statement of the need, the case is not a close one. It was reasonable for the FAA to conclude that only the preferred alternative could reasonably satisfy the need articulated in the EIS because the FAA's statement equated need with purpose. The case shows how, if need (i.e., the general, objective necessity the project is designed to meet) is fused with purpose (i.e., the specific, subjective policy choices of the agency, taking into account the preferences of the applicant), it becomes straightforward for an agency to avoid examining any alternative but the preferred one. When the need for a project is allowed to be defined as its purpose, by definition there can be only one alternative. If the need is for an expanded airport at Toledo to serve a specific air cargo carrier, it is unreasonable to demand consideration of any alternative site in Ft. Wayne or elsewhere because such alternatives do not fulfill the need. In *Citizens Against Burlington*, either Judge Thomas's invention of an economic goal for the project or the FAA's mixing together of purpose and need leads to the same result: no examination of any alternative other than the location of the expanded cargo hub at Toledo Express.

Lessons for Agencies and NEPA Litigants From *Citizens Against Burlington*

At first reading, Judge Thomas's opinion in *Citizens Against Burlington* may be seen as a complete victory for NEPA critics and federal agencies seeking to avoid the statute's procedural hurdles. The lessons of the case, however, are far less one-sided.

First, notwithstanding Judge Thomas's lengthy discussion about deference to an applicant's desires, the case should not be read as standing for the novel proposition that the scope of alternatives in an EIS depends on the nature of the federal action. At best, the discussion is an explanation of why the scope of alternatives properly matched the FAA's statement of the need for the project; at worst, the discussion is mere dicta.

Several reasons are immediately apparent why *Citizens Against Burlington* cannot establish a system of inquiry under NEPA that is dependent on the nature and degree of federal participation in a project. Most obviously, such a system would run counter to express CEQ guidance on the scope of alternatives, guidance which the court does not even discuss. A system that is dependent on the extent of federal involvement also would conflict directly with case law (including D.C. Circuit law), which holds that the scope of an EIS—including the project's impacts and alternatives—must include nonfederal elements of a project even when the federal government is only authorizing or permitting a small portion of the project.[114]

Additionally, such a system would violate the binding D.C. Circuit precedent in which the court has held that the scope of alternatives cannot be defined by the nature of the federal involvement in a project.[115] Judge Thomas fails to discuss this precedent as well. Finally, if the court had intended to disregard CEQ guidance, shift NEPA law, and overrule D.C. Circuit precedent, it is reasonable to expect that the court would at least have explained its intent to do so. That the court was silent on such precedents suggests that it had no such intention.

What Judge Thomas's discussion does highlight is the importance of defining the need for a project. An interesting—if hypothetical—question is whether the FAA's murky statement of need could have survived close judicial scrutiny. That statement appears vulnerable because of its lack of objectivity, its fusing of the agency's policy aims with objective statements of fact, and because it set criteria that made the preferred alternative the *only* reasonable alternative. One could argue that an agency's statement of need—like that for Toledo—is prima facie improper if it allows for examination of only a single alternative.

For prospective litigants, *Citizens Against Burlington* underscores the importance of challenging the adequacy of the statement of need in the EIS commenting process and again on judicial review. Making a record to demonstrate that the agency is responding to a broad need would make it substantially easier to show that a narrow range of alternatives is not responsive to the need.[116] An EIS that rejects all alternatives but the preferred one (or minor, cosmetic variations on the preferred alternative) should raise immediate skepticism not only that the scope of alternatives is improper, but also that the agency has fused its statements of purpose and need into a single self-justifying policy statement.

Similarly, agencies should be forced to distinguish between the need and purpose for a project and should be challenged when they use ill-defined terms such as "goals," "objectives," or "mission." The statutory and regulatory language is clear and defined; agencies should use such language to avoid the ambiguity that results when different courts try to use the same words for different purposes (e.g., the *Van Abbema* court and the *Citizens Against Burlington* court).

In *Citizens Against Burlington*, the FAA's confused statement of need was not at issue. Had it been, the Toledo EIS might have been vulnerable. A plaintiff can avoid a *Citizens Against Burlington* situation by ensuring that it creates a record to support the need for the project and by supporting its rejection of alternatives with reference to that need. While Judge Thomas's discussion suggests that an agency can define its "goals" by reference to an applicant's desires, agencies should not interpret that discussion as anything more than a reaffirmation of an agency's wide discretion to define the *purpose* of a *federal* action. Agencies still must examine all reasonable alternatives that fulfill the need for the proposed action, regardless of whether such alternatives match the agency's policy objectives or whether the agency can implement them.

nificant that Judge Thomas does not attempt to distinguish *Natural Resources Defense Council* and its holding that the scope of alternatives in an EIS cannot be limited by the nature of the agency's authority. That remains the law in the D.C. Circuit and elsewhere.

114. *See* National Forest Preservation Group v. Butz, 485 F.2d 408, 411-12, 3 ELR 20783, 20784 (9th Cir. 1973); Scientists' Inst. for Pub. Information v. Atomic Energy Comm'n, 481 F.2d 1079, 1088-89, 3 ELR 20525, 20529-30 (D.C. Cir. 1973).

115. *See, e.g.*, Natural Resources Defense Council, 458 F.2d at 834-36, 2 ELR at 20032-33.

116. In *Roosevelt Campobello*, for example, the court criticized plaintiffs for not challenging the adequacy of the statement of need during the public comment period. 684 F.2d 1041, 1046, 12 ELR 20903, 20905 (1st Cir. 1982).

ATTACHMENT 2.B

ENVIRONMENTAL IMPACT CHECKLISTS

- **A Listing and Example of the World Bank Checklists for Projects with Potentially Significant Environmental Impacts.** (Source: The World Bank. 1991. Environmental Assessment Sourcebook, Volume II)

- **Computer disks for Volumes I, II, and III of the World Bank Environmental Assessment Sourcebook.**

- **Model EIS Scoping Checklist.** (Source: New York State Department of Environmental Conservation. 1982. State Environmental Quality Review Handbook)

- **Checklist of Potential Environmental Impacts of a Transportation Project.** (Source: A. D. Little, Inc. 1971. Transportation and Environment: Synthesis for Action: Impact of the National Environmental Policy Act of 1969 on the Department of Transportation, Vol. I-III, prepared for the Office of the Secretary, Department of Transportation)

A Listing and Example of the World Bank Checklists for Projects with Potentially Significant Environmental Impacts. (Source: The World Bank. 1991. Environmental Assessment Sourcebook, Volumes II and III)

VOLUME II

Table 8.1 Agroindustry
8.2 Dams and Reservoirs
8.3 Fisheries
8.4 Flood Protection
8.5 Natural Forest Management
8.6 Plantation Development/Reforestation
8.7 Irrigation and Drainage
8.8 Livestock and Rangelands Management
8.9 Rural Roads
Table 9.1 Analytical Framework for Urban Environmental Problems
9.2 Roads and Highways
9.3 Inland Navigation
9.4 Port and Harbor Facilities
9.5 Large-Scale Housing Projects
9.6 Solid Waste Collection and Disposal Systems
9.7 Tourism Development
9.8 Wastewater Collection, Treatment, Reuse, and Disposal System

VOLUME III

Table 10.1 Industrial Hazard Management
10.2 Electric Power Transmission Systems
10.3 Oil and Gas Pipelines
10.4 Checklist -- Offshore Oil and Gas Development
10.5 Oil and Gas Development -- Offshore
10.6 Checklist -- Onshore Oil and Gas Development
10.7 Oil and Gas Development -- Onshore
10.8 Hydroelectric Projects
10.9 Thermoelectric Projects
10.10 Cement
10.11 Chemical and Petrochemical
10.12 Fertilizer
10.13 Food Processing
10.14 Iron and Steel Manufacturing
10.15 Nonferrous Metals
10.16 Petroleum Refining
10.17 Pulp, Paper, and Timber Processing
10.18 Mining and Mineral Processes

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems. (Source: The World Bank. 1991. Environmental Assessment Sourcebook, Volume II)

Potential Negative Impacts	Mitigating Measures
Direct	
1. Disturbance of stream channels, aquatic plant and animal habitat, and spawning and nursery areas during construction.	1. • Do not route sewer lines in stream channels. • Require erosion/sedimentation controls during construction.
2. Alterations in watershed hydrologic balance when wastewater is exported by collection in large upstream areas and discharge downstream.	2. • Consider sub-regional and small community systems in water-short areas. • Take full advantage of opportunities for wastewater reclamation/reuse, especially in water-short areas.
3. Degradation of neighborhoods or receiving water quality from sewer overflows, treatment works bypasses, or treatment process failure.	3. • Phase construction of collector systems and treatment works to avoid raw wastewater discharges. • Select appropriate technology. • Design for reliability, ease of maintenance. • Implement management and training recommendations, monitoring program, and industrial waste pretreatment program (see text for guidelines).
4. Degradation of receiving water quality despite normal system operation.	4. • Site and design treatment works and disposal or reuse systems on the basis of adequate data on the characteristics of the wastewater and the assimilative capacity of the receiving water body. • Use mathematical models for siting surface water discharges and determining required level of treatment, and for siting and designing ocean outfalls. • Take full advantage of appropriate land application alternatives, especially in water-short areas. • Implement monitoring program and industrial waste pre-treatment program (see text for guidelines).
5. Public health hazards in vicinity of discharges or reuse sites during normal operation of system.	5. • Select appropriate technology. • Ensure preapplication treatment and operating guidelines for land application and other water reuse systems are adequate to safeguard health of humans and livestock. • Restrict access to wastewater or sludge disposal sites where health hazards are unavoidable.
6. Contamination at land application sites: soil and crops by toxic substances and pathogens groundwater by toxic substances and nitrogen	6. • Site and design treatment works and disposal or reuse systems on the basis of adequate data on the characteristics of the wastewater and land application site. • Implement monitoring program and effective industrial waste pretreatment program (see text for guidelines). • Ensure preapplication treatment and operating guidelines for land application and other wastewater reuse systems are adequate.
7. Failure to achieve desired beneficial uses of receiving waters despite normal system operation.	7. • Establish realistic use objective and select water quality criteria consistent with desired uses. • Establish system performance standards by modeling or other means which will result in meeting criteria.

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
8. Odors and noise from treatment process or sludge disposal operations.	8. • Site treatment works only near compatible land uses. • Select appropriate technology. • Include odor control and low-noise equipment in design. • Implement management and training recommendations (see text).
9. Emissions of volatile organic compounds from treatment process.	9. • Establish effective industrial waste pretreatment program (see text for guidelines).
10. Soil, crop or groundwater contamination and disease vector breeding or feeding at sludge storage, reuse or disposal sites.	10. • Incorporate sludge management in system feasibility studies, technology selection, design, staffing, training, budgeting and startup plan. • Implement effective industrial waste pretreatment program (see text for guidelines). • Ensure preapplication treatment and operating guidelines for land application and other reuse or disposal systems are adequate to safeguard health of humans and livestock. • Inspect for compliance with operating guidelines.
11. Worker accidents during construction and operation, especially in deep trenching operations.	11. Enforce adherence to safety procedures.
12. Worker accidents caused by gas accumulation in sewers and other confined spaces or by hazardous materials discharged into sewers.	12. • Emphasize safety education and training for system staff. • Implement effective industrial waste pretreatment program (see text for guidelines). • Provide appropriate safety equipment and monitoring instruments. • Enforce adherence to safety procedures.
13. Serious public and worker health hazard from chlorine accidents.	13. • Incorporate safety provisions in design, operating procedures, and training. • Prepare contingency plan for accident response.
14. Nuisances and public health hazard from sewer overflows and backups.	14. • Routinely inspect sewers for illegal connections and obstructions. • Clean sewers as necessary. • Provide monitoring system with alarms for pump station failure. • Provide alternate power supply at critical pump stations. • Educate public to prevent disposal of solid waste in sewers.
15. Failure to achieve public health improvement in serviced area.	15. Conduct sanitation and hygiene education program.
16. Dislocation of residents by plant siting.	16. Assist with resettlement (see "Involuntary Resettlement" section).
17. Perceived or actual nuisances and adverse aesthetic impacts in neighborhood of treatment works.	17. Incorporate neighborhood improvements and useful public facilities in project.
18. Accidental destruction of archaeological sites during excavation.	18. Include notification and protection procedures for cultural properties in construction contract documents (see "Cultural Property" section).

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Indirect	
19. Unplanned development induced or facilitated by infrastructure.	19. • Coordinate installation of sewerage with land use planning. • Strengthen land use control regulations and institutions. • Integrate planning for infrastructure in urban development projects.
20. Regional solid waste management problems exacerbated by sludge.	20. • Incorporate sludge, excreta and septage in regional solid waste management planning and in wastewater system feasibility studies and technology selection. • Implement industrial waste pretreatment program.
21. Loss of fisheries productivity.	21. • Evaluate importance of receiving water in local and regional fisheries. • Implement mitigating measure for direct impacts 3, 4 and 7.
22. Reduction of tourist or recreational activity.	22. • Give special attention to real or perceived nuisances and aesthetic impacts in selecting site and technology. • Implement mitigating measures for direct impacts 3, 4, 5, 7, 8 and 14.

Computer disks for Volumes I, II, and III of the World Bank Environmental Sourcebook

Source: New York State Department of Environmental Conservation. 1982. State Environmental Quality Review Handbook.

APPENDIX A

Model EIS Scoping Checklist

Introduction

The following checklist of topics is intended as a starting point for developing a detailed scope for a project-specific Draft Environmental Impact Statement. Typically, no one project will require a discussion of all the topic areas contained in this document. Through the scoping process, this list of topics should be refined to reflect issues unique to the proposed project. Topic areas may be deleted, added, or elaborated upon, to arrive at the final scoping document.

The purpose of the checklist format is to identify the basic topic areas for the Draft EIS. This is accomplished by reviewing the list and placing a check in the box located to the left of those topics which should be discussed. The model scoping checklist can also be used as a worksheet, including comments, suggestions and identification of the particular example(s) that are relevant to a detailed discussion of the topic or issue that has been checked. Conversely, those topics which are not checked, are issues not associated with the project, and may be eliminated from discussion in the Draft EIS. Minimum requirements for any Draft EIS are already checked for convenience.

The next step is to expand the list to include or elaborate on those topics unique to the proposed project. A blank sheet is included at the end of the checklist for such additional information.

The scoping process involves several steps in addition to compiling a list of topics. Scoping also includes discussions on the quantity and quality of information required and the methods for obtaining that data.

NOTE: This checklist was designed to be used in conjunction with the section on scoping contained in the SEQR Guideline-Draft and Final EIS's. It is also important to emphasize that this checklist should serve only as a model to assist in the scoping of a Draft EIS. It should not be used as a substitute for actively scoping a Draft EIS for a specific project.

I. Cover Sheet

All EIS's (Draft or Final) shall begin with a cover sheet that indicates:

A. Whether it is a draft or final statement
B. Name or other descriptive title of the project
C. Location (county and town, village or city) of the project
D. Name and address of the lead agency which required preparation of the statement and the name and telephone number of a person at the agency to be contacted for further information
E. Name and address of the preparers of any portion of the statement and a contact name and telephone number
F. Date of acceptance of the Draft EIS
G. In the case of a Draft EIS, the deadline date by which comments are due should be indicated

II. Table of Contents and Summary

A table of contents and a brief summary are required for Draft and Final EIS's exceeding 10 pages in length. However, one should include these features in any size EIS to provide the review agency with easy reference to EIS topics.

The summary should include:

A. Brief description of the action
B. Significant, beneficial and adverse impacts, (issues of controversy must be specified)
C. Mitigation measures proposed
D. Alternatives considered
E. Matters to be decided (permits, approvals, funding)

III. Description of the Proposed Action

Place a check in the box to the left of those topics to be included in the draft EIS.

☐ A. PROJECT PURPOSE AND NEED
1. Background and history
2. Public need for the project, and municipality objectives based on adopted community development plans
3. Objectives of the project sponsor

☐ B. LOCATION
1. Establish geographic boundaries of the project (use of regional and local scale maps is recommended)
2. Description of access to site
3. Description of existing zoning of proposed site
4. Other:

☐ C. DESIGN AND LAYOUT
1. Total site area
a.) proposed impervious surface area (roofs, parking lots, roads)
b.) amount of land to be cleared
c.) open space
2. Structures
a.) gross leaseable area (GLA), if applicable
b.) layout of buildings (attached, enclosed, separate)
c.) site plans and profile views
3. Parking
a.) pavement area
b.) number of spaces and layout
4. Other:

☐ D. CONSTRUCTION AND OPERATION
1. Construction
a.) total construction period anticipated
b.) schedule of construction
c.) future potential development, on site or on adjoining properties
d.) other:
2. Operation
a.) type of operation
b.) schedule of operation
c.) other:

☐ E. CLOSURE AND POST CLOSURE PLANS (for projects of planned limited life such as landfills)

☐ F. APPROVALS
1. Required changes or variances to the zoning regulations
2. Other permit approval or funding requirements

IV. Environmental Setting

Place a check in the box to the left of those topics to be included in the Draft EIS.

Natural Resources

☐ A. GEOLOGY
☐ 1. Subsurface
a.) composition and thickness of subsurface material
examples:
—depth to, and nature of, bedrock formations and impermeable layers
—occurrence of an extractive mineral resource
—usefulness as construction material
b.) earthquake potential
☐ 2. Surface
a.) list of soil types
b.) discussion of soil characteristics
examples:
—physical properties (indication of soils hydrological (infiltration) capabilities)
—engineering properties (soil bearing capacity)
c.) distribution of soil types at project site
d.) suitability for use
examples:
—agriculture
—recreation
—construction
—mining
e.) other:
☐ 3. Topography
a.) description of topography at project site
examples:
—slopes
—prominent or unique features
b.) description of topography of surrounding area

☐ B. WATER RESOURCES
☐ 1. Groundwater
a.) location and description of aquifers and recharge areas
examples:
—depth to water table
—seasonal variation
—quality
—quantity
—flow

Human Resources .

☐ A. TRANSPORTATION
- ☐ 1. Transportation services
  - a.) description of the size, capacity and condition of services
    examples:
    —roads, canals, railroads, bridges
    —parking facilities
    —traffic control
  - b.) description of current level of use of services
    examples:
    —a.m. and p.m. peak hour traffic flow
    —vehicle mix
    —sources of existing traffic volume
- ☐ 2. Public transportation
  - a.) description of the current availability of service
  - b.) description of present level of use
- ☐ 3. Pedestrian environment
- ☐ 4. Other:

☐ B. LAND USE AND ZONING
- ☐ 1. Existing land use and zoning
  - a.) description of the existing land use of the project site and the surrounding area
    examples:
    —commercial
    —residential
    —agricultural
    —business
    —retail
    —industrial
    —vacant
  - b.) description of the existing zoning of site and surrounding area
- ☐ 2. Land use plans
  - a.) description of any land use plans or master plans which include project site and surrounding area
  - b.) discussion of future development trends or pressures
- ☐ 3. Other:

☐ C. COMMUNITY SERVICES (for this section include a list of existing facilities and a discussion of existing levels of usage and projected future needs)
- ☐ 1. Educational facilities
- ☐ 2. Police protection
- ☐ 3. Fire protection
- ☐ 4. Health care facilities
- ☐ 5. Social services
- ☐ 6. Recreational facilities
- ☐ 7. Utilities
- ☐ 8. Other:

☐ D. DEMOGRAPHY
- ☐ 1. Population characteristics
  - a.) discussion of the existing population parameters
    examples:
    —distribution
    —density
    —household size and composition
  - b.) discussion of projections for population growth
- ☐ 2. Other:

☐ E. CULTURAL RESOURCES
- ☐ 1. Visual resources
  - a.) description of the physical character of the community
    example:
    —urban vs. rural
  - b.) description of natural areas of significant scenic value
  - c.) identification of structures of significant architectural design
- ☐ 2. Historic and archaeological resources
  - a.) location and description of historic areas or structures listed on State or National Register or designated by the community
  - b.) identification of sites having potential significant archaeological value

b.) identification of present uses and level of use of groundwater
examples:
—location of existing wells
—public/private water supply
—industrial uses
—agricultural uses

☐ 2. Surface water
a.) location and description of surface waters located on project site or those that may be influenced by the project
examples:
—seasonal variation
—quality
—classification according to New York State Department of Health
b.) identification of uses and level of use of all surface waters
examples:
—public/private water supply
—industrial uses
—agricultural uses
—recreation
c.) description of existing drainage areas, patterns and channels
d.) discussion of potential for flooding, siltation, erosion and eutrophication of water sources

☐ C. AIR RESOURCES

☐ 1. Climate
a.) discussion of seasonal variations and extremes
examples:
—temperature
—humidity
—precipitation
—wind

☐ 2. Air quality
a.) description of existing air quality levels
examples:
—list the National and State Air Quality Standards for the project area and the compliance status for each standard
b.) identification of existing sources or pollutants-fixed or mobile
c.) identification of any sensitive receptors in project area
examples:
—hospitals, schools, nursing homes, parks
d.) description of existing monitoring program (if applicable)

☐ D. TERRESTRIAL AND AQUATIC ECOLOGY

☐ 1. Vegetation
a.) list vegetation types on the project site and within the surrounding area
b.) discussion of site vegetation characteristics
examples:
—species present and abundance
—age
—size
—distribution
—dominance
—community types
—unique, rare and endangered species
—value as habitat for wildlife
—productivity

☐ 2. Fish and Wildlife
a.) list of fish and wildlife species on the project site and within surrounding area, including migratory and resident species
b.) discussion of fish and wildlife population characteristics
examples:
—species present and abundance
—distribution
—dominance
—unique, rare and endangered species
—productivity

☐ 3. Wetlands
a.) list wetland areas within or contiguous to the project site
b.) discuss wetland characteristics
examples:
—acreage
—vegetative cover
—classification
—benefits of wetland such as flood and erosion control, recreation

☐ 3. Noise
a.) identification of existing level of noise in the community
b. identification of major sources of noise
examples:
—airports
—major highways
—industrial/commercial facilities

☐ 4. Other:

V. Significant Environmental Impacts

Identify those aspects of the environmental setting in Section IV that may be adversely or beneficially affected by the proposed action and require discussion.

VI. Mitigation Measures to Minimize Environmental Impact

Describe measures to reduce or avoid potential adverse impacts identified in Section V. The following is a brief listing of typical measures used for some of the major areas of impact.

Natural Resources

☐ A. GEOLOGY
1. Subsurface
a.) use excavated material for land reclamation
b.) use facility wastes (ash, sludge) for land reclamation
c.) other:
2. Surface
a.) use topsoil stockpiled during construction for restoration and landscaping
b.) minimize disturbance of non-construction sites
c.) design and implement soil erosion control plan
d.) other:
3. Topography
a.) avoid construction on areas of steep slope
b.) design adequate soil erosion devices to protect areas of steep slope
c.) other:

☐ B. WATER RESOURCES
1. Groundwater
a.) design adequate system of treatment for stormwater runoff prior to recharge of groundwater
b.) maintain permeable areas on the site
c.) institute a program for monitoring water quality in adjacent wells
d.) other:
2. Surface water
a.) ensure use of soil erosion control techniques during construction and operation to avoid siltation
examples:
—hay bales
—temporary restoration of vegetation to disturbed areas
—landscaping
b.) design adequate stormwater control system
c.) restrict use of salt or sand for road and parking area snow removal
d.) avoid direct discharges to surface water resources
e.) other:

☐ C. AIR RESOURCES
1. Air quality
a.) assure proper construction practices
examples:
—fugitive dust control
—proper operation and maintenance of construction equipment
b.) design traffic improvements to reduce congestion and vehicle delay
c.) install and ensure the proper operation of emission control devices
d.) initiate a program for monitoring of air quality
e.) other:

☐ D. TERRESTRIAL AND AQUATIC ECOLOGY

1. Vegetation
   a.) restrict clearing to only those areas necessary
   b.) preserve part of site as a natural area
   c.) after construction, landscape site with naturally occurring vegetation
   d.) purchase open space at another location and dedicate to local government or conservation organization
   e.) other:
2. Fish and Wildlife
   a.) provide adequate habitat (shelter and food) for remaining wildlife species
   b.) schedule construction to avoid sensitive periods of fish and wildlife life cycles
   c.) other:

Human Resources

☐ A. TRANSPORTATION

1. Transportation services
   a.) design adequate and safe access to project site to handle projected traffic flow
   b.) install adequate traffic control devices
   c.) optimize use of parking areas
   d.) encourage car pooling and operation of facility during non-peak traffic times
   e.) design special routing and restricted hours for delivery truck traffic
   f.) other:
2. Public transportation
   a.) adjust public transportation routes and schedules to service the facility
   b.) encourage use of public transportation by using incentive programs for employees or by selling tickets in facility
   c.) other:

☐ B. LAND USE AND ZONING

1. Existing land use and zoning
   a.) design project to comply with existing land use plans
   b.) design functional and visually appealing facility to set standard and precedent for future surrounding land use
   c.) other:

☐ C. COMMUNITY SERVICES

1. Police protection
   a.) minimize local police protection responsibilities by providing private security force
   b.) provide security systems, alarms for facility
   c.) provide equipment, funds or services directly to the community
   d.) other:
2. Fire protection
   a.) use construction materials that minimize fire hazards
   b.) incorporate sprinkler and alarm systems into building design
   c.) provide equipment, funds or services directly to the community
   d.) other:
3. Utilities
   a.) install utility services underground
   b.) incorporate water saving fixtures into facility design
   c.) incorporate energy-saving measures into facility design
   d.) other:

☐ D. CULTURAL RESOURCES

1. Visual resources
   a.) design exterior of structure to physically blend with existing surroundings
   b.) minimize visual impact through thoughtful and innovative design of lighting and signs (consider: height, size, intensity, glare and hours of lighting operation)
   c.) design landscaping to be visually pleasing and to serve as a buffer between surrounding land uses, parking areas, operational equipment and facilities
   d.) other:

2. Historic and archaeologic resources
   a.) allow historical and archaeological officials access to the project site during excavation
   b.) devote space within project site to a display of historical and archaeological artifacts of local interest
   c.) preserve architecturally significant structures and make a photographic and statistical record of those that must be destroyed
   d.) other:
3. Noise
   a.) schedule construction/operation to occur during "normal business" hours minimizing noise impact during sensitive times (early morning, night)
   b.) assure adherence to construction noise standards
   c.) design berms and landscaping to block and absorb noise
   d.) other:

VII. Adverse Environmental Effects that Cannot be Avoided if the Project is Implemented

Identify those adverse environmental effects in Section V that can be expected to occur regardless of the mitigation measures considered in Section VI.

VIII. Alternatives

This section contains categories of alternatives with examples. Discussion of each alternative should be at a level sufficient to permit a comparative assessment of costs, benefits and environmental risks for each alternative. It is not acceptable to make simple assertions that a particular alternative is or is not feasible. Identify those categories of alternatives which should be included in the EIS by placing a check in the box located to the left of the topic.

☐ A. ALTERNATIVE DESIGN AND TECHNOLOGIES
   1. Site layout
      a.) density and location of structures
      b.) location of access routes, parking and utility routes
   2. Orientation
      a.) compatibility with slope and drainage patterns
      b.) site size and setback requirements
   3. Technology
      a.) pollution control equipment
      b.) innovative vs. proven technologies
   4. Mix of activities
      a.) addition of businesses which would affect the operational nature of the facility

☐ B. ALTERNATIVE SITES
   1. Limiting factors
      a.) availability of land
      b.) suitability of alternate site to accomodate design requirements
      c.) availability of utilities
      d.) suitable market area
      e.) compatibility with local zoning and master plan
      f.) compatibility with regional objectives
      g.) accessibility of site to transportation routes and the service population

☐ C. ALTERNATIVE SIZE
   1. Increase or decrease project size to minimize possible impacts
   2. Increase or decrease project size to correspond to market and community needs

☐ D. ALTERNATIVE CONSTRUCTION/OPERATION SCHEDULING
   1. Commence construction at a different time
   2. Phase construction/operation
   3. Restrict construction/operation work schedule

☐ E. ALTERNATIVE LAND USE
1. Suitability of site for other uses
   a.) other types of commercial uses
   b.) other types of industry
   c.) different types of housing
   d.) other:
2. Public vs. private use

☐ F. NO ACTION
1. Impacts of no action
   a.) effect on public need
   b.) effect on private developers' need
   c.) beneficial or adverse environmental impacts

☐ G. OTHER:

IX. Irreversible and Irretrievable Commitment of Resources

Identify those natural and human resources listed in Section IV that will be consumed, converted or made unavailable for future use.

X. Growth Inducing Aspects

Describe in this section the potential growth aspects the proposed project may have. Listed below are examples of topics that are typically affected by the growth induced by a project.

☐ A. POPULATION
1. Increases in business and resident population due to the creation or relocation of business
2. Increases in resident population due to the construction of housing

☐ B. SUPPORT FACILITIES
1. Businesses created to serve the increased population
2. Service industries created to supply new facility

☐ C. DEVELOPMENT POTENTIAL
1. Introduction or improvement of infrastructure (roads, waste disposal, sewers, water) to service proposed project
2. Creation of further growth potential by construction of improved infrastructure

☐ D. OTHER:

XI. Effects on the Use and Conservation of Energy Resources

Identify the energy sources to be used, anticipated levels of consumption and ways to reduce energy consumption. The examples listed below are typical issues to be considered when addressing this topic.

☐ A. PROPOSED ENERGY SOURCES AND ALTERNATIVES

☐ B. ANTICIPATED SHORT-TERM/LONG-TERM LEVELS OF ENERGY CONSUMPTION

☐ C. INDIRECT EFFECTS ON ENERGY CONSUMPTION
1. Increased dependence on automobile use
2. Increased levels of traffic due to proposed project

☐ D. ENERGY CONSERVATION MEASURES
1. Design methods to reduce fuel use for heating, cooling, and lighting
   a.) conventional technology
   examples:
   —insulation
   —thermopane windows
   —use of low wattage lights
   b.) innovative technology
   examples:
   —heat pumps
   —solar panels
   —wind energy
   —use of waste heat from an industrial plant
   c.) efficient layout
   examples:
   —orientation of structures in relation to summer and winter sunlight
   —clustering of structures to maximize common walls
   —shortening of utility runs
   —shared insulation and heating
2. Indirect energy benefits
   a.) location and design of facility to accomodate mass transit
   b.) use of shuttle buses
   c.) location of facility to minimize travel distance

☐ E. OTHER:

XII. Appendices

Following is a list of materials typically used in support of the EIS.

A. List of underlying studies, reports and information considered and relied on in preparing statement

B. List all federal, state, regional, or local agencies, organizations, consultants and private persons consulted in preparing the statement

C. Technical exhibits (if any) at a legible scale

D. Relevant correspondence regarding the projects may be included (required in the Final EIS)

Additional Draft EIS Scoping Topics

Indicate any additional topics for discussion in the Draft EIS. Attach additional sheets if necessary.

Checklist of Potential Environmental Impacts of a Transportation Project (Source: A.D. Little, Inc. 1971. Transportation and Environment: Synthesis for Action: Impact of the National Environmental Policy Act of 1969 on the Department of Transportation, Vol. I-III, prepared for the Office of the Secretary, Department of Transportation, July 1971.)

CATEGORY	PLANNING, DESIGN	CONSTRUCTION	OPERATION
I. Noise Impacts			
A. Public health			
B. Land Use			
II. Air Quality Impacts			
A. Public health			
B. Land Use			
III. Water Quality Impacts			
A. Ground Water			
1. Flow and water table alterations			
2. Interaction with surface drainage			
B. Surface Water			
1. Shoreline and bottom alteration			
2. Effects of filling and dredging			
3. Drainage and flood characteristics			
C. Quality Aspects			
1. Effect of effluent loadings			
2. Implication of other actions, such as			
a. Disturbance of benthic layers			
b. Alteration of currents			
c. Changes in flow regime			
d. Saline intrusion in ground water			
3. Land use			
4. Public health			
IV. Soil Erosion Impacts			
A. Economic and Land Use			
B. Pollution and Siltation			
V. Ecological Impacts			
A. Flora			
B. Fauna (other than humans)			
VI. Economic Impacts			
A. Land Use			
1. In immediate vicinity of project			
2. In local jurisdiction served			
3. In region			
B. Tax Base			
1. Loss through displacement			
2. Gain through increased values			
C. Employment			
1. Access to existing opportunities			
2. Creation of new jobs			
3. Displacement from jobs			
D. Housing and Public Services			
1. Demand for new services			
2. Alteration in existing services			
E. Income			
F. Damage to economically-valuable natural resources			
VII. Sociopolitical Impacts			
A. Damage to, or use of:			
1. Cultural resources			
2. Scientific resources			
3. Historical resources			
4. Recreational areas			
B. Lifestyle and Activities			
1. Increased mobility			
2. Disruption of community			
C. Perception of cost/benefit by different cohesive groups			
1. Racial			
2. Ethnic			
3. Income class			
D. Personal Safety			
VIII. Aesthetic and Visual Impacts			
A. Scenic Resources			
B. Urban Design			
C. Noise			
D. Air Quality			
E. Water Quality			

ATTACHMENT 2.C

THE INTERDISCIPLINARY EA TEAM

- **The Interdisciplinary Team - Its Characteristics and Responsibilities.**
  (Source: Shipley Associates. 1990. Applying the NEPA Process, Shipley Associates, P.O. Box 460, Bountiful, Utah 84011)

The Interdisciplinary Team - Its Characteristics and Responsibilities (Source: Shipley Associates. 1990. Applying the NEPA Process, Shipley Associates, P.O. Box 460, Bountiful, Utah 84011)

The quality of the interdisciplinary team is more than just the sum of the quality of its members—the creativity sparked by the interaction through brainstorming is explosive when members are appropriate to the task and they understand their responsibilities. This information provides the basis for selecting team members and directing the role that each member will fill in the analysis process.

The Team Leader

A. The responsibilities of the team leader are to:

- Be fully accountable to the responsible official.
- Manage and direct all steps of the NEPA analysis process including scoping, as delegated by the responsible official.
- Be the liaison between the responsible official and the team negotiating time frames and responsibilities of individual team members, requesting clarification and guidance from the responsible official, and reporting progress on the analysis at appropriate milestones.
- Ensure that the results of all steps in the analysis are consistent with agency management or master plans.
- Plan and manage (and possibly facilitate) all team meetings as well as meetings with outside agencies, applicants, and the public as delegated by the responsible official.
- Monitor the progress of work of each team member.
- Ensure that all milestones and deadlines are met, and renegotiate them as necessary.
- Evaluate the performance of all team members.
- Motivate team members to accomplish their best work efficiently.
- Mediate and resolve conflicts with the assistance of responsible official as necessary.
- Ensure that all information provided by the team members is appropriate, timely, complete, and analytic.
- Maintain the planning record or delegate the responsibility.
- Keep the results of the analysis organized.
- Be the liaison with the writer/editor of the document.

B. Personal and professional characteristics and skills that the team leader must have are:

- Facilitation skills: the ability to manage team members in an interactive setting that is personally risk-free for each member within a creative, positive, efficient, caring, and objective atmosphere
- Knowing the steps required in the NEPA analysis process, including when to return to a previous step and when to request clarification and guidance from the responsible official, and being experienced in application of the process
- Being an active listener, ensuring that all team members understand and have a chance to constructively comment and build on all comments made by team members
- Being an accomplished communicator, using both verbal and body language effectively
- Motivation skills including an understanding of the need of different personality and temperament types, a sincere dedication to the success of the project, and a willingness to work with individual team members to resolve difficulties
- Creativity, the ability to make the team more than a sum of its individual parts
- Sound judgment about local and regional agency politics
- Ability and willingness to meet deadlines and to recognize and renegotiate inappropriate deadlines
- Ability to communicate effectively with people throughout the agency hierarchy and with people from other agencies and the public
- Ability to communicate criticism and praise constructively and effectively

Core Team Members

A. The responsibilities of core team members are to:

- Interactively and objectively identify and clarify the environmental issues, develop alternative ways to meet project objectives while minimizing or avoiding environmental impacts, and clearly predict impacts on specific environmental resources.
- Gather appropriate data in a technically correct manner.
- Help develop and implement an appropriate public involvement strategy.
- Develop the document format.
- Help write the document using the interdisciplinary process.
- Provide clearly written information to any writer/editors.
- Provide constructive peer review of written and verbal information.
- Ensure all resource information and analyses are consistent with agency management or master plans.
- Interactively review proposal onsite as well as monitor implementation and environmental effects.

B. Personal and professional characteristics and skills that the core team members must have are:

- Expertise, experience, and training in their particular resource field
- Knowledge of the NEPA analysis process and experience in application of the process
- Team-building skills such as the ability to encourage the risk-free atmosphere for all team members; ask questions affirmatively; disagree constructively; encourage all members to actively participate; and negotiate objectively, flexibly, and with tolerance
- Good communication skills including written, verbal, and body language
- Creativity in conceptualizing and solving problems
- Ability to understand different personality and temperament types and recognize their value in maintaining diversity and creativity on the team
- Ability and willingness to communicate complex technical environmental information in plain language to team members with little or no background in a particular discipline
- Willingness to ask questions about a particular discipline and insist on clear answers
- A sense of humor

Extended Team Members

A. The responsibilities of the extended team members are to:

- Provide resource data or data interpretation and other functional assistance as requested by the team leader or members.
- Provide information and expertise for identifying issues, alternatives, and environmental impacts as requested.
- Provide written information as requested.

B. Personal and professional characteristics and skills that the extended team members must have are:

- Expertise, experience, and training in their particular resource field
- Ability and willingness to write and speak in plain language
- Ability and willingness to meet deadlines
- Ability to prioritize their time

ATTACHMENT 2.D

PLANNING RECORDS

- **Contents of a Planning Record.** (Source: Environmental Policy and Procedures Handbook. U.S. Forest Service Handbook 1909.15, Region 10, Supplement No. 1, Juneau, AK 8/90)

Contents of a Planning Record. (Source: Environmental Policy and Procedures Handbook. U.S. Forest Service Handbook 1909.15, Region 10, Supplement No. 1, Juneau, AK 8/90)

A. The Planning Record includes:

- A copy of all notices appearing in the FEDERAL REGISTER.
- All formal recommendations and directions from line officers, staff/directors, the interdisciplinary team (IDT) leader, or other entities and all formal requests for such recommendations or directions.
- All records of consultation with the public, interest groups, and other agencies.
- A record of all announcements for public participation activities including a copy of the announcement as published in each source, the date of the announcement, the medium or source used to make the announcement (newspaper, magazine, television, or radio), and the area of circulation.
- A record of each major public participation activity including the date and location of the activity, names of participants or contributors, purpose of the activity, and summary of accomplishments of the activity (public comments, questions, suggestions, and decisions or agreements). Include hearing transcripts and tapes.
- Any draft of a work product or other document if it is clear that (a) the draft was used in the planning/decisionmaking process (e.g., an unsigned draft wilderness plan used for its technical content) or (b) a draft circulated externally for comment (e.g., drafts provided to state agencies or interest groups for comment).
- All transmittal memoranda or letters enclosing or documenting circulation of any of the above products.
- All decision documents and any accompanying news release, circulation, or mailing lists, or other attachments, summaries, and so forth.
- Published final and draft Environmental Impact Statements (EIS), Records of Decision (ROD), Environmental Assessments (EA), Decision Notices (DN), Decision Memos (DM), and any maps, charts, summaries, and so forth, made publicly available with these documents.
- Documents referenced (including other NEPA documents or decisions) in a draft, supplemental or final EIS, ROD, EA, DN, or DM. If the references are lengthy, include a copy of the cover and the specific chapter, section, or page referenced along with identifying information including the author, title, and date. Documents which are not readily available should be included in their entirety.
- All completed work products, which may or may not be marked as final, including IDT, specialist or resource reports, studies, inventories, or study plans prepared by the Forest Service or other entities.
- Electronic data frozen at a date specified, such as the date of use in the decision or the date of the decision. Include electronically generated data in the planning record either as hard copy or on electronic storage media such as disks or tapes suitable for producing a hard copy on demand.

- Forms indicating the location and physical description (dimensions, number of pages, color, edition, and so forth) of any document not physically included in the planning record due to size, bulk, volume, or availability and examples of such documents if available.
- Both formal and informal selection criteria for determining membership on the interdisciplinary planning team.
- Each IDT member's specific qualifications including expertise, years of experience and education, and the specific contribution the team member makes to the development of the guide or plan. Document when IDT members join and leave the team.
- Minutes of interdisciplinary team meetings, management team meetings, or other staff meetings including the date, all participants or contributors, their titles and/or positions, and a summary of major happenings such as accomplishments, agreements, and decisions.
- Documentation of all coordination activities with adjacent regions and national forests including the date, major participants or contributors, their titles and/or positions, and a summary of major happenings such as accomplishments, agreements, and decisions.
- Records of each meeting or activity involving external coordination, including other federal, state, county, local governments, Indian tribes and special interest groups including the type, date, location of the activity, all participants or contributors, purpose of the activity, summary of accomplishments, including information exchanged, comments, questions, suggestions received, and decisions or agreements.
- A dated copy of all agreements with Indian tribes and state or other federal agencies.
- Final computer runs used in the analysis.

B: Documents Not Included in the Planning Record. The documents listed below are part of the work process and may have some value as background or historical information. These work documents should either be destroyed or be clearly disassociated from the formal Planning Record.

The Planning Record should not include:

- Drafts of any document, except as specified above.
- Informal preliminary internal deliberations, such as comments on internal drafts, informal notes of internal IDT meetings, and so forth.
- Other notes for which there is no documentation of circulation or adoption as final recommendations, direction, inventory, or analysis.
- Preliminary computer runs which were not used in the final decisionmaking process.
- Personnel documents, other than IDT selection records, and fiscal documents.

CHAPTER 3

SCOPING

CHAPTER 3

SCOPING

Scoping is a process of interaction between interested publics, government agencies and proponents to determine the important issues and alternatives that should be examined in environmental impact assessment. In its broadest sense, it includes public involvement throughout the EA process starting with public scoping meetings as soon as the proponent decides that information on the proposed activity is complete enough for the process to begin; continuing with public review and comment on the assessment documentation; and culminating with public involvement during the post-decision and follow-up phases. At any time during these various phases, the scope of a project EA can change. In the U.S., if there are substantial changes to a proposal or significant new circumstances or information relevant to environmental concerns, a supplement to an EA document can be prepared. Scoping is especially useful for controversial activities that involve diverse interest groups and government agencies.

During the scoping process, formal and informal opportunities should be provided for the public and government agencies to voice their concerns, raise new issues, suggest modifications to proposed actions, and present additional alternatives. For the proponent, scoping provides the opportunity to describe the proposed activity and to obtain additional information from the public and government agencies (e.g., studies and reports relevant to the project, identification of local expertise, and regulatory constraints). In addition, scoping enhances the proponent's credibility, improves relationships with the affected parties, and may help in avoiding unforseen developments or surprises.

A report summarizing the scoping process, the significant alternatives and issues, and including comments received from the public should be prepared and made available to all interested parties. The report should describe the issues and the extent of coverage to be expected in the EIA.

The objectives of scoping (Attachment 3.A) are:

- To identify the affected public and agency concerns;
- To facilitate an efficient EIA preparation process, through assembling the cooperating agencies, assigning EIA writing tasks,

ascertaining all the related permits and reviews that must be scheduled concurrently, and setting time or page limits;

- To define the issues and alternatives that will be examined in detail in the EIA while simultaneously devoting less attention and time to issues which cause no concern; and
- To save time in the overall process by helping to ensure that draft statements adequately address relevant issues, reducing the possibilities that new comments will cause a statement to be rewritten or supplemented.

NEEDS

- **Preliminary Project Information.** Prior to public and government agency involvement, the proponent should assemble and make available to known interested parties a packet of information about the proposed activity, including a preliminary outline of the EIA. The information packet is based on environmental information prepared during the initiation phase (Chapter 2.1). The information serves as a starting point for discussion at scoping meetings and any other public meetings; it helps to focus discussion on the proposed activity. In general, the information should:

  - describe the purpose and need for the proposed activity,
  - describe the proposed activity,
  - identify the potentially affected geographic area,
  - describe the important characteristics of the area,
  - review the preliminary alternatives, and
  - discuss known project-related issues.

- **Early Planning.** Scoping meetings should be held very early in the EA process. The key to successful meetings is appropriate notification and participation of the publics and government agencies and availability/distribution of enough information on the proposed activity so that the public and relevant agencies can participate effectively. If the proposed activity is regional or national in scale, several meetings may be held in different locations. The duration of meetings will vary depending on the level of controversy or interest in the proposed activity.

- **Public Involvement Strategy.** Public involvement, particularly when it occurs early in the EA process, can result in better reasoned and more legally defensible decisions, as well as, less controversy and broader public acceptance of the decisions. There

are a variety of techniques available for involving the public (Table 2-1); however, each public involvement strategy must be tailored to the circumstances of the proposed activity, as well as the community in which the public involvement process is to occur. Once the interested publics and government agencies are identified, their continued involvement should be solicited throughout the EA process.

Although scoping meetings are designed to involve the public, the proponent has the ultimate responsibility for selecting the alternatives to be evaluated in the environmental assessment. Thus, the proponent seldom tries to reach a consensus among participants at meetings/hearings on what issues are significant and which alternatives should be evaluated. Rather, careful notes are taken (often by tape recorder or a court reporter) and revisions are made to the scope of work later, as appropriate. Decisions on the choice of alternatives are guided by public interest and the proponent's mandated responsibilities.

TOOLS

- **Public Meetings.** There is no uniform set of guidelines for the conduct of scoping meetings or public hearings. In general, scoping meetings precede preparation of EA documentation and public hearings follow publication of the draft EA documentation. In public hearings, citizens can testify about the draft documentation and hear the testimony of others. A scoping meeting is generally less formal than a hearing. In either case, meetings are best conducted by an independent, neutral moderator who has a thorough understanding of EA requirements and who has been involved in the development of the specific procedures to be followed. Legal counsel is usually present at the meetings. A professional moderator is trained to focus the discussions, maintain the schedule, and de-fuse impending controversy. In the opening remarks, the moderator should:
  - explain what scoping is,
  - describe the procedure for the meeting,
  - point out that comments should be relevant to the proposed activity,
  - reiterate that no decision has been made on the proposal or the contents of the EA documentation, and
  - encourage the audience to focus on the alternatives, issues, and additional information that they can provide.

Relative to public meetings, the following activities have been shown to be useful:

- A premeeting/prehearing conference of all identified and potentially interested publics and government agencies to identify key procedural and substantive issues related to the proposed activity.
- Preparation and distribution of a handout that explains what scoping is and how the particular meeting/hearing is to be conducted.
- Development of a format for the meeting/hearing to include style of meeting, logistics and set up of the meeting room, and procedures for speakers (i.e., registration, order of speaking, time allowed). Question and answer sessions can be useful in meetings as well as hearings, provided the process is carefully structured in advance (i.e., the appropriate expertise is present to respond). Town hall meeting forums (a roving moderator with microphone) are useful if the meeting is small. In general, for scoping meetings, the moderator's opening statement can be brief and informal. For hearings, the moderators opening statement is more formal, longer, and proponent presentations are generally limited.
- A post meeting/hearing consultation with key participants to provide additional information and clarification/understanding of each others positions. Such meetings should be informal but the basic ground rules need to be clear to everyone.

The process of scoping is not limited to interagency and public meetings. Other activities that have been shown to be useful include:

- **Advisory Committees.** When projects are large and/or controversial, appointment of an advisory committee of independent experts can help to identify issues, generate alternatives, provide mitigation measures, and review and comment on EA documentation.
- **Workshops.** Representatives of interested groups can be invited to work together in small groups to assess alternatives and evaluate their feasibility.

In each of the above cases, however, the final decision on the scope and content of the EA is the responsibility of the agency.

- **Other Public Involvement Strategies.** Table 2-1 lists public involvement strategies and evaluates their usefulness. In addition to these, agencies are increasingly using a special telephone number (i.e., a hotline) to take public comments before, after or instead of a public meeting.

ISSUES

The importance of scoping to the preparation of adequate and effective EA documentation is recognized by most publics and government agencies. It originated in response to the uneven implementation of NEPA by U.S. government agencies (i.e., some agencies obscured the important issues in massive EA documents while others prepared brief documents that failed to analyze the important issues). The concept has been adopted by other countries (e.g., Canada, The Netherlands, Poland) as a means to determine important issues and alternatives to be examined during EA. Although the principle of scoping is appropriate at all levels of decisionmaking, at the broadest level of government decisionmaking (i.e., for policy, program, and plan initiatives), scoping is mostly internal to an agency. Other affected government agencies may be asked to participate, but the public is seldom invited.

In practice, approaches to scoping vary widely depending on the nature of a proposed activity, the proponent's resources, and the public interest. Throughout the process, it is important to remain flexible, keeping in mind that the overall goal of EA is providing appropriate information and analyses in order that informed decisions can be made.

- The benefits of scoping include:
  - early identification of areas that will need attention (e.g., information gaps, additional research, additional professional expertise, regulatory constraints);
  - improved efficiency and effectiveness. The public is provided with opportunities to understand and influence the EA process early on and the proponent gains insight into the issues of real concern. As a result, the proponent can focus the environmental analyses on realistic alternatives and mitigation measures at the early stages of project planning;
  - resolution of problems before documents are prepared and decisions are made which lessens the opportunities for surprises and for litigation; and
  - enhanced credibility and public support. Although conflicts may still arise, if the public understands the purpose and need for the proposed activity and if it is clear that the

proponent is considering all reasonable alternatives, then the public is more likely to be satisfied with the final decision.

- Some common problems associated with scoping are:
  - poorly defined purpose, need, and objectives of the proposed action,
  - poorly prepared and/or tardy information packets,
  - failure to contact all affected parties,
  - lack of interest/participation by the public and government agencies,
  - unprepared participants,
  - negative public attitude toward the proposed activity, and
  - unfocused public comments that fail to address the effects that the EA documentation should evaluate.

LINKAGES

Scoping and the results of scoping are integral parts of the overall environmental assessment process. Formal scoping meetings are a catalyst for careful planning at the initiation stage. The results of the scoping process determine the alternatives, issues and mitigation measures analyzed in the EA documentation. Decisionmaking is influenced by public participation.

REFERENCES

Bregman, J. I. and K. M. Mackenthun. 1992. Environmental Impact Statements. Lewis Publishers, Inc., Chelsea, Michigan. 279 pp.

Federal Environmental Assessment Review Office (FEARO). 1976. Initial Assessment Guide. Federal Assessment Review Office, Ottawa K1A 0H3, Ontario, Canada.

U.S. Council on Environmental Quality (CEQ). 1981. Memorandum: Scoping Guidance. Washington, D.C. 19 pp.

ATTACHMENT 3.A

SCOPING GUIDANCE

- **Memorandum: Scoping Guidance.** (Source: Council on Environmental Quality, April 30, 1991)

Memorandum: Scoping Guidance
(Council on Environmental Quality
April 30, 1981)

I. Introduction

A. Background of this document.

In 1978, with the publication of the proposed NEPA regulations (since adopted as formal rules, 40 C.F.R. Parts 1500-1508), the Council on Environmental Quality gave formal recognition to an increasingly used term – scoping. Scoping is an idea that has long been familiar to those involved in NEPA compliance: In order to manage effectively the preparation of an environmental impact statement (EIS), one must determine the scope of the document – that is, what will be covered, and in what detail. Planning of this kind was a normal component of EIS preparation. But the consideration of issues and choice of alternatives to be examined was in too many cases completed outside of public view. The innovative approach to scoping in the regulations is that the process is open to the public and state and local governments, as well as to affected federal agencies. This open process gives rise to important new opportunities for better and more efficient NEPA analyses; and simultaneously places new responsibilities on public and agency participants alike to surface their concerns early. Scoping helps insure that real problems are identified early and properly studied; that issues that are of no concern do not consume time and effort; that the draft statement when first made public is balanced and thorough; and that the delays occasioned by re-doing an inadequate draft are avoided. Scoping does not create problems that did not already exist; it ensures that problems that would have been raised anyway are identified early in the process.

Many members of the public as well as agency staffs engaged in the NEPA process have told the Council that the open scoping requirement is one of the most far-reaching changes engendered by the NEPA regulations. They have predicted that scoping could have a profound positive effect on environmental analyses, on the impact statement process itself, and ultimately on decisionmaking.

Because the concept of open scoping was new, the Council decided to encourage agencies' innovation without unduly restrictive guidance. Thus the regulations relating to scoping are very simple. They state that "there shall be an early and open process for determining the scope of issues to be addressed" which "shall be termed scoping," but they lay down few specific requirements. (Section 1501.7*). They require an open process with public notice; identification of significant and insignificant issues; allocation of EIS preparation assignments; identification of related analysis requirements in order to avoid duplication of work; and the planning of a schedule for EIS preparation that meshes with the agency's decisionmaking schedule. (Section 1501.7(a)). The regulations encourage, but do not require, setting time limits and page limits for the EIS, and holding scoping meetings. (Section 1501.7(b)). Aside from these general outlines, the regulations left the agencies on their own. me Council did not believe, and still does not, that it is necessary or appropriate to dictate the specific manner in which over 100 federal agencies should deal with the public. However, the Council has received several requests for more guidance. In 1980 we decided to investigate the agency and public response to the scoping requirement, to find out what was working and what was not, and to share this with all agencies and the public.

The Council first conducted its own survey, asking federal agencies to report some of their scoping experiences. The Council then

*All citations are to the NEPA regulations, 40 C.F.R. Parts 1500-1508 unless otherwise specified.

contracted with the American Arbitration Association and Clark McGlennon Associates to survey the scoping techniques of major agencies and to study several innovative methods in detail.[*] Council staff conducted a two-day workshop in Atlanta in June 1980, to discuss with federal agency NEPA staff and several EIS contractors what seems to work best in scoping of different types of proposals, and discussed scoping with federal, state and local officials in meetings in all 10 federal regions.

This document is a distillation of all the work that has been done so far by many people to identify valuable scoping techniques. It is offered as a guide to encourage success and to help avoid pitfalls. Since scoping methods are still evolving, the Council welcomes any comments on this guide, and may add to it or revise it in coming years.

B. What scoping is and what it can do.

Scoping is often the first contact between proponents of a proposal and the public. This fact is the source of the power of scoping and of the trepidation that it sometimes evokes. If a scoping meeting is held, people on both sides of an issue will be in the same room and, if all goes well, will speak to each other. The possibilities that flow from this situation are vast. Therefore, a large portion of this document is devoted to the productive management of meetings and the de-fusing of possible heated disagreements.

Even if a meeting is not held, the scoping process leads EIS preparers to think about the proposal early on, in order to explain it to the public and affected agencies. The participants respond with their own concerns about significant issues and suggestions of alternatives. Thus as the draft EIS is prepared, it will include, from the beginning, a reflection or at least an acknowledgement of the cooperating agencies' and the public's concerns. This reduces the need for changes after the draft is finished, because it reduces the chances of overlooking a significant issue or reasonable alternative. It also in many cases increases public confidence in NEPA and the decisionmaking process, thereby reducing delays, such as from litigation, later on when implementing the decisions. As we will discuss further in this document, the public generally responds positively when its views are taken seriously, even if they cannot be wholly accommodated.

But scoping is not simply another "public relations" meeting requirement. It has specific and fairly limited objectives: (a) to identify the affected public and agency concerns; (b) to facilitate an efficient EIS preparation process, through assembling the cooperating agencies, assigning EIS writing tasks, ascertaining all the related permits and reviews that must be scheduled concurrently, and setting time or page limits; (c) to define the issues and alternatives that will be examined in detail in the EIS while simultaneously devoting less attention and time to issues which cause no concern; and (d) to save time in the overall process by helping to ensure that draft statements adequately address relevant issues, reducing the possibility that new comments will cause a statement to be rewritten or supplemented.

Sometimes the scoping process enables early identification of a few serious problems with a proposal, which can be changed or solved because the proposal is still being developed. In these cases, scoping the EIS can actually lead to

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[*]The results of this examination are reported in "Scoping the Content of EISs: An Evaluation of Agencies' Experiences," which is available from the Council or the Resource Planning Analysis Office of the U.S. Geological Survey, 750 National Center, Reston, Va. 22092.

the solution of a conflict over the proposed action itself. We have found that this extra benefit of scoping occurs fairly frequently. But it cannot be expected in most cases, and scoping can still be considered successful when conflicts are clarified but not solved. This guide does not presume that resolution of conflicts over proposals is a principal goal of scoping, because it is only possible in limited circumstances. Instead, the Council views the principal goal of scoping to be an adequate and efficiently prepared EIS. Our suggestions and recommendations are aimed at reducing the conflicts among affected interests that impede this limited objective. But we are aware of the possibilities of more general conflict resolution that are inherent in any productive discussions among interested parties. We urge all participants in scoping processes to be alert to this larger context, in which scoping could prove to be the first step in environmental problem-solving.

Scoping can lay a firm foundation for the rest of the decisionmaking process. If the EIS can be relied upon to include all the necessary information for formulating policies and making rational choices, the agency will be better able to make a sound and prompt decision. In addition, if it is clear that all reasonable alternatives are being seriously considered, the public will usually be more satisfied with the choice among them.

II. Advice for Government Agencies Conducting Scoping

A. General context.

Scoping is a process, not an event or a meeting. It continues throughout the planning for an EIS, and may involve a series of meetings, telephone conversations, or written comments from different interested groups. Because it is a process, participants must remain flexible. The scope of an EIS occasionally may need to be modified later if a new issue surfaces, no matter how thorough the scoping was. But it makes sense to try to set the scope of the statement as early as possible.

Scoping may identify people who already have knowledge about a site or an alternative proposal or a relevant study, and induce them to make it available. This can save a lot of research time and money. But people will not come forward unless they believe their views and materials will receive serious consideration. Thus scoping is a crucial first step toward building public confidence in a fair environmental analysis and ultimately a fair decisionmaking process.

One further point to remember: the lead agency cannot shed its responsibility to assess each significant impact or alternative even if one is found after scoping. But anyone who hangs back and fails to raise something that reasonably could have been raised earlier on will have a hard time prevailing during later stages of the NEPA process or if litigation ensues. Thus a thorough scoping process does provide some protection against subsequent lawsuits.

B. Step-by-step through the process.

1. Start scoping after you have enough information.

Scoping cannot be useful until the agency knows enough about the proposed action to identify most of the affected parties, and to present a coherent proposal and a suggested initial list of environmental issues and alternatives. Until that time there is no way to explain to the public or other agencies *what* you want them to get involved *in*. So the first stage is to gather preliminary information from the applicant, or to compose a clear picture of your proposal, if it is being developed by the agency.

2. Prepare an information packet.

In many cases, scoping of the EIS has been preceded by preparation of an environmental assessment (EA) as the basis for the decision to proceed with an EIS. In such cases, the EA will, of course, include the preliminary information that is needed.

If you have not prepared an EA, you should put together a brief information packet consisting of a description of the proposal, an initial list of impacts and alternatives, maps, drawings, and any other material or references that can help the interested public to understand what is being proposed. The proposed work plan of the EIS is not usually sufficient for this purpose. Such documents rarely contain a description of the goals of the proposal to enable readers to develop alternatives.

At this stage, the purpose of the information is to enable participants to make an intelligent contribution to scoping the EIS. Because they will be helping to plan what will be examined during the environmental review, they need to know where you are now in that planning process.

Include in the packet a brief explanation of what scoping is, and what procedure will be used, to give potential participants a context for their involvement. Be sure to point out that you want comments from participants on very specific matters. Also reiterate that no decision has yet been made on the contents of the EIS, much less on the proposal itself. Thus, explain that you do not yet have a preferred alternative, but that you may identify the preferred alternative in the draft EIS. (See Section 1502.14(e)). This should reduce the tendency of participants to perceive the proposal as already a definite plan. Encourage them to focus on recommendations for improvements to the various alternatives.

Some of the complaints alleging that scoping can be a waste of time stem from the fact that the participants may not know what the proposal is until they arrive at a meeting. Even the most intelligent among us can rarely make useful, substantive comments on the spur of the moment. Don't expect helpful suggestions to result if participants are put in such a position.

3. Design the scoping process for each project.

There is no established or required procedure for scoping. The process can be carried out by meetings, telephone conversations, written comments, or a combination of all three. It is important to tailor the type, the timing and the location of public and agency comments to the proposal at hand.

For example, a proposal to adopt a land management plan for a National Forest in a sparsely populated region may not lend itself to calling a single meeting in a central location. While people living in the area and elsewhere may be interested, any meeting place will be inconvenient for most of the potential participants. One solution is to distribute the information packet, solicit written comments, list a telephone number with the name of the scoping coordinator, and invite comments to be phoned in. Otherwise, small meetings in several locations may be necessary when face-to-face communication is important.

In another case, a site-specific construction project may be proposed. This would be a better candidate for a central scoping meeting. But you must first find out if anyone would be interested in attending such a meeting. If you simply assume that a meeting is necessary, you may hire a hall and a stenographer, assemble your staff for a meeting, and find that nobody shows up. There are many proposals that just do not generate sufficient public interest to cause people to attend another public meeting. So a wise early step is to contact known local citizens groups and civic leaders.

In addition, you may suggest in your initial scoping notice and information packet that all those who desire a meeting should call to request one. That way you will only hear from those who are seriously interested in attending.

The question of where to hold a meeting is a difficult one in many cases. Except for site specific construction projects, it may be unclear where the interested parties can be found. For example, an EIS on a major energy development program may involve policy issues and alternatives to the program that are of interest to public groups all over the nation, and to agencies headquartered in Washington, D.C., while the physical impacts might be expected to be felt most strongly in a particular region of the country. In such a case, if personal contact is desired, several meetings would be necessary, especially in the affected region and in Washington, to enable all interests to be heard.

As a general guide, unless a proposal has no site specific impacts, scoping meetings should not be *confined* to Washington. Agencies should try to elicit the views of people who are closer to the affected regions.

The key is to be flexible. It may not be possible to plan the whole scoping process at the outset, unless you know who all the potential players are. You can start with written comments, move on to an informal meeting, and hold further meetings if desired.

There are several reasons to hold a scoping meeting. First, some of the best effects of scoping stem from the fact that all parties have the opportunity to meet one another and to listen to the concerns of the others. There is no satisfactory substitute for personal contact to achieve this result. If there is any possibility that resolution of underlying conflicts over a proposal may be achieved, this is always enhanced by the development of personal and working relationships among the parties.

Second, even in a conflict situation people usually respond positively when they are treated as partners in the project review process. If they feel confident that their views were actually heard and taken seriously, they will be more likely to be satisfied that the decisionmaking process was fair even if they disagree with the outcome. It is much easier to show people that you are listening to them if you hold a face-to-face meeting where they can see you writing down their points, than if their only contact is through written comments.

If you suspect that a particular proposal could benefit from a meeting with the affected public at any time during its review, the best time to have the meeting is during this early scoping stage. The fact that you are willing to discuss openly a proposal before you have committed substantial resources to it will often enhance the chances for reaching an accord.

If you decide that a public meeting is appropriate, you still must decide what type of meeting, or how many meetings, to hold. We will discuss meetings in detail below in "Conducting a Public Meeting." But as part of designing the scoping process, you must decide between a single meeting and multiple ones for different interest groups, and whether to hold a separate meeting for government agency participants.

The single large public meeting brings together all the interested parties, which has both advantages and disadvantages. If the meeting is efficiently run, you can cover a lot of interests and issues in a short time. And a single meeting does reduce agency travel time and expense. In some cases it may be an advantage to have all interest groups hear each others' concerns, possibly promoting compromise. It is definitely important to have the staffs of the cooperating agencies, as well as the lead agency, hear the public views of what the significant issues are; and it will be difficult and expensive for the cooperating agencies to attend several meetings.

But if there are opposing groups of citizens who feel strongly on both sides of an issue, the setting of the large meeting may needlessly create tension and an emotional confrontation between the groups. Moreover, some people may feel intimidated in such a setting, and won't express themselves at all.

The principal drawback of the large meeting, however, is that it is generally unwieldy. To keep order, discussion is limited, dialogue is difficult, and often all participants are frustrated, agency and public alike. Large meetings can serve to identify the interest groups for future discussion, but often little else is accomplished. Large meetings often become "events" where grandstanding substitutes for substantive comments. Many agencies resort to a formal hearing-type format to maintain control, and this can cause resentments among participants who come to the meeting expecting a responsive discussion.

For these reasons, we recommend that meetings be kept small and informal, and that you hold several, if necessary, to accommodate the different interest groups. The other solution is to break a large gathering into small discussion groups, which is discussed below. Using either method increases the likelihood that participants will level with you and communicate their underlying concerns rather than make an emotional statement just for effect.

Moreover, in our experience, a separate meeting for cooperating agencies is quite productive. Working relationships can be forged for the effective participation of all involved in the preparation of the EIS. Work assignments are made by the lead agency, a schedule may be set for production of parts of the draft EIS, and information gaps can be identified early. But a productive meeting such as this is not possible at the very beginning of the process. It can only result from the same sort of planning and preparation that goes into the public meetings. We discuss below the special problems of cooperating agencies, and their information needs for effective participation in scoping.

4. Issuing the public notice.

The preliminary look at the proposal, in which you develop the information packet discussed above, will enable you to tell what kind of public notice will be most appropriate and effective.

Section 1501.7 of the NEPA regulations requires that a notice of intent to prepare an EIS must be published in the Federal Register prior to initiating scoping.[**] This means that one of the appropriate means of giving public notice of the upcoming scoping process could be the same Federal Register notice. And because the notice of intent must be published anyway, the scoping notice would be essentially free. But use of the Federal Register is not an absolute requirement, and other means of public notice often are more

[**]Several agencies have found it useful to conduct scoping for environmental assessments. EAs are prepared where answering the question of whether an EIS is necessary requires identification of significant environmental issues; and consideration of alternatives in an EA can often be useful even where an EIS is not necessary. In both situations scoping can be valuable. Thus the Council has stated that scoping may be used in connection with preparation of an EA, that is, before publishing any notice of intent to prepare an EIS. As in normal scoping, appropriate public notice is required, as well as adequate information on the proposal to make scoping worthwhile. But scoping at this early stage cannot *substitute* for the normal scoping process unless the earlier public notice stated clearly that this would be the case, *and* the notice of intent expressly provides that written comments suggesting impacts and alternatives for study will still be considered.

effective, including local newspapers, radio and TV, posting notices in public places, etc. (See Section 1506.6 of the regulations.)

What is important is that the notice actually reach the affected public. If the proposal is an important new national policy in which national environmental groups can be expected to be interested, these groups can be contacted by form letter with ease. (See the *Conservation Directory* for a list of national groups.[****]) Similarly, for proposals that may have major implications for the business community, trade associations can be helpful means of alerting affected groups. The Federal Register notice can be relied upon to notify others that you did not know about. But the Federal Register is of little use for reaching individuals or local groups interested in a site specific proposal. Therefore notices in local papers, letters to local government officials and personal contact with a few known interested individuals would be more appropriate. Land owners abutting any proposed project site should be notified individually.

Remember that issuing press releases to newspapers, and radio and TV stations is not enough, because they may not be used by the media unless the proposal is considered "newsworthy." If the proposal is controversial, you can try alerting reporters or editors to an upcoming scoping meeting for coverage in special weekend sections used by many papers. But placing a notice in the legal notices section of the paper is the only guarantee that it will be published.

5. Conducting a public meeting.

In our study of agency practice in conducting scoping, the most interesting information on what works and doesn't work involves the conduct of meetings. Innovative techniques have been developed, and experience shows that these can be successful.

One of the most important factors turns out to be the training and experience of the moderator. The U.S. Office of Personnel Management and others give training courses on how to run a meeting effectively. Specific techniques are taught to keep the meeting on course and to deal with confrontations. These techniques are sometimes called "meeting facilitation skills."

When holding a meeting, the principle thing to remember about scoping is that it is a process to initiate preparation of an EIS. It is not concerned with the ultimate decision on the proposal. A fruitful scoping process leads to an adequate environmental analysis, including all reasonable alternatives and mitigation measures. This limited goal is in the interest of all the participants, and thus offers the possibility of agreement by the parties on this much at least. To run a successful meeting you must keep the focus on this *positive* purpose.

At the point of scoping therefore, in one sense all the parties involved have a common goal, which is a thorough environmental review. If you emphasize this in the meeting you can stop any grandstanding speeches without a heavy hand, by simply asking the speaker if he or she has any concrete suggestions for the group on issues to be covered in the EIS. By frequently drawing the meeting back to this central purpose of scoping, the opponents of a proposal will see that you have not already made a decision, and they will be forced to deal with the real issues. In addition, when people see that you are genuinely seeking their opinion, same will volunteer useful information about a particular subject or site that they may know better than anyone on your staff.

As we stated above, we found that informal meetings in small groups are the most

[****]The Conservation Directory is a publication of the National Wildlife Federation, 1421 16th St., N.W., Washington, D.C. 20036.

satisfactory for eliciting useful issues and information. Small groups can be formed in two ways: you can invite different interest groups to different meetings, or you can break a large number into small groups for discussion.

One successful model is used by the Army Corps of Engineers, among others. In cases where a public meeting is desired, it is publicized and scheduled for a location that will be convenient for as many potential participants as possible. The information packet is made available in several ways, by sending it to those known to be interested, giving a telephone number in the public notices for use in requesting one, and providing more at the door of the meeting place as well. As participants enter the door, each is given a number. Participants are asked to register their name, address and/or telephone number for use in future contact during scoping and the rest of the NEPA process.

The first part of the meeting is devoted to a discussion of the proposal in general, covering its purpose, proposed location, design, and any other aspects that can be presented in a lecture format. A question and answer period concerning this information is often held at this time. Then if there are more than 15 or 20 attendees at the meeting, the next step is to break it into small groups for more intensive discussion. At this point, the numbers held by the participants are used to assign them to small groups by sequence, random drawing, or any other method. Each group should be no larger than 12, and 8-10 is better. The groups are informed that their task is to prepare a list of significant environmental issues and reasonable alternatives for analysis in the EIS. These lists will be presented to the main group and combined into a master list, after the discussion groups are finished. The rules for how priorities are to be assigned to the issues identified by each group should be made clear before the large group breaks up.

Some agencies ask each group member to vote for the 5 or 10 most important issues. After tallying the votes of individual members, each group would only report out those issues that received a certain number of votes. In this way only those items of most concern to the members would even make the list compiled by each group. Some agencies go further, and only let each group report out the top few issues identified. But you must be careful not to ignore issues that may be considered a medium priority by many people. They may still be important, even if not in the top rank. Thus instead of simply voting, the members of the groups should rank the listed issues in order of perceived importance. Points may be assigned to each item on the basis of the rankings by each member, so that the group can compile a list of its issues in priority order. Each group should then be asked to assign cut-off numbers to separate high, medium and low priority items. Each group should then report out to the main meeting all of its issues, but with priorities clearly assigned.

One member of the lead agency or cooperating agency staff should join each group to answer questions and to listen to the participants' expressions of concern. It has been the experience of many of those who have tried this method that it is better not to have the agency person lead the group discussions. There does need to be a leader, who should be chosen by the group members. In this way, the agency staff member will not be perceived as forcing his opinions on the others.

If the agency has a sufficient staff of formally trained "meeting facilitators," they may be able to achieve the same result even where agency staff people lead the discussion groups. But absent such training, the staff should not lead the discussion groups. A good technique is to have the agency person serve as the recording secretary for the group, writing down each impact and alternative that is suggested for study by the participants. This enhances the neutral status of the agency representative, and ensures

that he is perceived as listening and reacting to the views of the group. Frequently, the recording of issues is done with a large pad mounted on the wall like a blackboard, which has been well received by agency and public alike, because all can see that the views expressed actually have been heard and understood.

When the issues are listed, each must be clarified or combined with others to eliminate duplication or fuzzy concepts. The agency staff person can actually lead in this effort because of his need to reflect on paper exactly what the issues are. After the group has listed all the environmental impacts and alternatives and any other issues that the members wish to have considered, they are asked to discuss the relative merits and importance of each listed item. The group should be reminded that one of its tasks is to eliminate insignificant issues. Following this, the members assign priorities or vote using one of the methods described above.

The discussion groups are then to return to the large meeting to report on the results of their ranking. At this point further discussion may be useful to seek a consensus on which issues are really insignificant. But the moderator must not appear to be ruthlessly eliminating issues that the participants ranked of high or medium importance. The best that can usually be achieved is to "deemphasize" some of them, by placing them in the low Priority category.

6. What to do with the comments.

After you have comments from the cooperating agencies and the interested public, you must evaluate them and make judgments about which issues are in fact significant and which ones are not. The decision of what the EIS should contain is ultimately made by the lead agency. But you will now know what the interested participants consider to be the principal areas for study and analysis. You should be guided by these concerns, or be prepared to briefly explain why you do not agree. Every issue that is raised as a priority matter during scoping should be addressed in some manner in the EIS, either by in-depth analysis, or at least a short explanation showing that the issue was examined, but not considered significant for one or more reasons.

Some agencies have complained that the time savings claimed for scoping have not been realized because after public groups raise numerous minor matters, they cannot focus the EIS on the significant issues. It is true that it is always easier to add issues than it is to subtract them during scoping. And you should realize that trying to *eliminate* a particular environmental impact or alternative from study may arouse the suspicions of some people. Cooperating agencies may be even more reluctant to eliminate issues in their areas of special expertise than the public participants. But the way to approach it is to seek consensus on which issues are less important. These issues may then be deemphasized in the EIS by a brief discussion of why they were not examined in depth.

If no consensus can be reached, it is still your responsibility to select the significant issues. The lead agency cannot abdicate its role and simply defer to the public. Thus a group of participants at a scoping meeting should not be able to "vote" an insignificant matter into a big issue. If a certain issue is raised and in your professional judgment you believe it is not significant, explain clearly and briefly in the EIS why it is not significant. There is no need to devote time and pages to it in the EIS if you can show that it is not relevant or important to the proposed action. But you should address in some manner all matters that were raised in the scoping process, either by an extended analysis or a brief explanation showing that you acknowledge the concern.

Several agencies have made a practice of sending out a post-scoping document to make public the decisions that have been made on

what issues to cover in the EIS. This is not a requirement, but in certain controversial cases it can be worthwhile. Especially when scoping has been conducted by written comments, and there has been no face-to-face contact, a postscoping document is the only assurance to the participants that they were heard and understood until the draft EIS comes out. Agencies have acknowledged to us that "letters instead of meetings seem to get disregarded easier." Thus a reasonable quid pro quo for relying on comment letters would be to send out a post-scoping document as feedback to the commentors.

The post-scoping document may be as brief as a list of impacts and alternatives selected for analysis; it may consist of the "scope of work" produced by the lead and cooperating agencies for their own EIS work or for the contractor; or it may be a special document that describes all the issues and explains why they were selected.

7. Allocating work assignments and setting schedules.

Following the public participation in whatever form, and the selection of issues to be covered, the lead agency must allocate the EIS preparation work among the available resources. If there are no cooperating agencies, the lead agency allocates work among its own personnel or contractors. If there are cooperating agencies involved, they may be assigned specific research or writing tasks. The NEPA regulations require that they normally devote their own resources to the issues in which they have special expertise or jurisdiction by law. (Sections 1501.6(b)(3), (5), and 1501.7(a)(4)).

In all cases, the lead agency should set a schedule for completion of the work, designate a project manager and assign the reviewers, and must set a time limit for the entire NEPA analysis if requested to do so by an applicant. (Section 1501.8).

8. A few ideas to try.

a. Route design workshop

As part of a scoping process, a successful innovation by one agency involved route selection for a railroad. The agency invited representatives of the interested groups (identified at a previous public meeting) to try their hand at designing alternative routes for a proposed rail segment. Agency staff explained design constraints and evaluation criteria such as the desire to minimize damage to prime agricultural land and valuable wildlife habitat. The participants were divided into small groups for a few hours of intensive work. After learning of the real constraints on alternative routes, the participants had a better understanding of the agency's and applicant's viewpoints. Two of the participants actually supported alternative routes that affected their own land because the overall impacts of these routes appeared less adverse.

The participants were asked to rank the five alternatives they had devised and the top two were included in the EIS. But the agency did not permit the groups to apply the same evaluation criteria to the routes proposed by the applicant or the agency. Thus public confidence in the process was not as high as it could have been, and probably was reduced when the applicant's proposal was ultimately selected.

The Council recommends that when a hands-on design workshop is used, the assignment of the group be expanded to include evaluation of the reasonableness of all the suggested alternatives.

b. Hotline

Several agencies have successfully used a special telephone number, essentially a hotline, to take public comments before, after, or instead of a public meeting. It helps to designate a named staff member to receive these calls so that some continuity and personal relationships can be developed.

c. Videotape of sites

A videotape of proposed sites is an excellent tool for explaining site differences and limitations during the lecture-format part of a scoping meeting.

d. Videotape meetings

One agency has videotaped whole scoping meetings. Staff found that the participants took their roles more seriously and the taping appeared not to precipitate grandstanding tactics.

e. Review committee

Success has been reported from one agency which sets up review committees, representing all interested groups, to oversee the scoping process. The committees help to design the scoping process. In cooperation with the lead agency, the committee reviews the materials generated by the scoping meeting. Again, however, the final decision on EIS content is the responsibility of the lead agency.

f. Consultant as meeting moderator

In some hotly contested cases, several agencies have used the EIS consultant to actually run the scoping meeting. This is permitted under the NEPA regulations and can be useful to de-fuse a tense atmosphere if the consultant is perceived as a neutral third party. But the responsible agency officials must attend the meetings. There is no substitute for developing a relationship between the agency officials and the affected parties. Moreover, if the responsible officials are not prominently present, the public may interpret that to mean that the consultant is actually making the decisions about the EIS, and not the lead agency.

g. Money saving tips

Remember that money can be saved by using conference calls instead of meetings, tape-recording the meetings instead of hiring a stenographer, and finding out whether people want a meeting before announcing it.

C. Pitfalls.

We list here some of the problems that have been experienced in certain scoping cases, in order to enable others to avoid the same difficulties.

1. Closed meetings.

In response to informal advice from CEQ that holding separate meetings for agencies and the public would be permitted under the regulations and could be more productive, one agency scheduled a scoping meeting for the cooperating agencies some weeks in advance of the public meeting. Apparently, the lead agency felt that the views of the cooperating agencies would be more candidly expressed if the meeting were closed. In any event, several members of the public learned of the meeting and asked to be present. The lead agency acquiesced only after newspaper reporters were able to make a story out of the closed session. At the meeting, the members of the public were informed that they would not be allowed to speak, nor to record the proceedings. The ill feeling aroused by this chain of events may not be repaired for a long time. Instead, we would suggest the following possibilities:

a. Although separate meetings for agencies and public groups may be more efficient, there is no magic to them. By all means, if someone insists on attending the agency meeting, let him. There is nothing as secret going on there as he may think there is if you refuse him admittance. Better yet, have your meeting of cooperating agencies *after* the public meeting. That may be the most logical time anyway, since only then can the scope of the EIS be decided upon and assignments made among the agencies. If it is well done, the public meeting will satisfy most

people and show them that you are listening to them.

b. Always permit recording. In fact, you should suggest it for public meetings. All parties will feel better if there is a record of the proceeding. There is no need for a stenographer, and tape is inexpensive. It may even be better then a typed transcript, because staff and decisionmakers who did not attend the meeting can listen to the exchange and may learn a lot about public perceptions of the proposal.

c. When people are admitted to a meeting, it makes no sense to refuse their requests to speak. However, you can legitimately limit their statements to the subject at hand--scoping. You do not have to permit some participants to waste the others' time if they refuse to focus on the impacts and alternatives for inclusion in the EIS. Having a tape of the proceedings could be useful after the meeting if there is some question that speakers were improperly silenced. But it takes an experienced moderator to handle a situation like this.

d. The scoping stage is the time for building confidence and trust on all sides of a proposal, because this is the only time when there is a common enterprise. The attitudes formed at this stage can carry through the project review process. Certainly it is difficult for things to get better. So foster the good will as long as you can by listening to what is being said during scoping. It is possible that out of that dialogue may appear recommendations for changes and mitigation measures that can turn a controversial fight into an acceptable proposal.

2. *Contacting interested groups.*

Some problems have arisen in scoping where agencies failed to contact all the affected parties, such as industries or state and local governments. In one case, a panel was assembled to represent various interests in scoping an EIS on a wildlife-related program. The agency had an excellent format for the meeting, but the panel did not represent industries that would be affected by the program or interested state and local governments. As a result, the EIS may fail to reflect the issues of concern to these parties.

Another agency reported to us that it failed to contact parties directly because staff feared that if they missed someone they would be accused of favoritism. Thus they relied on the issuance of press releases which were not effective. Many people who did not learn about the meetings in time sought additional meeting opportunities, which cost extra money and delayed the process.

In our experience, the attempt to reach people is worth the effort. Even if you miss someone, it will be clear that you tried. You can enlist a few representatives of an interest group to help you identify and contact others. Trade associations, chambers of commerce, local civic groups, and local and national conservation groups can spread the word to members.

3. Tiering.

Many people are not familiar with the way environmental impact statements can be "tiered" under the NEPA regulations, so that issues are examined in detail at the stage that decisions on them are being made. See Section 1508.28 of the regulations. For example, if a proposed program is under review, it is possible that site specific actions are not yet proposed. In such a case, these actions are not addressed in the EIS on the program, but are reserved for a later tier of analysis. If tiering is being used, this concept must be made clear at the outset of any scoping meeting, so that participants do not concentrate on issues that are not going to be addressed at this time. If you can specify when these other issues *will* be addressed it will be easier to convince people to focus on the matters at hand.

4. Scoping for unusual programs.

One interesting scoping case involved proposed changes in the Endangered Species Program. Among the impacts to be examined were the effects of this conservation program *on user activities* such as mining, hunting, and timber harvest, instead of the other way around. Because of this reverse twist in the impacts to be analyzed, some participants had difficulty focusing on useful issues. Apparently, if the subject of the EIS is unusual, it will be even harder than normal for scoping participants to grasp what is expected of them.

In the case of the Endangered Species Program EIS, the agency planned an intensive 3 day scoping session, successfully involved the participants, and reached accord on several issues that would be important for the future implementation of the program. But the participants were unable to focus on impacts and program alternatives for the EIS. We suggest that if the intensive session had been broken up into 2 or 3 meetings separated by days or weeks, the participants might have been able to get used to the new way of thinking required, and thereby to participate more productively. Programmatic proposals are often harder to deal with in a scoping context than site specific projects. Thus extra care should be taken in explaining the goals of the proposal and in making the information available well in advance of any meetings.

D. Lead and Cooperating Agencies.

Some problems with scoping revolve around the relationship between lead and cooperating agencies. Some agencies are still uncomfortable with these roles. The NEPA regulations, and the *40 Questions and Answers about the NEPA Regulations*, 46 Fed. Reg. 18026, (March 23, 1981) describe in detail the way agencies are now asked to cooperate on environmental analyses. (See Questions 9, 14, and 30.) We will focus here on the early phase of that cooperation.

It is important for the lead agency to be as specific as possible with the cooperating agencies. Tell them what you want them to contribute during scoping: environmental impacts and alternatives. Some agencies still do not understand the purpose of scoping.

Be sure to contact and involve representatives of the cooperating agencies who are responsible for NEPA-related functions. The lead agency will need to contact staff of the cooperating agencies who can both help to identify issues and alternatives *and* commit resources to a study, agree to a schedule for EIS preparation, or approve a list of issues as sufficient. In some agencies that will be at the district or state office level (e.g., Corps of Engineers, Bureau of Land Management, and Soil Conservation Service) for all but exceptional cases. In other agencies you must go to regional offices for scoping comments and commitments (e.g., EPA, Fish and Wildlife Service, Water and Power Resources Service). In still others, the field offices do not have NEPA responsibilities or expertise and you will deal directly with headquarters (e.g., Federal Energy Regulatory Commission, Interstate Commerce Commission). In all cases you are looking for the office that can give you the answers you need. So keep trying until you find the organizational level of the cooperating agency that can give you useful information and that has the authority to make commitments.

As stated in *40 Questions and Answers about the NEPA Regulations*, the lead agency has the ultimate responsibility for the content of the EIS, but if it leaves out a significant issue or ignores the advice and expertise of the cooperating agency, the EIS may be found later to be inadequate. (46 Fed. Reg. 18030, Question 14b.) At the same time, the cooperating agency will be concerned that the EIS contain material sufficient to satisfy its decisionmaking needs.

Thus, both agencies have a stake in producing a document of good quality. The cooperating agencies should be encouraged not only to participate in scoping but also to review the decisions made by the lead agency about what to include in the EIS. Lead agencies should allow any information needed by a cooperating agency to be included, and any issues of concern to the cooperating agency should be covered, but it usually will have to be at the expense of the cooperating agency.

Cooperating agencies have at least as great a need as the general public for advance information on a proposal before any scoping takes place. Agencies have reported to us that information from the lead agency is often too sketchy or comes too late for informed participation. Lead agencies must clearly explain to all cooperating agencies what the proposed action is conceived to be at this time, and what present alternatives and issues the lead agency sees, before expecting other agencies to devote time and money to a scoping session. Informal contacts among the agencies before scoping gets underway are valuable to establish what the cooperating agencies will need for productive scoping to take place.

Some agencies will be called upon to be cooperators more frequently than others, and they may lack the resources to respond to the numerous requests. The NEPA regulations permit agencies without jurisdiction by law (i.e., no approval authority over the proposal) to decline the cooperating agency role. (Section 1501.6(c)). But agencies that do have jurisdiction by law cannot opt out entirely and may have to reduce their cooperating effort devoted to each EIS. (See Section 1501.6(c) and *40 Questions and Answers about the NEPA Regulations*, 46 Fed. Reg. 18030, Question 14a.) Thus, cooperators would be greatly aided by a priority list from the lead agency showing which proposals most need their help. This will lead to a more efficient allocation of resources.

Some cooperating agencies are still holding back at the scoping stage in order to retain a critical position for later in the process. They either avoid the scoping sessions or fail to contribute, and then raise objections in comments on the draft EIS. We cannot emphasize enough that the whole point of scoping is to avoid this situation. As we stated in *40 Questions and Answers about the NEPA Regulations*, "if the new alternative [or other issue] was not raised by the commentator during scoping, but could have been, commentors may find that they are unpersuasive in their efforts to have their suggested alternative analyzed in detail by the [lead] agency." (46 Fed. Req. 18035, Question 29b.)

III. Advice for Public Participants

Scoping is a new opportunity for you to enter the earliest phase of the decisionmaking process on proposals that affect you. Through this process you have access to public officials before decisions are made and the right to explain your objections and concerns. But this opportunity carries with it a new responsibility. No longer may individuals hang back until the process is almost complete and then spring forth with a significant issue or alternative that might have been raised earlier. You are now part of the review process, and your role is to inform the responsible agencies of the potential impacts that should be studied, the problems a proposal may cause that you foresee, and the alternatives and mitigating measures that offer promise.

As noted above, and in *40 Questions and Answers*, no longer will a comment raised for the first time after the draft EIS is finished be accorded the same serious consideration it would otherwise have merited if the issue had been raised during scoping. Thus you have a responsibility to come forward early with known issues.

In return, you get the chance to meet the responsible officials and to make the case for

your alternative before they are committed to a course of action. To a surprising degree this avenue has been found to yield satisfactory results. There's no guarantee, of course, but when the alternative you suggest is really better, it is often hard for a decisionmaker to resist.

There are several problems that commonly arise that public participants should be aware of:

A. Public input is often only negative

The optimal timing of scoping within the NEPA process is difficult to judge. On the one hand, as explained above (Section II.B.1.), if it is attempted too early, the agency cannot explain what it has in mind and informed participation will be impossible. On the other, if it is delayed, the public may find that significant decisions are already made, and their comments may be discounted or will be too late to change the project. Some agencies have found themselves in a tactical cross-fire when public criticism arises before they can even define their proposal sufficiently to see whether they have a worthwhile plan. Understandably, they would be reluctant after such an experience to *invite* public criticism early in the planning process through open scoping. But it is in your interest to encourage agencies to come out with proposals in the early stage because that enhances the possibility of your comments being used. Thus public participants in scoping should reduce the emotion level wherever possible and use the opportunity to make thoughtful, rational presentations on impacts and alternatives. Polarizing over issues too early hurts all parties. If agencies get positive and useful public responses from the scoping process, they will more frequently come forward with proposals early enough so that they can be materially improved by your suggestions.

B. Issues are too broad

The issues that participants tend to identify during scoping are much too broad to be useful for analytical purposes. For example, "cultural impacts" -- what does this mean? What precisely are the impacts that should be examined? When the EIS preparers encounter a comment as vague as this they will have to make their own judgment about what you meant, and you may find that your issues are not covered. Thus, you should refine the broad general topics, and specify which issues need evaluation and analysis.

C. Impacts are not identified

Similarly, people (including agency staff) frequently identify "causes" as issues but fail to identify the principal "*effects*" that the EIS should evaluate in depth. For example, oil and gas development is a cause of many impacts. Simply listing this generic category is of little help. You must go beyond the obvious causes to the specific effects that are of concern. If you want scoping to be seen as more than just another public meeting, you will need to put in extra work.

IV. Brief Points For Applicants.

Scoping can be an invaluable part of your early project planning. Your main interest is in getting a proposal through the review process. This interest is best advanced by finding out early where the problems with the proposal are, who the affected parties are, and where accommodations can be made. Scoping is an ideal meeting place for all the interest groups if you have not already contacted them. In several cases, we found that the compromises made at this stage allowed a project to move efficiently through the permitting process virtually unopposed.

The NEPA regulations place an affirmative obligation on agencies to "provide for cases where actions are planned by private applicants" so that designated staff are available to consult with the applicants, to advise applicants of

information that will be required during review, and to insure that the NEPA process commences at the earliest possible time. (Section 1501.2(d)). This section of the regulations is intended to ensure that environmental factors are considered at an early stage in the applicant's planning process. (See *40 Questions and Answers about the NEPA Regulations*, 46 Fed. Reg. 18028, Questions 8 and 9.)

Applicants should take advantage of this requirement in the regulations by approaching the agencies early to consult on alternatives, mitigation requirements, and the agency's information needs. This early contact with the agency can facilitate a prompt initiation of the scoping process in cases where an EIS will be prepared. You will need to furnish sufficient information about your proposal to enable the lead agency to formulate a coherent presentation for cooperating agencies and the public. But don't wait until your choices are all made and the alternatives have been eliminated. (Section 1506.1).

During scoping, be sure to attend any of the public meetings unless the agency is dividing groups by interest affiliation. You will be able to answer any questions about the proposal, and even more important, you will be able to hear the objections raised, and find out what the real concerns of the public are. This is, of course, vital information for future negotiations with the affected parties.

CHAPTER 4

ASSESSMENT

CHAPTER 4

ASSESSMENT

In this part of the sourcebook, "assessment" is used narrowly and includes tasks associated with the preparation of EA documents (i.e., those activities for which the core team is directly responsible). These include:

- description of the affected environments,
- description of the future environmental setting (without the proposed action),
- identification of potential environmental impacts of a proposed action and its reasonable alternatives,
- analysis and quantification, if possible, of potential impacts,
- evaluation of the significance of potential environmental impacts,
- description of mitigation measures for unavoidable environmental impacts, and
- preparation of an EA document for use by the decisionmaker.

However, "assessment" is often used broadly to include policy related activities such as defining issues, evaluating the overall significance of a proposed action, and choosing the appropriate alternative. For purposes of this sourcebook, we use "environmental assessment (EA) process" to describe the broad implications of environmental assessment. These include, in addition to assessment, the activities that precede and follow assessment (i.e., initiation, scoping, decisionmaking and post-decision analysis).

Affected Environments

The description of the affected environments must identify the important physical, biological, and social/cultural characteristics of the areas potentially exposed to the proposed action and alternatives and explain the reasons for the boundaries of the study areas. Only those elements which are relevant to the issues identified for the proposed action and alternatives need be identified and evaluated. It is normally one of the first activities undertaken in the assessment phase of EA and has been described as a "description of conditions existing at a point in time against which subsequent changes can be detected through monitoring" (Hirsch 1980). The approach commonly taken is subdivision of the resources into categories (Table 4.1-1). Depending on the size and complexity of the EA, core team members are chosen with expertise in the appropriate areas (Attachment 2.C). Experience from similar projects can be helpful in identifying environmental components that should be described.

The initial description of the affected environment should identify important gaps for which subsequent field or laboratory investigations are needed. For many areas which have already been studied, even if in a fragmented way, a meaningful characterization can be developed based on existing information. In other areas, field reconnaissance or study may be required even to complete a rough or initial characterization (Hirsch 1980). Reconnaissance-level information is that which is available from open literature, published or unpublished reports, existing records, authoritative sources, or brief field surveys performed by recognized experts. It is not based on information that can only be obtained by detailed onsite monitoring programs or studies (McBrayer et al., 1981).

Table 4.1-1. General Baseline Information on a Site and its Surroundings.*

Category	Type of information	Sources of information
Land use and zoning	Maps and tables showing present land use on the site and surrounding area; land ownership; regional, state, and local land-use plans and controls pertinent to the site and surrounding area.	State, regional, and local planning commissions; state agencies, such as Departments of Conservation, Fish and Game, and Parks; federal agencies, such as U.S. Geological Survey (USGS), Soil Conservation Service (SCS), Bureau of Land Management (BLM), Forest Service; onsite observations.
Floodplains and wetlands	Maps showing the locations of the 100- and 500-year floodplains and onsite wetlands; table showing onsite area for each floodplain or wetland; description of each onsite wetland, including dominant features and abundance of each wetland type.	Department of Housing and Urban Development (HUD) Flood Insurance Rate Maps and Federal Emergency Management Agency (FEMA) Flood Hazard Boundary Maps; USGS topographic maps; county soil surveys; U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory; U.S. Army Corps of Engineers (COE); onsite observations.
Prime and unique farmlands	Soils map of the site; description of onsite soil types; area of each soil on the site that is classified as prime or unique farmland.	SCS; state soil conservationist and local soil conservation office; state agricultural colleges.
Cultural and aesthetic resources	Location and description of cultural and aesthetic resources on or in the vicinity of the site, including historic and archaeological sites, Indian tribal resources, scenic, and other aesthetic resources.	State historic preservation office; National Register of Historic Places; National Register of Natural Landmarks; U.S. Bureau of Indian Affairs; local tribal headquarters; onsite observations.
Geology	Geological bedrock, and surface formations; topography; location and description of potential geologic hazards, including consideration of slope stability, mass movement, faults, subsidence, settlement, liquefaction, and volcanic activity.	USGS national distribution center, Reston, Virginia; USGS depositories of publications at each state land grant university; state geologist; USGS topographic and land-use maps; onsite observations.
Terrestrial and aquatic ecology	Map and description of vegetation types on the site; wildlife species and habitats; presence of rare, unique, or important ecological communities or habitats; description of aquatic habitat types and aquatic species present in water bodies; abundance of important species, trends in abundance, and distributions relative to the proposed project.	Ecologists and other biologists at local and state colleges and universities; private environmental and conservation organizations; state fish and game and conservation agencies; onsite observations, FWS habitat evaluation procedures.

Table 4.1-1. (continued)

Category	Type of information	Sources of information
Endangered and threatened species	Lists and descriptions of federal and state endangered, threatened, rare, and protected species and their critical habitat present in the region of the site; observations and reports of such species and habitats on the site or on other areas to be affected by the project.	Federal listing of endangered and threatened species, published annually and updated as needed in the Federal Register; state lists of endangered and threatened species, generally published by state departments of fish and game or conservation; local chapters of organizations concerned with environment and conservation (e.g., the National Audubon Society or the National Wildlife Federation); consultation with FWS regional office; onsite observations.
Groundwater	Description of groundwater resources potentially affected by the project, including aquifer characteristics, flow system characteristics, competing water use and availability, water quality, designation of any sole source aquifer; locations and depths of existing wells.	USGS; U.S. Environmental Protection Agency (EPA); delegated state agencies for administering EPA permit programs; state geological survey; geologists and hydrologists at local and state colleges and universities; National Waterwell Association; onsite well records.
Surface water	Description of surface water features that will be affected by the project; a map showing the drainage pattern of the site and its surroundings and onsite water bodies: data on water availability and water quality of affected water bodies; identification of existing permitted discharges to surface water.	USGS topographic maps; aerial photographs; comprehensive data bases such as Water Resources Abstracts, WATSTORE, NAWDEX, and STORET; state and federal agencies responsible for permitting, including EPA, COE and delegated state agencies; onsite observations.
Climate and air quality	Important climatic parameters, such as, average temperatures, relative humidity, precipitation, wind direction and speed, wind stability classes, mixing heights, fog occurrence, and meteorological extremes (e.g., tornado or hurricane frequency); identification of air quality control regions in which the site is located and those affected by emissions from the facility; description of the attainment or nonattainment status for the criteria pollutants; description of present ambient air quality; State Implementation Plan (SIP) restrictions; location of any Class I area (nondegradation areas, e.g., wilderness areas or national parks) affected by project emissions; discussion of trends in pollutant levels over time where data on air quality is available.	National Weather Service or Federal Aviation Administration stations; National Climatic Center, Asheville, North Carolina; local airports; U.S. EPA or state agency delegated to administer air quality permits; other industrial or research facilities that collect climatic or air quality data.
Noise**	Existing ambient background noise levels on the site and in the vicinity; major existing or planned noise sources and sensitive receptors (e.g., hospitals).	Onsite measurements; contacts with local and state agencies; examination of area maps.

Table 4.1-1. (continued)

Category	Type of information	Sources of information
Socioeconomics	Definition of socioeconomic impact region; current and projected population and relevant demographic characteristics; local government revenues, expenditures, and revenue-sharing arrangements; current and projected housing capacity; current and planned public service capacity (water, sewer, transportation, police, fire, health, education, and welfare); economic structure and labor force characteristics; local government characteristics; local organizations and interest groups; social structure and life styles; local support or opposition to the proposed project.	U.S. Bureau of Census, U.S. Department of Transportation, Department of Labor Statistics, Department of Commerce publications; employment commissions; chambers of commerce; tourist bureaus; academic reports - especially by local institutions; local newspapers; interviews with government officials; researchers; and interested parties; inspection of the site and region.

*The National Wildlife Federation's annual Conservation Directory lists organizations, agencies, and officials concerned with natural resource use and management.

**The Federal Interagency Committee on Urban Noise (1980) has published an excellent description of the noise policies and programs of federal agencies relating to land use.

- Establishment of time and space boundaries for the affected environment is a critical first step in EA. The team can expect more than one set of boundaries depending on the issue(s). The setting of boundaries usually represents a trade-off of constraints imposed by:

  - administrative boundaries (e.g., political, social, and economic realities),
  - project boundaries (e.g., the spatial and temporal extent of the project),
  - ecological boundaries (e.g., time and space scales over which affected natural systems operate), and
  - technical boundaries (e.g., the limited state-of-the-art in predicting or measuring ecological changes).

  It is important to distinguish between the categories since some are under the control of the EA team while others are relatively fixed (Beanlands and Duinker 1983).

- The data requirements for relevant analyses are based on understanding of the proposed action and any tentative mitigation, clearly defined EA objectives, and the requirements of the methodologies to be used for prediction of impacts. The EA team will:

  - assemble, evaluate, and present baseline data on the relevant environmental characteristics of the study area, including information on any changes anticipated before the project commences;
  - collate data from the various disciplinary areas and evaluate data usefulness, needs, and availability in relation to the proposed action;
  - identify gaps in information; and
  - avoid collecting unnecessary information and data.

- Before using existing environmental data for project assessment, a number of possible limitations must be checked. The quality of reported environmental data must be assessed, and this is generally not an easy task. One should look for quality control and assurance programs as an integral part of any past monitoring efforts. Responsible agencies, laboratories, or monitoring or analytical personnel should be contacted for information on the

estimated quality of the reported data. In general, work done by major federal agencies that have standard reference methods for sample collection and analysis should be useful. However, laboratories that may be consistent internally (be highly precise) in their sample analysis may show inaccuracies with other analytical groups.

The reliability and comparability of existing data to present site-specific conditions should be checked. Existing data for geographic areas removed from exact locations of interest will usually have to be verified in the field for comparability. Any significant environmental changes after the field data have been collected, such as from new pollution sources or from recent environmental events such as flooding or fire, should be determined.

TOOLS

The use of checklists can help the EA team identify potential impacts (Attachment 2.B, Part 4.2), ensure that significant environmental parameters are not overlooked, and provide an outline of data needs. It can also help to identify alternatives which might lessen impact. Checklists are suited to identification of direct impacts but generally not to identification of indirect impacts. A matrix is an extension of a checklist where one axis lists description of the proposed action while the other lists environmental conditions. The Leopold matrix (Leopold et. al. 1971) provides a format for comprehensive review to remind investigators of the variety of interactions that might be involved (Figure 4.1-1). The number of actions listed horizontally in the complete Leopold matrix is 100 and the vertical list of environmental characteristics contains 88, which give a total of 8,800 possible interactions. The vertical list can be used as a checklist to identify important environmental factors.

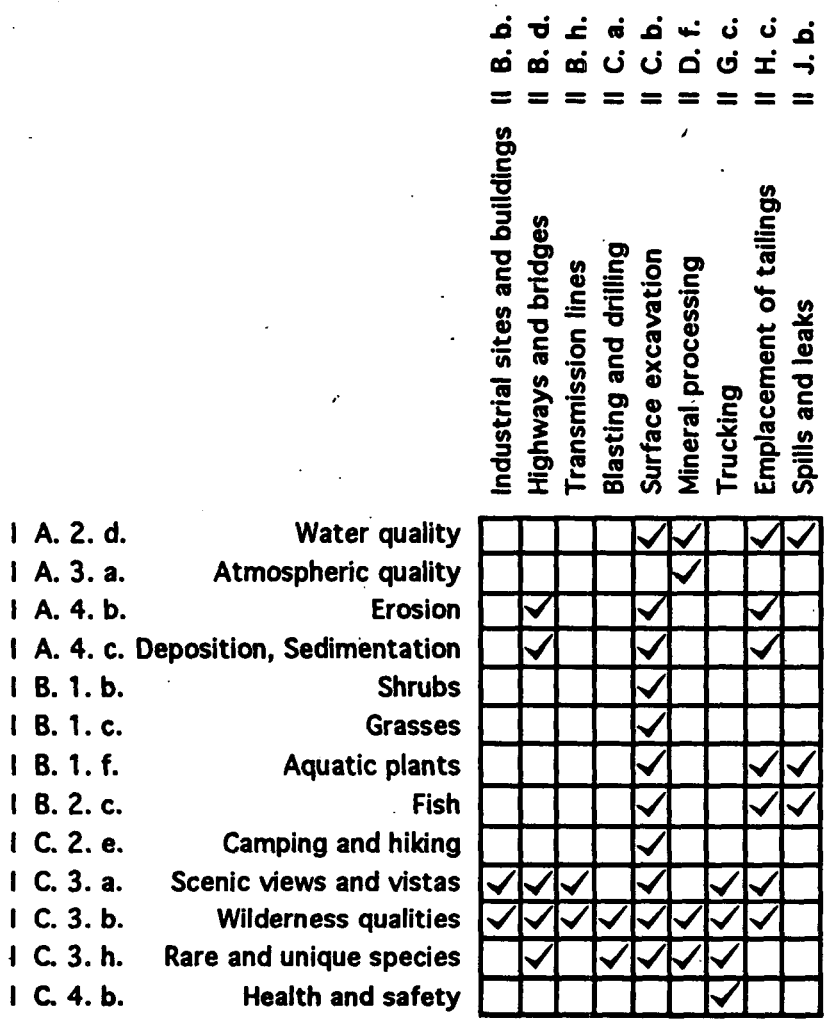

FIGURE 4.1-1. A reduced matrix for a phosphate mining lease. (Source: Leopold et al. 1971)

Environmental field studies can be more or less extensive depending upon the existing information. Their scope will vary in relation to the nature of the proposed action and the information gaps that need to be filled. Field studies document the existing environmental conditions and contribute to trend information in the potentially affected region. They provide a reference baseline from which the assessment team can predict the effects of the proposed action, recommend alternatives, define appropriate mitigation measures, and design future programs to monitor the accuracy of predictions and the effectiveness of mitigation.

An environmental field study is only part of the EA process and as such is influenced by external factors. These include, for example:

- other socioeconomic studies being performed,
- political and legal requirements to be met,
- specific features and timing of the proposed action,
- project planning and engineering,
- stages of the decisionmaking process requiring environmental input, and
- how the baseline data will be used in the construction, operation, and closure phases of an approved action.

For example, the identification of permeable strata in geotechnical studies may dictate an emphasis on biological effects of leachates contaminating surface waters down-slope from a development; or frequent temperature inversions detected by atmospheric studies may call for increased emphasis on the biological effects of gaseous emissions; or water resource studies may reveal a general lack of surface water in a region, thereby requiring greater emphasis on a few surface water bodies as critical habitats in the ecological studies.

Most important is the integration of environmental field studies with engineering design studies. Impact predictions will be accurate only to the extent that the best possible environmental knowledge is combined with detailed engineering plans in the presence of good professional judgment.

Once environmental components of interest are identified, it is necessary to choose methods for measuring the appropriate parameters. Methods selection is tempered by the limitations of the state of the art, which include considerations of accuracy, efficiency, and cost-effectiveness, and the amenability of various methods to statistical analysis. Stepwise procedures for applying these important constraints to the final design of environmental studies are too extensive to be included in this sourcebook. However, the U.S. Fish and Wildlife Service Manual "A Systems Approach to Ecological Baseline Studies" (1978) contains the conceptual framework for field studies and practical step-by-step approaches to designing baseline studies.

Whenever possible, existing data should be used to reduce the costs of EA. Attachment 4.A lists some of the sources of environmental monitoring data in the United States and elsewhere. In developing countries, such data are less available which limits description of the affected environment and prediction of potential impacts.

Federal and state air and water quality monitoring generally is designed as a large-scale regional surveillance effort, and thus is particularly useful for policy, plan, and program EA. When local data can be located, they often are not in a readily usable form; specific parameters and analytical methods may not be adequate, or quality control and assurance may not be sufficient. Existing data usually are not computerized with an adequate and comprehensive indexing code for geographical locations. Thus, they are useful only to describe general environmental conditions and recent trends in environmental quality and will generally have limited use for site-specific analysis of environmental change. Unfortunately, in the U.S. and other countries, central sources for identifying all national, regional, and local monitoring efforts do not exist. Information can be gathered from individual federal (Attachment 4.A) and regional agencies by contacting the agency directly or, in some rare instances, by contacting a central information source (e.g., the Oak Ridge National Laboratory Carbon Dioxide Information Analysis Center; Attachment 4.A).

In addition to the U.S. federal laws listed in Part D, other federal laws contain provisions that affect the content and scope of an EA under certain circumstances. Laws on water pollution control, clear air, and surface mining control and reclamation as well as permits or licenses may require baseline data. If a development involves leasing lands from federal agencies, studies may be called for in lease stipulations (e.g., leases for prototype oil shale development). Requirements at the regional level of government may be more strict than those at the federal level. In the U.S., sixteen states, the District of Columbia, and Puerto Rico have environmental policy acts or "little NEPAs", and 18 other states and the District of Columbia have limited environmental review requirements established by statute, executive order or other administrative directives (Part D). For the most part, proponents will have had previous experience on similar projects and will be able to direct the assessment team to other agencies that should be contacted.

A summary of applicable legal requirements should be prepared that includes:

- federal, tribal, regional, or local agencies with decision-making or review responsibilities;
- applicable federal, tribal, regional, or local laws, regulations or permits and their specific environmental requirements;
- official interpretations of the laws, regulations or permits;
- information needs identified by federal, tribal, regional, or local agency representatives; and
- specific requirements of any reports that must be produced.

Once this information is available, the existing data for the site should be compared to the requirements (e.g., water quality criteria) to determine the information gaps and the extent of additional monitoring data or other required information (e.g., archaeological or protected species surveys).

ISSUES

- Descriptions of the affected environment must concentrate on issues that are significant and appropriate for the size and location of the proposed action and alternatives rather than amassing needless detail. The level of detail should be sufficient to convey to a reader or reviewer the nature of the natural and human resources. Where an action (and its anticipated effects) is essentially confined to a particular piece of property, it may be appropriate to describe natural and man-made features of the property and vicinity. Where the action extends across several regions or political subdivisions, as with a transmission line, pipeline, or canal, the discussion of existing environments may necessarily be less detailed in certain categories.

- Field studies should not be undertaken without clearly defined objectives and understanding of the problem to which the data will be applied. The data must be consistent with the needs of: the EA team for modeling or predictive purposes, the decisionmaker and the project planners, and the legal and socioeconomic requirements.

- Careful consideration must be given to the need for and value of existing data in relation to their inherent limitations (e.g., fragmented, inaccessible, unstandardized) and their usefulness in

impact analysis and prediction. The focus is often on collecting information and data that are readily available rather than on what is needed for analysis. The data requirements should be defined by what is needed for assessment of the endpoints.

In addition to the seriousness of anticipated impacts, the level of effort expended on description of the affected environment is determined by cost and time factors. In general, the resources available will be no more, and often less, than the minimum that is required by the decision process. Thus, it is important to focus on those elements of the affected environment most pertinent to the decision process and to use those methods that are most cost effective in obtaining adequate data. Time may influence the scope of this part of EA in several ways. For instance, the environmental parameters of interest may vary from season to season and even year to year and data collection to establish these patterns may not be synchronized with the needs of the decisionmaker.

Data collected must be amenable for use in models, experimental designs or statistical analysis so that project-induced effects can be separated from naturally occurring changes.

LINKAGES

Description of the affected environment should be structured around the issues, valued resource components, and assessment endpoints identified during initiation and scoping. The results of data collection and any field studies are the basis for assessment of potential environmental impacts of proposed actions and alternatives. An appropriate, well-documented description of the affected environment will aid the decisionmaker in the identification and resolution of problems associated with the proposed action. Moreover, it is the basis for post-decision monitoring.

Beanlands, G. E., and P. N. Duinker. 1983. An Ecological Framework for Environmental Assessment in Canada. Institute for Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia and Federal Environmental Assessment Review Office, Hull, Quebec.

Bregman, J. I., and K. M. Mackenthun. 1992. Environmental Impact Statements. Lewis Publishers, Inc. 121 South Main Street, Chelsea, Michigan 48118. 279 pp.

Federal Interagency Committee on Urban Noise. 1980. Guidelines for Considering Noise in Land Use Planning and Control.

Hirsch, A. 1980. The baseline study as a tool in environmental impact assessment. In: Biological Evaluation of Environmental Impacts, The Proceedings of a Symposium. Fish and Wildlife Service FWS/OBS-80/26. pp. 84-93.

McBrayer, J. F., S. B. Gough, R. C. Robertson, and H. E. Zittel. 1981. Identifying alternatives at a reconnaisance level. Environmental Impact Assessment Review 2:190-195.

Leopold, L. B., F. E. Clarke, B. B. Hanshaw, and J. R. Balsley. 1971. A Procedure for Evaluating Environmental Impact. U.S. Department of the Interior, Geological Survey Circular 645.

U.S. Fish and Wildlife Service. 1978. A Systems Approach to Ecological Baseline Studies. FWS/OBS-78/21. 406 pp. Available from National Technical Information Service, telephone (703) 487-4780.

National Wildlife Federation. Annual Conservation Directory. National Wildlife Federation, Washington, D.C., telephone (202) 797-6800.

ATTACHMENT 4.A

SOURCES OF ENVIRONMENTAL DATA

- **Federal Interagency Initiatives to Coordinate Environmental Data and Analysis** (Source: Council on Environmental Quality. 1993. Environmental Quality. 23rd Annual Report)

- **Environmental Statistics Programs Managed by Agencies of the U.S. Government** (Source: Council on Environmental Quality. 1993. Environmental Quality. 23rd Annual Report)

- **Summary and table of contents for the Manual of Federal Geographic Data Products** (Source: Federal Geographic Data Committee. 1993)

- **State of the Environment Reports and Statistical Compendia Published by International Organizations** (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

- **Table of contents for A Guide To Selected National Environmental Statistics In The U.S. Government** (Source: U.S. Environmental Protection Agency. 230-R-92-003. April 1992)

Federal Interagency Initiatives to Coordinate Environmental Data and Analysis (Source: Council on Environmental Quality. 1993. Environmental Quality. 23rd Annual Report)

Program	Lead Agency	Coverage
Interagency Committee on Environmental Trends	CEQ	In 1991 CEQ established an interagency committee with the participation of all agencies involved in environmental data to undertake development of a framework for U.S. state-of-the-environment reporting.
National Acid Precipitation Assessment Program 1990 (NAPAP)	CEQ	NAPAP, established by the 1980 Acid Precipitation Act, coordinates federally funded research and assessment to develop a firm scientific basis for acid rain policies. The Clean Air Act Amendments of 1990 extended NAPAP, which monitors the influence of the Clean Air Act on environmental impacts.
Environmental Monitoring and Assessment Program (EMAP)	EPA	A long-term research, monitoring, and assessment program, initiated in 1988 to provide regional and national reports on the conditions of U.S. ecological resources. During the next five years, EMAP monitoring networks will estimate trends in national ecological indicators on a regional basis; monitor selected indicators of natural and anthropogenic stresses; seek associations between human-induced stresses and ecological conditions and provide periodic statistical summaries and interpretive reports on status and trends for resource managers and the public.
EPA Center for Environmental Statistics	EPA	EPA Development Staff established the Center for Environmental Statistics to gather environmental data from a variety of sources; address data quality and statistical issues; and use data to provide information on environmental conditions. The Center currently is situated within the EPA Environmental Statistics and Information Division.
Intergovernmental Monitoring Task Force	EPA and USGS	Established in 1991 by the EPA Office of Water and the USGS. The task force coordinates efforts with NOAA, FWS, COE, USDA, OMB, and DOE to identify and recommend solutions to water quality monitoring problems; establish a national framework for water quality monitoring; agree on environmental indicators; and share water quality data through system linkages and increased quality assurance and control.
Federal Geographic Data Committee (FGDC)	DOI	FGDC, with 14 departments and agencies promotes coordinated development, use, and dissemination of surveying, mapping, and related spatial data. Established by OMB Circular A-16, "Coordination of Surveying, Mapping, and Related Spatial Data Activities," the committee stresses coordination and standards.
Ocean Pollution Data and Information Network (OPDIN)	NOAA	A 10-year interagency effort by 11 federal agencies to improve accessibility and usefulness of data and to increase communication and coordination on ocean and Great Lakes pollution information; the network publishes information guides and responds to requests for information.
FCCSET/CEES IWGMDGC	OSTP	Within the President's Office of Science and Technology Policy (OSTP), the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) established the Committee on Earth and Environmental Sciences (CEES) as a forum to coordinate interagency programs, including the U.S. Global Change Research Program (USGCRP). Chaired by NASA and NOAA, the Interagency Working Group on Data Management for Global Change (IWGDMGC) is developing recommendations on interagency management of research data. In 1991 the National Research Council drafted a "U.S. Strategy for Global Change Data and Information Management."

Federal Interagency Initiatives to Coordinate Environmental Data and Analysis (continued)

Program	Lead Agency	Coverage
President's Water Quality Initiative	USDA	This initiative addresses nonpoint source contamination of surface water and groundwater by agricultural chemicals: 11 agencies, including TVA, USGS, EPA, NOAA, FWS, and COE, comprise the working group on the Water Quality. Cooperative programs include the USDA Management Systems Evaluation Areas, the USGS National Water Quality Assessment, and the EPA Midwest Agrichemical Surface/Subsurface Transport and Effects Research project.
Water Information Coordination Program (WICP)	USGS	OMB Memorandum M-92-01 of December 10, 1991, established the Water Information Coordination Program to include all federal organizations that fund, collect, or use water resources information. WICP convenes an Interagency Coordinating Committee for Water Information and a Federal Advisory Committee on Water Data for Public Use. The program is establishing effective working relationships with state and local agencies, Indian tribes, and the private sector. WICP will plan, design, and operate a cost-effective national network for water-data collection; develop uniform standards for water information collection, management, and dissemination; establish a National Water Information Clearinghouse; and annually report to OMB to document funding and program activities.
National Resources Inventory (NRI)	USDA Soil Conservation Service	This national multi-resource inventory is conducted every 5 years to determine status, condition, and trends of soil, water, and related resources NRI and associated soils data are used to formulate policy and assist in strategic planning of conservation and environmental programs at national, regional, and local levels.
Forest Health Monitoring Program	USDA Forest Service	This long-term monitoring program was started in 1990 to measure, interpret, and report effects of forest pests, air pollution, other stressors, and management methods on the health of U.S. forests. The program included 14 states in 1992 and will be expanded nationwide in future years. It has three increasingly intensive phases: detection monitoring to determine annual differences from baseline conditions or trends; in-depth evaluation monitoring to determine cause, extent, and severity of detected changes; and intensive-site ecosystem monitoring to provide detailed, long-term research data for predicting future conditions. Cooperators include EPA, the National Association of State Foresters, and other state and federal resource agencies.

Federal Interagency Initiatives to Coordinate Environmental Data and Analysis (continued)

Program	Lead Agency	Coverage

NOTE: The following abbreviations appear in the environmental data tables:

BLM	=	Bureau of Land Management, Department of Interior
CEQ	=	President's Council on Environmental Quality
COE	=	U.S. Department of Defense, Army Corps of Engineers
DOC	=	U.S. Department of Commerce
DOE	=	U.S. Department of Energy
DOI	=	U.S. Department of the Interior
EC	=	European Community
EPA	=	U.S. Environmental Protection Agency
FAO	=	United Nations Food and Agriculture Organization
FWS	=	Fish and Wildlife Service, Department of the Interior
NASA	=	National Aeronautics and Space Administration
NOAA	=	National Oceanic and Atmospheric Administration, Department of Commerce
OMB	=	President's Office of Management and Budget
OSTP	=	President's Office of Science and Technology Policy
RPA	=	Forest and Rangeland Renewable Natural Resources Policy Act
USDA	=	U.S. Department of Agriculture
USGS	=	U.S. Geological Survey, Department of the Interior

Environmental Statistics Programs Managed by Agencies of the U.S. Government (Source: Council on Environmental Quality. 1993. Environmental Quality. 23rd Annual Report)

Program	Sponsor	Coverage	Frequency/Most Recent Report
Major Uses of Land in the United States	USDA Economic Research Service	Estimated acreage and inventories of major U.S. land uses and of cropland used for crops.	Intervals of major land uses coincide with the Census of Agriculture; 1991 report with 1987 data. Annual reports for cropland used for crops; 1992 report with preliminary 1992 data.
Agricultural Chemical Usage Statistics	USDA National Agricultural Statistics Service and Economic Research Service	Estimated treatment acreage and application quantity of fertilizer nutrients and pesticide ingredients applied to field crops, vegetables, and fruits; includes state estimates for those states where the commodities are predominantly produced.	Annual collection for field crops; 1992 report with 1991 data. Biennial reports for vegetables and fruits; 1991 report for vegetables with 1990 data and 1992 report for fruits with 1991 data.
Pollution Abatement Control Expenditures (PAC)	DOE Bureau of Economic Analysis	Summary of all spending for PAC by business, government, and consumers, and by type.	Annual reports; 1992 report with 1990 data.
Energy and Environmental Database	DOC Bureau of the Census, Center for Economic Studies (CES)	Census Bureau and EPA data files have been integrated, yielding longitudinal plant and firm level data on production inputs, outputs, costs, energy consumption, pollution emissions, and pollution abatement expenditures.	Annual collection
Forest Insect and Disease Conditions in the United States	USDA Forest Service	Data for U.S. federal, state, and private forestlands; data analyses by region, ownership, type of insect/disease, area affected, trend data available.	Annual collection; 1992 report with 1991 data.
RPA Assessment of the Forest and Rangeland Situation	USDA Forest Service	Inventory with trend information on extent, condition, ownership, and composition of U.S. forests; wildlife habitat, forage production, and other resource characteristics.	5-year cycle; 1989 reports with 1987 data.
Land Areas of the National Forest System	USDA Forest Service	Data on extent and characteristics of forest, range, and related lands in the National Forest System.	Annual reports.
Tree Planting in the United States	USDA Forest Service	Summary of tree planting in the United States.	Annual reports; 1992 report with 1991 data.
Survey of Pollution Abatement Costs and Expenditures	DOC Bureau of the Census	Annual operating costs and capital expenditures for pollution abatement activities in manufacturing industries.	Annual collection.

Environmental Statistics Programs (continued)

Program	Sponsor	Coverage	Frequency/Most Recent Report
Classified Shellfishing Waters	NOAA	Monitors classified shellfishing waters as indicators of bacterial water quality nationwide; classifies waters for commercial harvest of oysters, clams, and mussels based on actual or potential pollution sources and coliform bacteria levels in surface waters.	5-year surveys; most recent 1990.
Fisheries Statistics Program	NOAA	National compilation, analysis, and dissemination of biological, economic, and sociological statistics from U.S. commercial (domestic and high seas) and recreational fisheries. Mostly marine; historical time series, some dating back to 1800s; some world (FAO, EC) fishery data, foreign nation data on fisheries in U.S. Waters. Data types include landings, prices and fishing efforts; number of vessels, gear and fishermen; annual processed products; trade in fisheries products; species composition; length frequencies; per capita consumption; and aquaculture.	Collect daily/monthly/yearly information from primary and secondary sources; monthly, quarterly, and annual publications; user requests via hard copy, magnetic tapes, diskettes. CD-ROM, PC Bulletin Board.
National Climatic Data Center (NCDC)	NOAA	NCDC collects, processes, archives, and disseminates worldwide meteorological and climatological data from a global network of stations; coverage is global, land and sea, primarily of U.S. dependencies, especially for summarized data.	Responds to over 33,000 user requests per year; these records date from mid-nineteenth century to present.
National Oceanographic Data Center (NODC)	NOAA	NODC collects, processes archives, and disseminated such worldwide oceanographic data as marine biology, marine pollution, wind and waves, surface and subsurface currents, and temperature.	Responds to over 10,000 user requests per year; records date from late-nineteenth century to present.
National Geophysical Data Center (NGDC)	NOAA	NGDC collects, processes, archives, and disseminates such worldwide geophysical data as solid earth geophysics, earthquake seismology, geomagnetic surveys, marine geology and geophysics, solar-terrestrial physics, and glaciology.	Responds to 11,000 user requests per year; records date from mid-nineteenth century to present.
National Coastal Pollutant Discharge Inventory Program	NOAA	Compiles pollutant-loading estimates for point, nonpoint, and riverine sources in coastal counties or the 200-mile Exclusive Economic Zone. Such sources discharge to the estuarine, coastal, and oceanic waters of the contiguous United States, excluding the Great Lakes.	East, West and Gulf Coast estimates are for 1982, 1984, and 1987 respectively. In 1993 estimates will be updated to 1991 for all three marine coasts.

Environmental Statistics Programs (continued)

Program	Sponsor	Coverage	Frequency/Most Recent Report
National Estuarine Inventory	NOAA	Compiles, evaluates, and assesses information on 102 estuaries in the continental United States, including data on salinity, bottom sediments, freshwater inflow, pesticide use, land use, distribution of estuarine fishes and invertebrates, population, water quality, recreation use, and wetlands.	Many projects are ongoing assessments; others involve a snapshot view of existing data. Topics of the Coastal Trends series include a summary report on U.S. estuaries (1990), coastal wetlands (1991), housing starts (1992), coastal pollution (expected 1993), oil spills (expected 1993).
Month and State Current Emissions Trends	DOE Argonne National Laboratory	Emissions estimates for NOx, SO2, and VOCs by month and state from 1975 to the present for 68 emission source groups.	Monthly; 1975 to present.
National Energy Information Center	DOE Information Administration	Collects and publishes data; prepares analyses on energy production, consumption, prices, and resources; makes projections of energy supply and demand.	Annual reports.
Carbon Dioxide Information Analysis Center	DOE Oak Ridge National Laboratory	Compiles, evaluates, and distributes information related to carbon dioxide.	Data collection ranges from hourly to decadal.
Integrated Data Base Program	DOE	Maintains data on all spent radioactive fuel and waste in the United States.	Annual data collection and reporting.
National Wetlands Inventory	FWS	Develops comprehensive information on the characteristics and extent of U.S. wetlands resources; wetlands map coverage for 70% of lower 48 states, 22% of Alaska, and all of Hawaii, Puerto Rico, and Guam.	Continuous wetlands trend for lower 48 states; statistical estimates of U.S. wetlands acreage beginning in 1990.
Gap Analysis	FWS	Develops standardized distribution maps of surface vegetation, terrestrial vertebrates, and endangered species in the lower 48 states and Hawaii.	First analysis, 1988 national assessment to be completed in 1998, to be updated at 5-year intervals.
National Contaminant Biomonitoring Program	FWS	Documents temporal and geographic trends in concentrations of persistent environmental contaminants that may threaten fish and wildlife; covers major U.S. rivers and Great Lakes.	2-to-4 year intervals.
North American Breeding Bird Survey	FWS	Provides uniform basis for assessing long-term trends in avian populations throughout North America; total number of individuals by species, survey route, and state.	2-year intervals.

Environmental Statistics Programs (continued)

Program	Sponsor	Coverage	Frequency/Most Recent Report
Waterfowl Breeding Population and Habitat	FWS	Provides annual breeding population estimates; measures breeding habitat changes over major portion of duck breeding range in North America.	Annual surveys and reports.
Statistics and Information Services	Bureau of Mines	Collects, analyzes, and publishes data on metal production and consumption, including scrap and waste.	Monthly, quarterly, and annually.
Public Land Statistics	BLM	Collects summary statistics of land ownership in the United States and BLM natural resource management programs at the state level.	Annual reports.
National Stream Quality Accounting network (NASQAN) and National Hydrologic Benchmark Network	USGS	NASQAN provides a national uniform basis for assessing large-scale, long-term trends in physical, chemical, and biological characteristics of waters; monitors for pH, alkalinity, sulfate, nitrate, phosphorus, calcium, magnesium, sodium, potassium, chloride, suspended sediment, fecal coliform bacteria, fecal streptococcal bacteria, dissolved oxygen, dissolved oxygen deficit, and trace elements; the Benchmark Network monitors water quality in surface waters largely unaffected by human activities.	Yearly data summaries for each state.
National Trends Network	USGS	Monitors atmospheric deposition under National Acid Precipitation Assessment Program (NAPAP); 150 stations predominantly in rural areas, in combination with USDA National Atmospheric Deposition Program (NADP); almost 200 sites nationwide.	NAPAP publications.
National Water Conditions Reporting System	USGS	Collects and analyzes streamflow data, groundwater levels, reservoir contents, and limited water-quality data from 5 sites on major rivers.	Published in month newsletter, *National Water* Conditions.
National Land Use and Cover Program	USGS	Includes land-use and land-cover maps and digitized data. Statistics by political units, hydrologic units, and census county subdivisions are available. Classes include urban or built-up land, agricultural land, rangeland, forestland, water areas, wetland, barren land, tundra, and perennial snow and ice. Maps are available for most of the country at 1:250,000 scale.	USGS publications.
Water Data Program	USGS	Nearly 60,000 water-data stations throughout the nation are used to obtain records on stream-flow, stage (height), reservoir and lake stage and storage, groundwater levels, well and spring discharge, and quality on surface water and groundwater. Data, stored in the WATSTORE database, are available in machine readable form or as computer printed tables or graphs, statistical analyses, and digital plots.	Published by water year for each state.
National Water Use Information Program	USGS	Determines purposes for U.S. fresh and saline surface water and groundwater withdrawn, water consumed during use; and water returned to source after use.	National compilations every 5 years; most recent.

Environmental Statistics Programs (continued)

Program	Sponsor	Coverage	Frequency/Most Recent Report
Water Resources Assessment Program	USGS	Summarizes statistics on state and national water resources for USGS biennial report, *National Water Summary*, each report oriented to water resource theme, such as groundwater quality.	Biennial; 1991 report covered floods and droughts.
Earth Observing System	NASA	Measures key environmental variables using series of unmanned satelites; part of NASA Mission to Planet Earth program; EODIS, its data and information system, will coordinate with the Global Change Data and Information System, which includes the NOAA data and information system.	NASA publications.
National Air Pollution Control Program	EPA Office of Air Quality Planning and Standards	Collects and analyzes data on ambient air quality and air pollution levels and compares them to National Ambient Air Quality Standards (NAAQS).	Annual reports on air quality and emission estimates.
Comprehensive Environmental Response, Compensation, and Liability Information System	EPA Office of Emergency and Remedial Response	Contains information on over 30,000 abandoned or uncontrolled hazardous waste sites.	Updated on-line.
Environmental Radiation Ambient Monitoring System (ERAMS)	EPA Office of Radiation Programs	Monitors radiation in air, drinking water, surface water, and milk.	Sampling intervals from twice weekly to bi-annual, based on analyses, at 332 stations; since 1973.
Hazardous and Nonhazardous Surveys	EPA Office of Solid Waste	Collect data through survey and regulated entity reports on hazardous and non-hazardous (solid) wastes generation and management; information on regulated entities and the waste volumes they generate and manage.	Current data is from 1985 biennial report and two 1986 surveys.
Toxics Release Inventory	EPA Office of Toxic Substances	Mandatory annual inventory of releases of 328 toxic chemicals to air, water, land, and off-site disposal from more than 17,000 manufacturing facilities across the country. Material is available on CD-ROM.	Annual reports.
Water Pollution Control Act Section 305(b) Assessments	EPA Office of Water	Compiles state reports on water quality status of surface water and groundwater, as required by section 305(b), Federal Water Pollution Control Act; the states prepare assessments using various monitoring data.	1990 biennial report as of 1988.
Ambient Water Monitoring Program/STORET	EPA Office of Water	largest database for water quality information; data contained in STORET with over 170 million data points from states and federal agencies, such as USGS, on surface water and groundwater quality, sediments, streamflow, and fish tissue contamination.	Updated on-line.

Environmental Statistics Programs (continued)

Program	Sponsor	Coverage	Frequency/Most Recent Report
Public Water System Supervision Program	EPA Office of Water	Contains information about public water supplies (PWSs) and their compliance with monitoring requirements, maximum contaminant level (MCL) regulations, and other requirements of the Safe Drinking Water Act; data is stored in the Federal Reporting Data System.	Quarterly state and EPA regional reports.
National Pollutant Discharge Elimination System Program	EPA Office of Water	Tracks permit compliance and enforcement status of facilities covered by water pollution permits; information is contained in the Permit Compliance System. (PCS)	Monthly facility reports entered on an ongoing basis.
Municipal Construction Program	EPA Office of Water	Inventory of existing or proposed publicly owned treatment works (POTWs) that need construction or renovation to meet Clean Water Act requirements; information is maintained in the Needs Survey System.	2-year update from each state; biennial report submitted to the Congress.
Coastal and ocean Protection Programs	EPA Office of Water	Covers environmental data (water quality, biological, permitting, environmental impact data) for discharges and pollutant loadings to coastal waters as well as ocean dumping; information contained in Ocean Data Evaluation System (ODES).	Biennial reports to the Congress for National Estuary Program; annual reports to the Ocean Dumping Program; special reports on coastal programs.

Note: Neither this table nor the source document, which describes 72 federal programs, are exhaustive. For instance, USDA also maintains mission-oriented statistics in such areas as crops, snowpack, soil erosion, national forests management, and wildfires. The DOC Bureau of Census maintains social, demographic, and economic statistics relevant tot he environment. NOAA maintains statistics on marine resources and coastal wetlands. BLM maintains statistics for BLM lands, including condition, wildlife, minerals, and use; and NPS collects comparable statistics on the status of national parks. The Bureau of Mines collects, interprets, and publishes data on production, consumption, and trade of over 100 minerals. FWS maintains data on FWS lands and conducts surveys of fishing, hunting, and wildlife-associated recreation every 5 years, with the most recent report in 1991. USGS maps national land use and land cover, and EPA conducts regional and other pollution surveys. DOT compiles highway and other transportation statistics, and the U.S. Coast Guard maintains data on marine pollution spills.

Source: U.S. Environmental Protection Agency, Center for Environmental Statistics, *Guide to Selected National Environmental Statistics in the U.S. Government (draft), (Washington, DC; EPA, 1992).*

Summary and Table of Contents for the Manual of Federal Geographic Data Products (Source: Federal Geographic Data Committee. 1993)

Manual of Federal Geographic Data Products

The *Manual of Federal Geographic Data Products* describes Federal geographic data products that are national in scope and commonly distributed to the public. Geographic data products include maps, digital data, aerial photography and multispectral imagery, earth science, and other geographically-referenced data sets. Federal agencies were encouraged to list only those geographic data products that are supported by an office to which the public could make inquiries and place orders. Federal agencies also were encouraged to list only those geographic data that would be available by January 1993.

Data products are described in a standardized format and grouped by producing agency. A cross-reference matrix is provided to help readers find products by data type.

The products listed in the *Manual* include only those that currently are distributed by the agencies. Readers interested in historical Federal geographic data products should contact the Reference Services Staff of the National Archives and Records Administration at (202) 501-5579. The Map and Geography Division of the Library of Congress also has an extensive collection of current and historical geographic data products from Federal and non-Federal sources. The Division can be reached at (202) 707-MAPS.

While much effort was made to ensure that the *Manual* is comprehensive, inevitably there will be products that were overlooked. In addition, rapidly changing geographic data technologies, especially digital technologies, are resulting in new products and new forms of existing products. Readers should contact the offices listed in the *Manual* to inquire about the availability of new products and references to other Federal geographic data. The FGDC intends to revise the *Manual* approximately every 2 years.

Readers are invited to provide corrections and to suggest other Federal products or information for inclusion in future editions of the *Manual*. Readers also are encouraged to comment on the usefulness of the *Manual*, and to suggest improved methods of presenting the information.

For more information about the FGDC, its activities, the *Manual*, or to be added to the newsletter mailing list, please contact:

Federal Geographic Data Committee Secretariat
U.S. Geological Survey
590 National Center
Reston, VA 22092
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(703) 648-4533

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Appendix A: Reader Response Form A-1

State of the Environment Reports and Statistical Compendia Published by International Organizations (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

Commission of the European Communities (CEC)

CEC, *The State of the Environment in the European Community* 1986, (Luxembourg: CEC, 1987). Earlier editions were published in 1977 and 1979.

Eurostat, *Basic Statistics of the Community*, annual (Luxembourg: CEC, 1990).

Eurostat, *Environment Statistics* 1989, annual (Luxembourg: CEC, 1990).

Organization for Economic Cooperation and Development (OECD)

OECD, *Environmental Data Compendium* 1991, (Paris: OECD, 1991). Earlier versions were published in 1984 (pilot), 1985, and 1987.

OECD, *The State of the Environment*, (Paris: OECD, 1991). Previous editions were published in 1979 and 1985.

United Nations

A. L. Dahl and L. L. Baumgart, *The State of the Environment in the South Pacific*, (Geneva, Switzerland: UNEP, 1983).

United Nations Economic and Social Commission for Asia and the Pacific, *State of the Environment in Asia and the Pacific*, (Bangkok: UNESCAP, 1985).

United Nations Environment Programme (UNEP), *Environmental Data Report 1991-92, biennial* (Oxford, England: Basil Blackwell, 1991). This report is coproduced with Kings College, London; the World Resources Institute in Washington, D.C.; and the U.K. Department of the Environment. It was intended to complement the more easily understood *World Resources Report*.

UNEP, *State of the World Environments, annual* (Nairobi: UNEP, 1991). The 1982 and 1987 reports were also published as, respectively, M. W. Holdgate, M. Kassas, and G. F. White, eds., *The World Environment 1972-1982*, (Dublin: Tycooly International, 1982); and E. El-Hinnawi and M. H. Hashmi, *The State of the Environment*, (Guildford, England: Butterworth-Heinemann, 1987).

UNEP, *State of the World Environments*, annual (Nairobi: UNEP, 1991). The 1982 and 1987 reports were also published as, respectively, M. W. Holdgate, M. Kassas, and G. F. White, eds., *The World Environment* 1972-1982, (Dublin: Tycooly International, 1982); and E. El-Hinnawi and M. H. Hashmi, *The State of the Environment*, (Guildford, England: Butterworth-Heinemann, 1987).

UNEP, *The State of the Marine Environment*: UNEP *Regional Seas Programme*, (Nairobi: UNEP, 1990). The following regions were covered for the years indicated: West and Central Africa (1984), East Africa (1980, 1982, 1984, and 1985), Kuwait (1985), South Asia (1985), East Asia (1985), Red Sea and Gulf of Aden (1985), Indian Ocean (1985), and Oceania and the Pacific (1985).

United Nations Statistical Office and United Nations Economic Commission for Europe, *Environmental Statistics in Europe and North America: An Experimental Compendium*, (New York: UNSO and UNECE, 1987).

World Bank

World Bank, *The World Bank and the Environment*, (Washington, DC; World Bank, 1990).

World Bank, *World Development Report 1991*, annual, (Oxford, England: Oxford University Press, 1991).

World Resources Institute

A.L. Hammond, ed., *World Resources 1990-1991*, biennial, (Oxford, England: Oxford University Press, 1990). This publication is coproduced with UNEP and the International Institute for Environment and Development.

World Resources Institute. The 1992 *Information Please Environmental Almanac*, (Boston: Houghton Mifflin, 1991).

Source: J. Parker and C. Hope, "The state of the environment: a survey of reports from around the world," *Environment* 34(1):20. (Heldref Publications).

United States
Environmental Protection
Agency

Policy, Planning,
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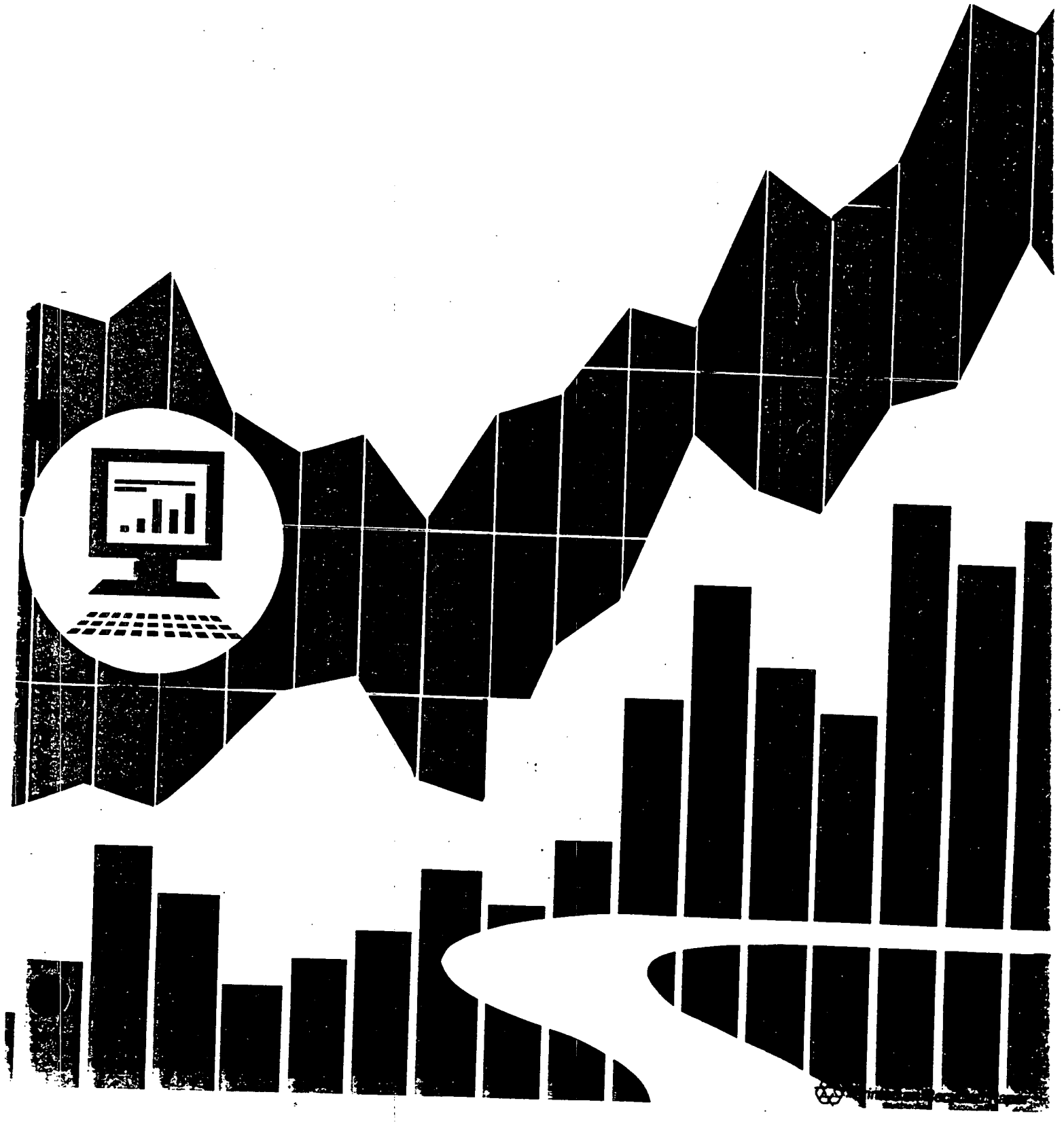
EPA

A Guide To Selected National Environmental Statistics In The U. S. Government



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ATTACHMENT 4.B

COMPUTER-AIDED ENVIRONMENTAL ASSESSMENT

Luhar, A. K., and P. Khanna. 1988. Computer-aided rapid environmental impact assessment. Environmental Impact Assessment Review 8:9-25.

ENVIRON IMPACT ASSESS REV 1988;8:9–25

COMPUTER-AIDED RAPID ENVIRONMENTAL IMPACT ASSESSMENT

ASHOK K. LUHAR AND P. KHANNA

Environmental impact assessment of a project attempts to bring about compatibility between ecology and economics. A computer-aided, quantitative and rapid methodology for environmental impact assessment is presented in this paper. The cost of abatement of deleterious environmental impacts is one of the factors used to identify the best project option from environmental and cost considerations. The methodology is based on the three basic steps of environmental impact assessment vis-à-vis identification, prediction, and evaluation. Several models and predictors for different environmental components are incorporated in the computer program. An evaluation method is presented based on mathematical functions for value function graphs for different aesthetic, environmental, and health risks.

Most of the countries had to review their environment policies following the Stockholm Conference on Human Environment (June 1972) wherein developed countries visualized environmental problems as an affliction of industrialization and suggested "no growth" policy as the only viable means of protecting the biosphere. However, developing countries, including India, shared the view that environmental problems of developing countries are mostly due to lack of development rather than excessive development. Clearly, therefore, the raison d'etre of environment policy in developing countries must be development with conservation.

The environment is now firmly on the political agenda in both developed and developing countries and there is a growing realization that procedures, methods, and techniques to assess the likely environmental, health, and social impacts of projects, plans, and policies must now be given the same emphasis that economic assessments have been accorded thus far. It is here that environmental impact assessment (EIA) must play a crucial role in resolving the conflicts between developmental objectives and the concern for environmental quality.

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TABLE 1. Identification information used as input

Environmental Component	Information Needed
Air	Existing air quality, meteorology, topography, emission rates of different pollutants, some physical parameters of the project components, etc.
Water	Existing water quality, aquatic ecosystem of receiving body, water temperature, water flow and chemical composition of effluent, physical parameters of the receiving body, etc.
Land	Present state of the soil, porosity of the soil, other physical and chemical properties of the soil, etc.
Biological	Existing state of the biological environment (flora and fauna) of the area, population and its distribution, etc.
Socioeconomic	Demography, ethnic composition of the area, age distribution of the people, etc.
Noise	Type of noise sources (vis-à-vis point, line, etc.) and their relative intensity, etc.

Notwithstanding the fact that EIA is conceived to be a valuable planning and decision-making tool, in practice it suffers from several limitations, particularly its major requirements for time, finance, expertise, and data. It is therefore not surprising that most developing countries have resorted to rudimentary approaches (eg, checklists) in the absence of objective screening and scoping criteria, guidelines for rapid EIA, and tools for prediction and evaluation. In addition, there is the problem of quantifying intangible impacts of the project.

With a view to obviating some of the aforementioned limitations, a rapid and quantitative methodology for EIA is presented in this paper. The present contribution provides an approach, and therefore no attempt has been made to incorporate all parameters and rigorous mathematical models available in the literature. However, it does include the cost of mitigating detrimental environmental impacts.

Definition of EIA

Many definitions of EIA have been provided (Battelle 1978; UNEP 1978; Munn 1979), but none of them may be accepted as complete. The work presented in this paper is based on the definition given by Heer and Hagerty (1977):

> EIA consists in establishing quantitative values for selected parameters which indicate the quality of the environment before, during and after an action.

Computer-Aided Rapid EIA

The technique presented here is a rapid EIA technique for assessing impacts on the major environmental components: air, water, land, noise, biological, and socioeconomic, most relevant to developing countries.

The process of EIA can be divided into three parts: identification, prediction and evaluation of impacts (Canter 1977). The computer algorithm has been prepared based on these general steps of EIA.

Identification

The identification part of EIA involves the description of existing environmental components, the project, and the project area. The description included in computer-aided methodology is presented in Table 1. The identification of significant impacts in individual cases is project specific and no attempt has been made in this paper to incorporate these as the objective here is to suggest general purpose methodology.

Prediction

Prediction is essentially the quantification step. The impacts of project activities are predicted through mathematical models and other predictors of environmental quality. It should be noted that a model should be calibrated, verified, and validated before use.

Unfortunately, in developing countries, nonavailability of sufficient data hampers the efforts to calibrate, verify, and validate the models. The attempt in this paper, therefore, is to incorporate models with limited data requirements. Such an approach is considered rational in the context of rapid assessment.

Evaluation

In the evaluation step, impacts are converted into environmental quality predictors with recourse to value function graphs. Value function graphs have been prepared for different environmental components based on the aesthetic, environmental, and health risks of different pollutants and their standards. The mathematical forms of value function curves have been formulated through polynomial regression and incorporated in the computer program. Subindices are converted into a single index by taking their weighted sum. The weights given to different environmental risks and costs for various environmental components depend on the type of project under assessment.

A Computer Package for Rapid EIA

A computer algorithm is depicted in Figure 1. The algorithm is designed in keeping with the nonavailability of complete databases in developing countries. Instead, the program uses simple identification information presented in Table 1 as input available from the project area.

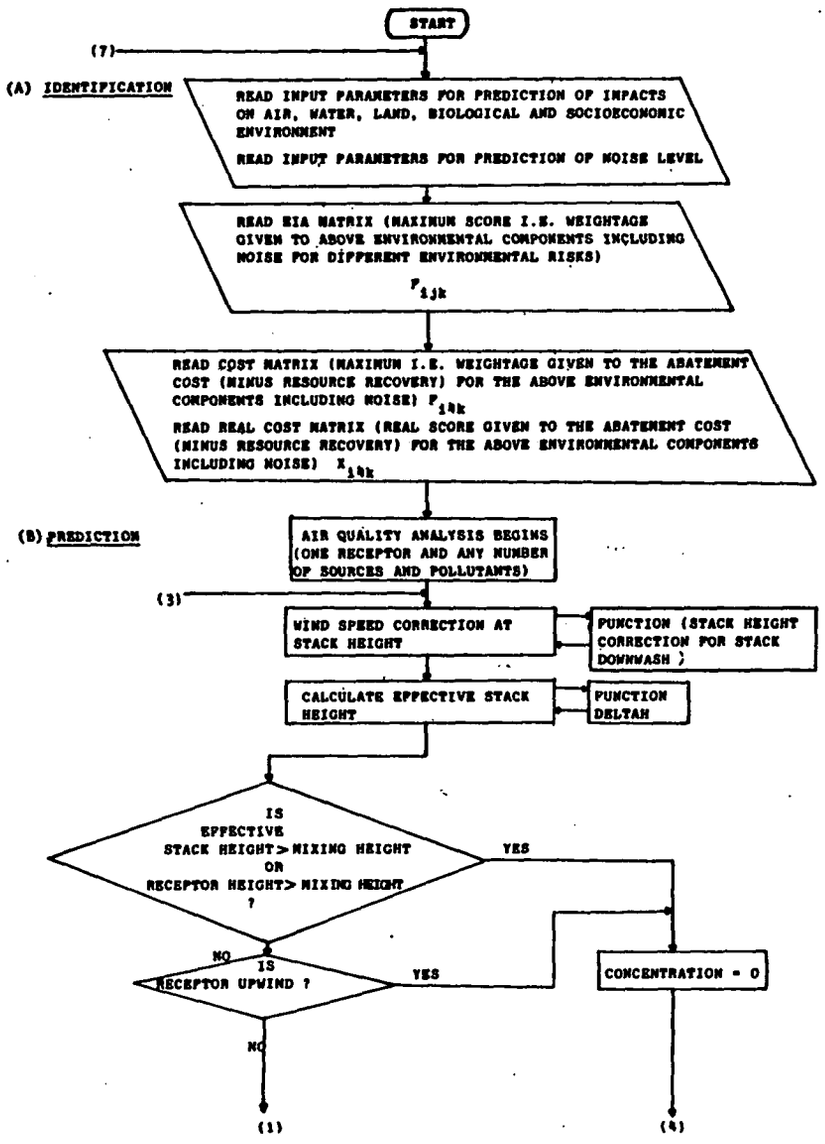


FIGURE 1. General Flow Chart of Computer-Aided Rapid Environmental Impact Assessment. (A) Identification; (B) Prediction; (C) Cost-Effective Evaluation.

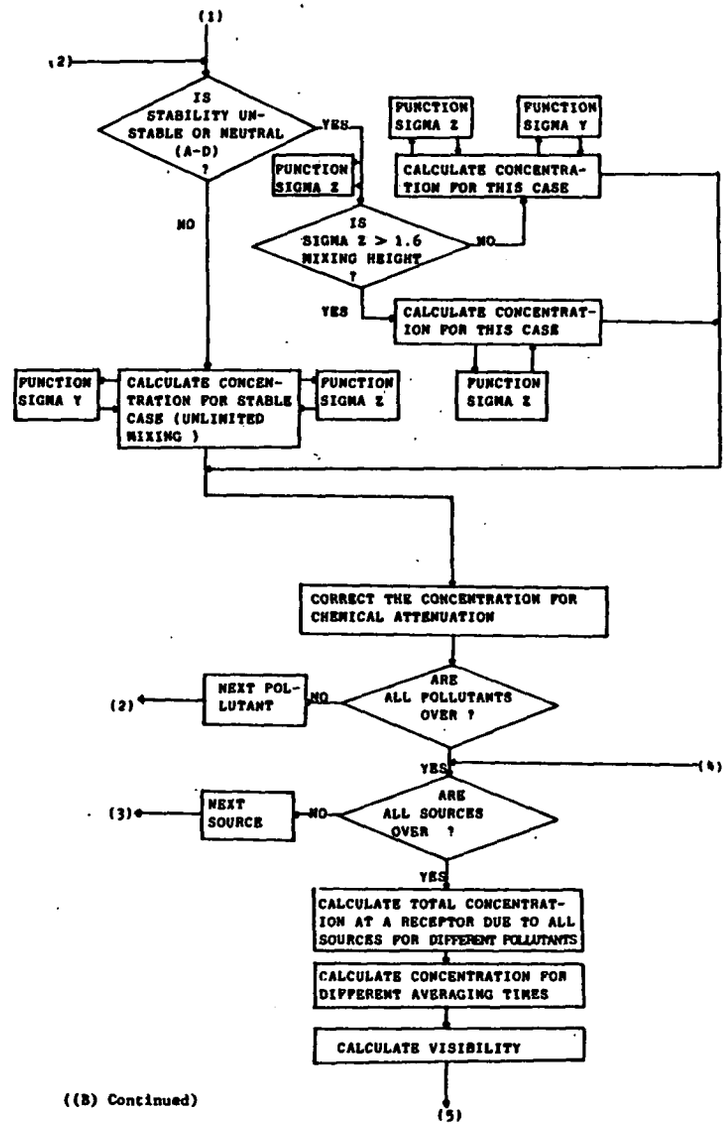


FIGURE 1. (Continued)

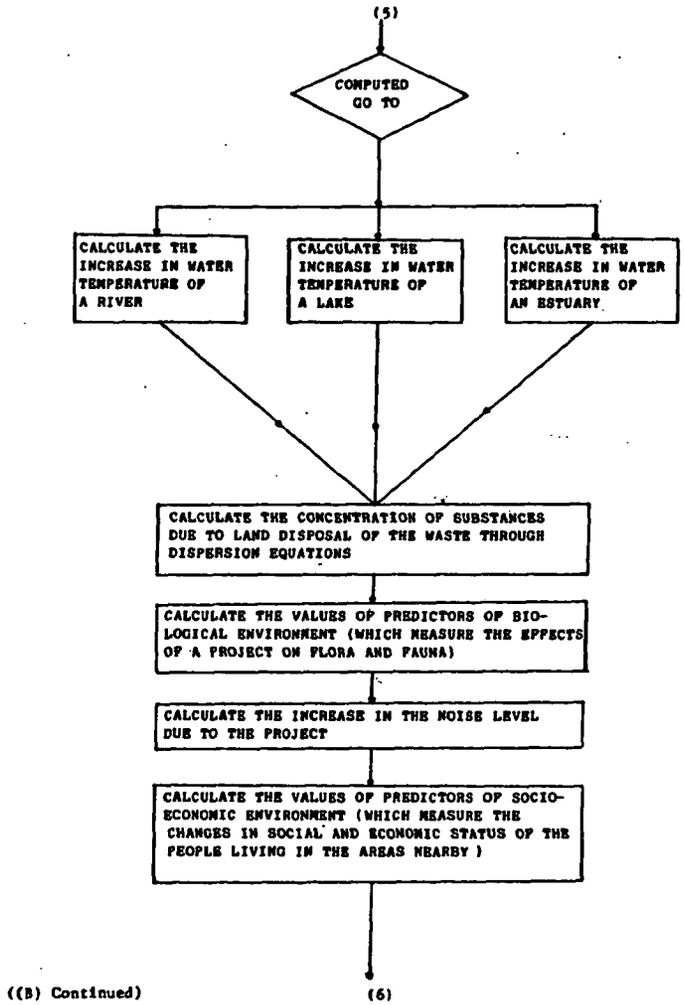


FIGURE 1. (Continued)

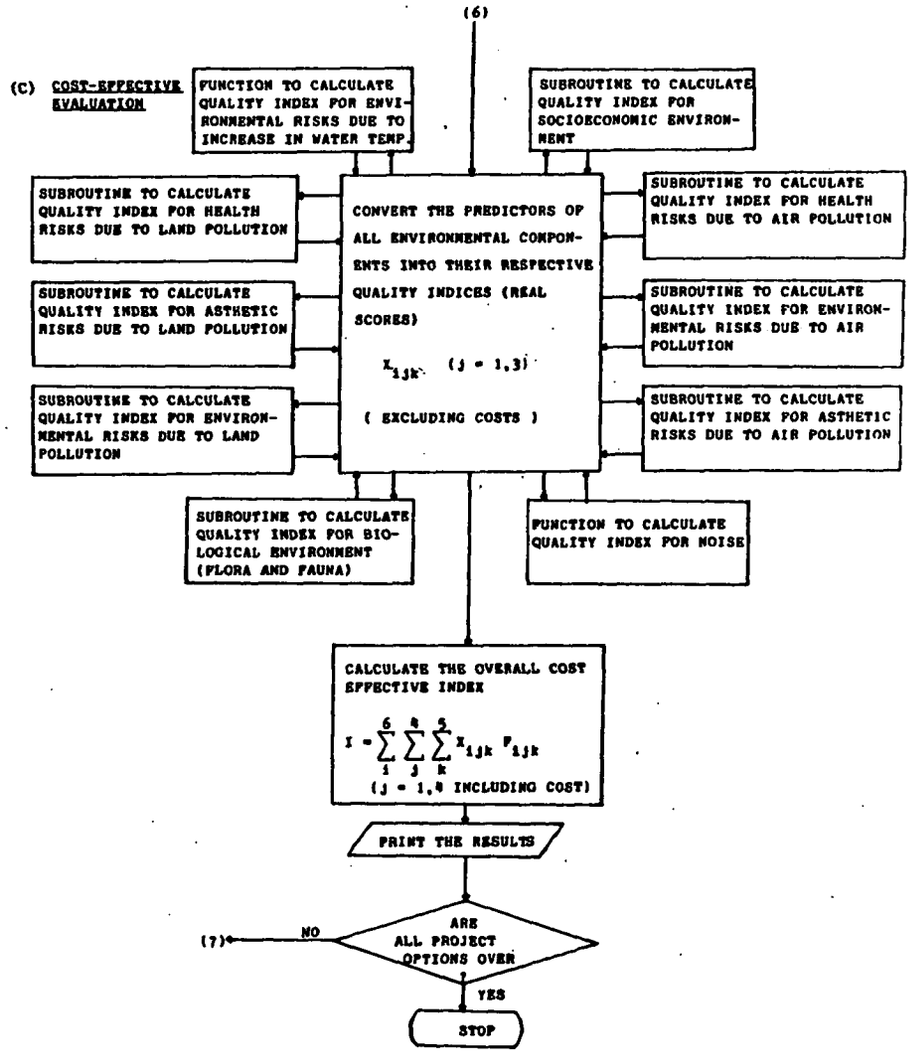


FIGURE 1. (Continued)

Brief descriptions of mathematical models incorporated in the program for prediction of impacts follow:

Air

A short-term Gaussian point source model, which has been incorporated in the RAM program of the US Environmental Protection Agency (Novak and Turner 1976), has been used for the prediction of air pollution levels. The model uses P-G dispersion parameters and calculates plume rise using Briggs' equations. Wind speed is corrected at the stack height using the power law relation given by Deacon (Wark and Warner 1981). Concentrations are corrected for stack downwash and chemical attenuation (Dobbins 1979). The latter correction, however, cannot be applied to all pollutants because of the complex chemistry associated with them. The concentrations are converted for different averaging times, as required by value function curves, using the power law relation (Stern 1976). Visibility is reckoned from the concentration of particulates. The pollutants considered in the program are NO_2, CO, O_3, SO_2, TSP, and hydrocarbons. The model can also be used for long-term predictions by taking the average over a wind rose. The assessment of impacts on air quality is described in detail by Clark et al. (1984), Jakeman and Simpson (1985), and Shen (1986).

Water

The program incorporates the case of thermal pollution (as in thermal power projects) with recourse to simple diffusion equations (Parker and Krenkel 1970; Zaric 1978) for predicting the increase in temperature of a water body (river, lake, or estuary) at different locations. The program can be generalized (for other projects) by incorporating prediction models for conservative and nonconservative pollutants.

Land

The prediction refers to the horizontal and vertical concentrations of pollutants consequent to land disposal of waste waters. The model parameters are highly dependent on soil characteristics.

Biological Environment

Various predictors, described in the literature (Rau and Wooten 1980) have been used to predict the impacts of a proposed project on a biological environment. Sample plot or quadrants methods and a roadside count method are used to predict the impacts of the project on flora and fauna, respectively. The predictio refers to the Importance Value and Census Index.

Socioeconomic Environment

Two predictors, the Index of Qualitative Variation and the Dependency Ratio calculated from demographic data, have been used to predict the impacts of the project on the socioeconomic environment.

TABLE 2. Environmental impact assessment matrix

Environmental Component (i)	Associated risks and control costs (j)	Environmental parameters and predictors (k)
Air	Health risks	NO_2, CO, TSP × SO_2, O_3
	Environmental risks	NO_2, CO, SO_2, TSP, hyrocarbons
	Aesthetic risks	Visibility, odor[1]
	Cost of control[2]	NO_2, SO_2, TSP
Water	Health risks	Helminths,[1] virus,[1] coliforms[1]
	Environmental risks	BOD, temperature
	Aesthetic risks	Mosquito,[1] fly,[1] and odor[1] nuisances, suspended solids
	Cost of control[2]	BOD, temperature
Land	Health risks	Pathogens on land[1]
	Environmental risks	BOD
	Aesthetic risks	Mosquito,[1] fly,[1] and odor[1] nuisances
	Cost of control[2]	BOD
Biological	Environmental risks	Importance value,[1] census index[1]
	Aesthetic Risks	
	Cost of control[2]	Importance value,[1] census index[1]
		Flora, fauna
Socioeconomic	Environmental risks	Index of qualitative variation,[1] dependency ratio[1]
	Cost of control[2]	
		Socioeconomic status
Noise	Health risks	Noise level
	Aesthetic risks	Noise level
	Cost of control[2]	Noise level

[1]Monitored data required for the program
[2]Control cost data required for the program
BOD = Biochemical oxygen demand

Noise

Models are available in literature to predict the noise levels from point and line sources (Rau and Wooten 1980; Magrab 1975). Inputs for the models are receptor location, sound intensity, or sound power (for a point source), number of vehicles and their speeds (for a line source), etc.

The tabular form of the EIA matrix, used in the program, is shown in Table 2. Out of some number (preferably 1000), weight is assigned to each element of the matrix based on its relative significance. A subindex is calculated for each of the matrix elements using value function graphs incorporated in the program in mathematical forms. A subindex value of 1 is considered best while a value of 0 is considered worst. Value function graphs for aesthetic, environmental, and health risks for the air environment are included in Figures 2 through 12. Average time for Figures 6, 7, 9, and 11 is 24 hours; for Figures 4, 5, 8, 10, and 12 the average times are annual, one hour, three hours, eight hours, and

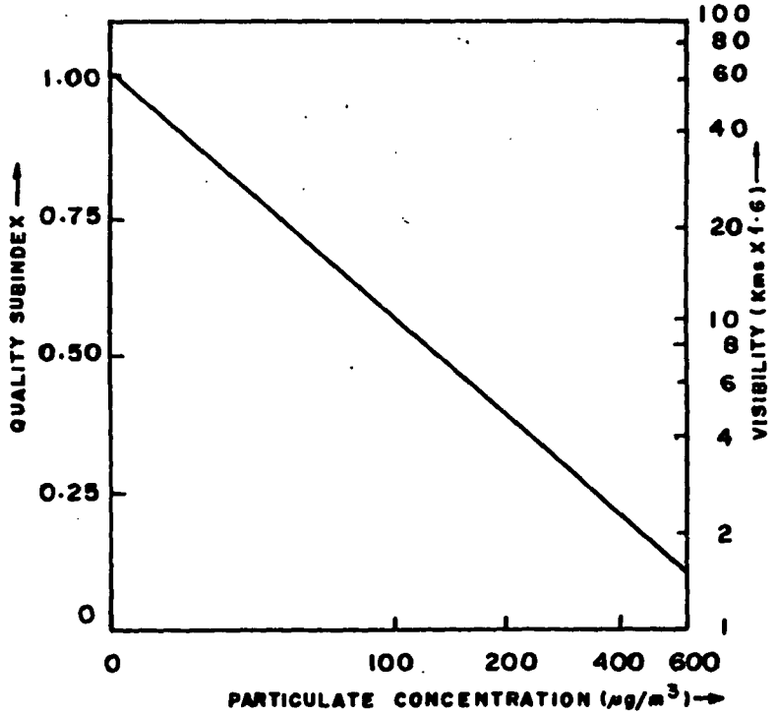


FIGURE 2 Value Function Curve for Visibility (Aesthetic Risk)

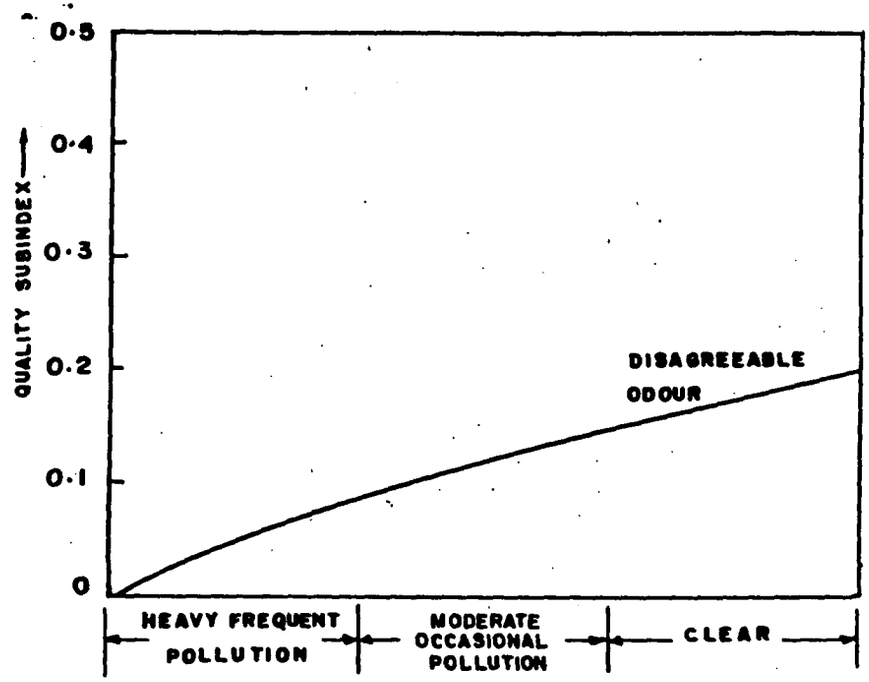


FIGURE 3. Value Function Curve for Odor (Aesthetic Risk)

two hours, respectively. An overall index is calculated by taking the weighted sum of subindices for all the project options including the no-project option.

$$\text{Overall index of a project option } I = \sum_i \sum_j \sum_k X_{ijk} F_{ijk}$$

i = number of environmental components (max. i = 6)

j = number of environmental risks (+ one cost element) for *i*th component (max. j = 4)

k = number of pollutants or predictors for *i*th component and *j*th risks (max. k = 5)

X = quality subindex of a particular element, i, j, and k

F = maximum score or weight given to a particular element, i, j, and k

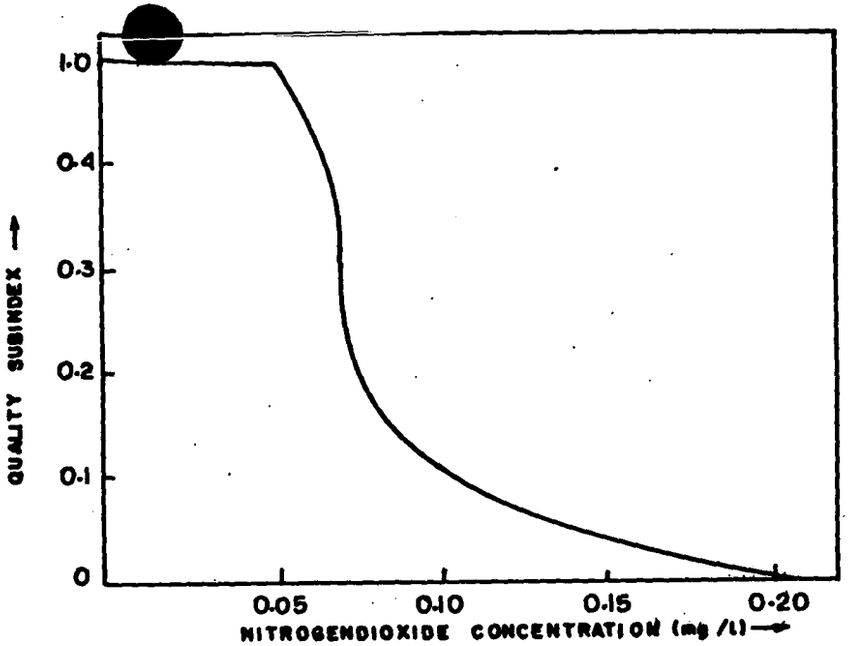


FIGURE 4. Value Function Curve for NO_2 (Environmental Risk)

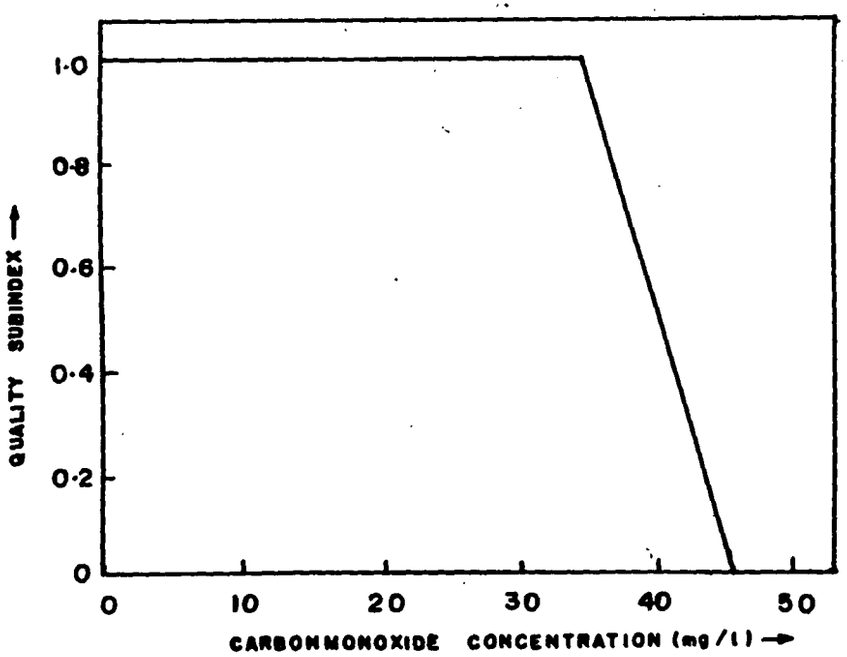


FIGURE 5. Value Function Curve for CO (Environmental Risk)

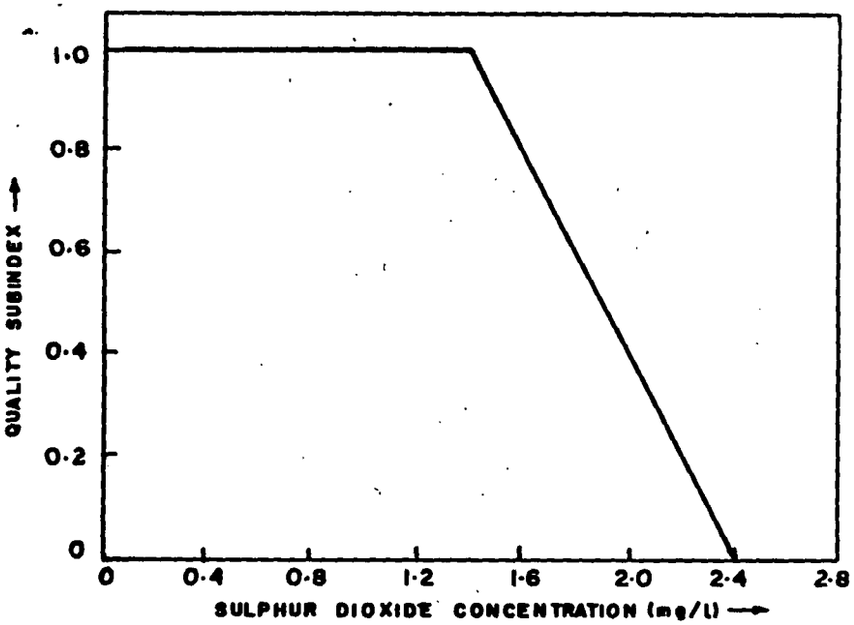


FIGURE 6. Value Function Curve for SO_2 (Environmental Risk)

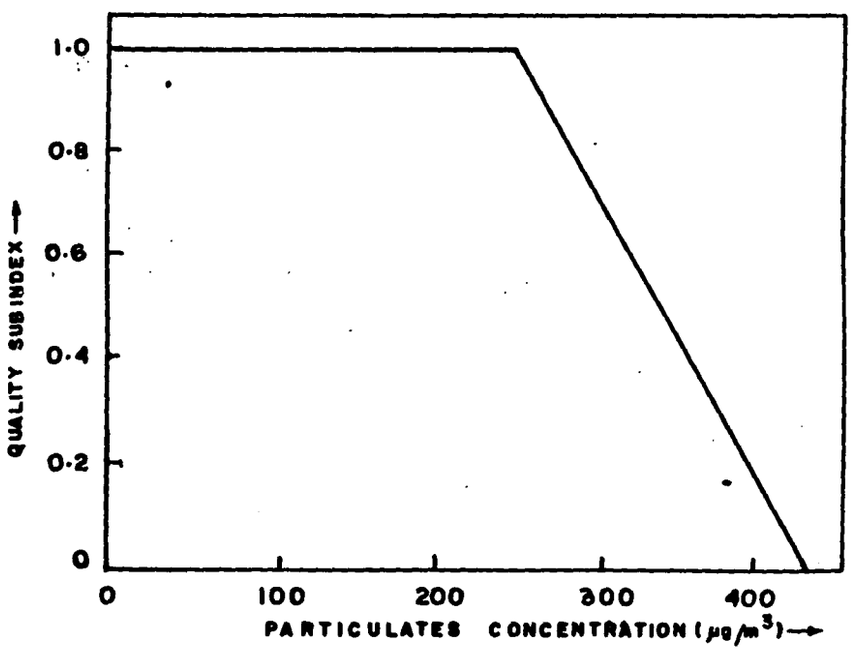


FIGURE 7. Value Function Curve for Particulates (Environmental Risk)

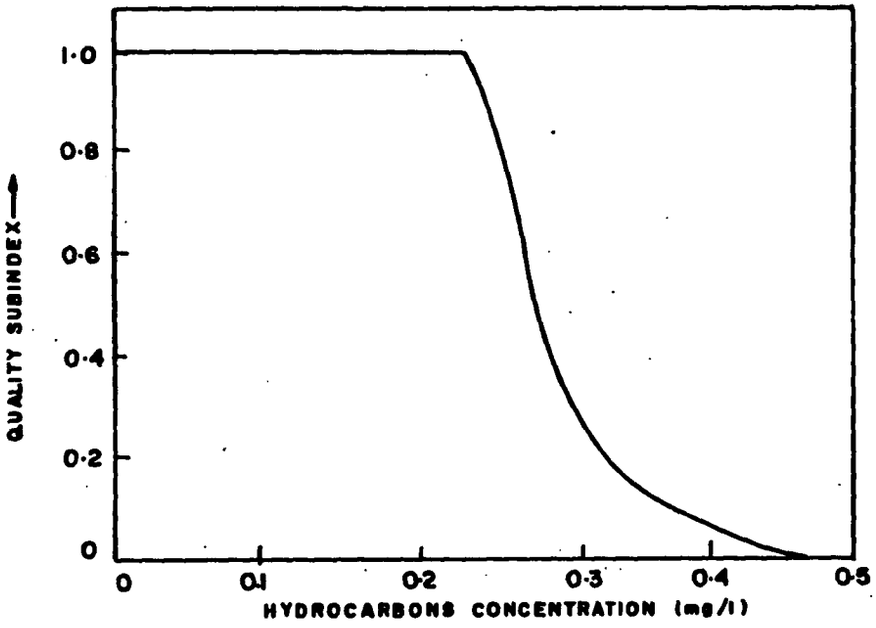


FIGURE 8. Value Function Curve for Hydrocarbons (Environmental Risk)

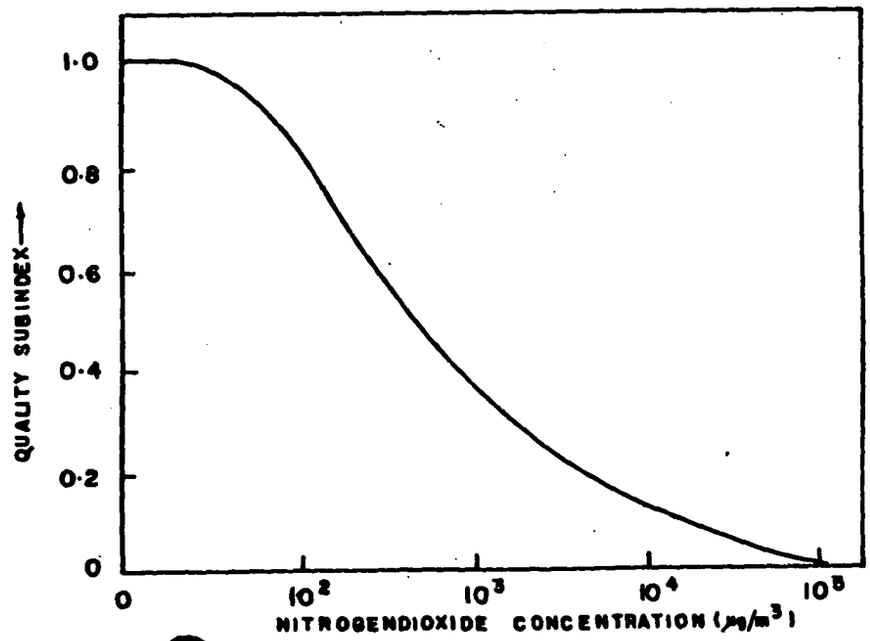


FIGURE 9. Function Curve for NO_2 (Health Risk)

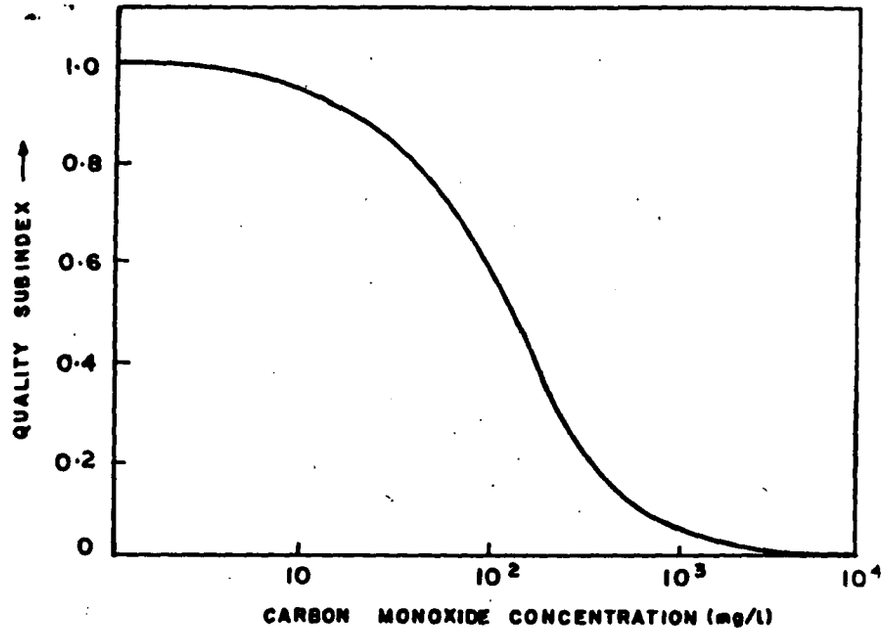


FIGURE 10 Value Function Curve for CO (Health Risk)

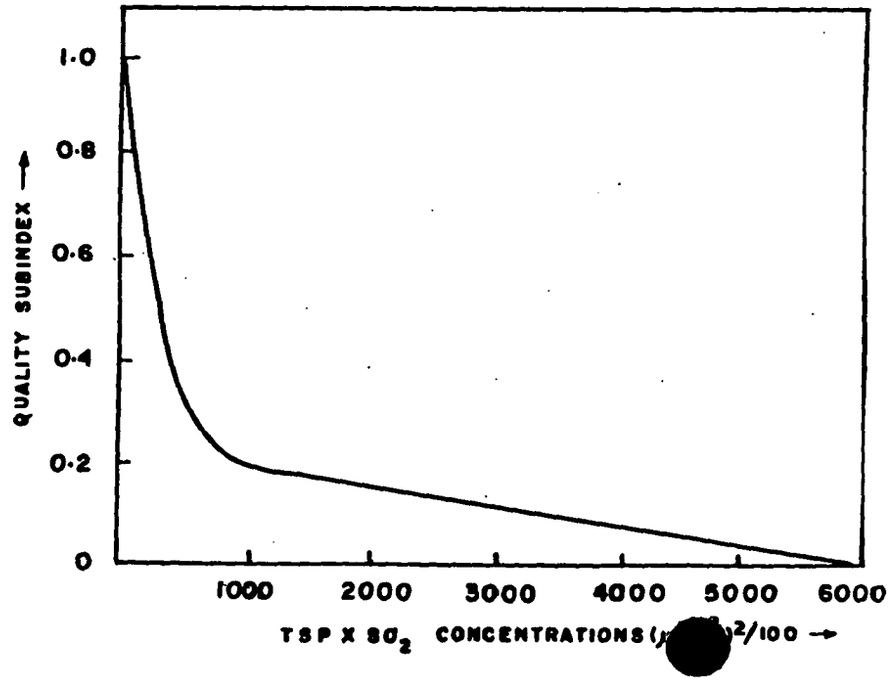


FIGURE 11. Value Function Curve for TSP × SO_2 (Health Risk)

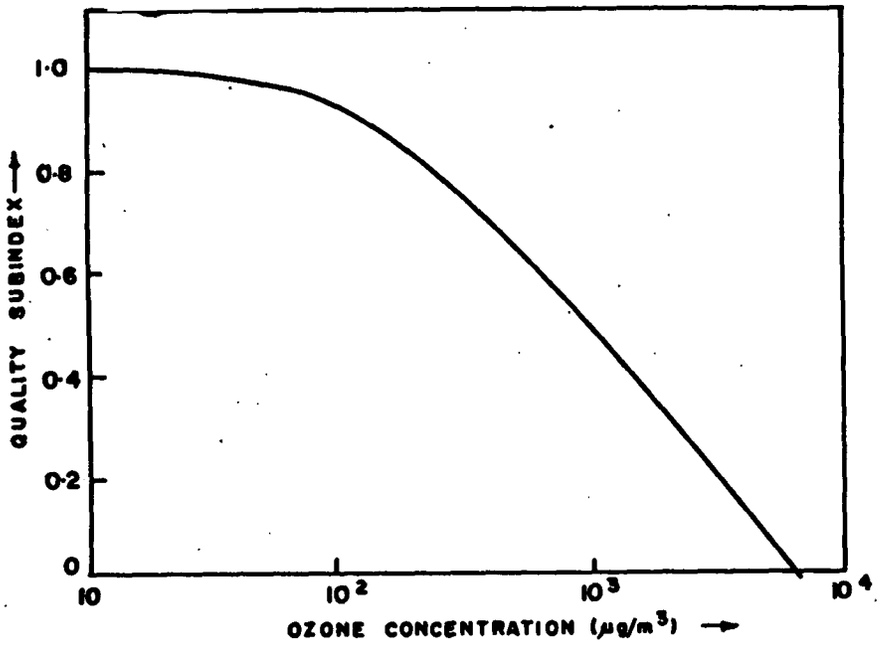


FIGURE 12. Value Function Curve for O_3 (Health Risk)

The option that provides highest value of I is considered as the best option followed by other project options according to their decreasing indices.

Conclusions

The scope of EIA in most developing countries is restricted to the questionnaire type checklists defeating the purpose of the exercise as a decision-making tool. This presentation is a limited step in the development of computer-aided quantitative EIA. The paper essentially presents a framework for rapid EIA and covers six environmental components (air, water, land, noise, biological, and socio-economic environments) and the costs of mitigation measures.

The work presented here forms a part of a project sponsored by the Ministry of Environment and Forests, Government of India.

REFERENCES

Battelle Institute. 1978. *The Selection of Projects for EIA*. Brussels. Commission of the European Communities Environment and Consumer Protection Service.

Canter, L. W. 1977. *Environmental Impact Assessment*. New York: McGraw-Hill.

Clark, A. I., McIntre, A. E., Lester, J. N., and Perry, R. 1984. Air quality impa assessment. *Environ. Monit. and Assess.* 4:205–232.

Dobbins, R. A. 1979. *Atmospheric Motion and Air Pollution*. New York: Wiley-Inte science.

Heer, J. E., and Hagerty, D. J. 1977. *Environmental Assessments and Statements*. Ne York: Van Nostrand Reinhold.

Jakeman, A. J., and Simpson, R. W. 1985. Assessment of air quality impacts from a elevated point source. *J. Environmental Management* 20(1):63–72.

Magrab, E. B. 1975. *Environmental Noise Control*. New York: Wiley.

Munn, R. E. (ed). 1979. *Environmental Impact Assessment: Principles and Procedures* Toronto: International Council of Scientific Unions, Scientific Committee on Problem of the Environment.

Novak, J. H., and Turner, B. 1976. An efficient Gaussian plume multiple source ai quality algorithm. *J. Air Pollut. Control Assoc.* 26(6):570–575.

Parker, F. L., and Krenkel, P. A. 1970. *Physical and Engineering Aspects of Therma Pollution*. London: Butterworths.

Rau, J. G., and Wooten, D. C. (eds). 1980. *Environmental Impact Analysis Handbook*. New York: McGraw-Hill.

Shen, T. T. 1986. Assessment of air pollution impact. *Atmospheric Environmen* 20(10):2039–2045.

Stern, A. C. 1976. *Air Pollution*, Vol. 1. New York: Academic Press.

UNEP. 1978. *Draft Guidelines for Assessing Industrial Environmental Impact and Environmental Criteria for the Siting of Industry*. Paris: UNEP Industry and Environmental Office.

Wark, K., and Warner, C. P. 1981. *Air Pollution, Its Origin and Control*. New York: Harper and Row.

Zaric, Z. P. (ed). 1978. *Thermal Effluent Disposal from Power Generation*. Washington, DC: Hemisphere.

Impact Identification

Many choices have to be made in the EA process, among which are the choice of impacts that should be assessed (Chapters 2 and 3) and the level of analysis that is required. An impact is described as a change in an environmental or socioeconomic parameter, resulting from a proposed action compared to the situation had the proposed action not been initiated (Wathern 1988). Because there are so many possible impacts of a proposed activity, limits and constraints must be determined early in the planning process and endpoints must be established. For example, issues that are identified during scoping are often too broad for analytical purposes (e.g., ecosystem health). They must be focused on expected impacts to valued ecosystem components (e.g., Hudson River striped bass population) and then decisions made on an assessment endpoint (e.g., abundance or yield). The nature of the impacts must also be determined (e.g., direct/indirect, short/long term, reversible/irreversible). Estimates of the magnitude, likelihood, and temporal and spatial distribution of potential impacts from the proposed activity must be provided to the EA team by the proponent. Five main classes of impact-identification techniques exist: ad hoc methods (e.g., brainstorming, expert panels, field reconnaissance), checklists, matrices, networks, and map overlays (Westman 1985).

NEEDS

An interdisciplinary approach is critical to the impact identification stage(s) of the EA process. During project initiation all of the technical and scientific experts, including the proponent, must gather to identify and clarify the potential impacts of the proposed action on valued resources. Discussions should include the how, where, and when of directly, indirectly, and cumulatively affected resources. During and following scoping, the team can expect additional impacts to be identified. Effective assessment depends on team members understanding how the proposed action and the affected resources are interrelated and the role that each discipline has in the integrated analysis.

TOOLS

- Early intra-and interagency consultation and public scoping provide opportunities for identifying potential impacts and determining the extent of subsequent analyses. In particular, federal, tribal,

regional, and local regulatory agencies should be contacted to determine if the proposed action violates any ordinances, laws, plans or policies.

There are generally 18 categories for consideration in EA many of which have some regulatory constraints:

- Geology
- Topography
- Soils
- Ground Water Resources
- Surface Water Resources
- Terrestrial Ecology
- Aquatic Ecology
- Environmentally Sensitive and Species
- Air Quality
- Land Use
- Demography
- Noise
- Socioeconomics
- Infrastructural Services
- Transportation
- Cultural Resources
- Economics
- Human Health and Safety

Existing environmental analyses should always be used to the extent possible in identifying and analyzing impacts. This approach builds on work that has already been done and that has passed public and agency scrutiny. It helps to ensure that appropriate impacts are identified and allows the EA team to concentrate on issues that are unique to the proposed action. Existing analyses can include resource management plans, activity plans, EIAs for similar or related actions including programmatic EIA documents. The pertinent information can be summarized for use and the documents referenced in order to keep the content of the EA document focused on significant impacts.

Ad hoc procedures involve assembling panels of specialists to identify impacts in their areas of expertise (Canter 1977). Such panels were used in the early days of EA but have been mostly replaced by scoping, interagency consultation, the growth of experienced multidisciplinary EA teams and, if appropriate, the formal expert judgment process (Chapter 4.3). Ad hoc panels have value in early planning for assembling information, comparing alternative sites and developing strategies (Lohani and Halim 1987). The resulting information is usually qualitative and readily understood (e.g., identification of general areas and types of impacts) rather than technical, quantitative, and suitable for predictive analyses.

- Field reconnaissance is essentially qualitative in contrast to baseline studies that gather data to resolve specific problems (e.g., sampling of plant or animal populations to determine variability). A site reconnaissance is conducted to complement and confirm background information from the literature and from human sources on the environmental and socioeconomic setting for a proposed action (McBrayer et al. 1981). It is normally one of the first activities of the EA team and its value for understanding problems associated with the proposed action is inestimable. Site visits must be planned around clearly defined objectives. If multiple sites are involved, it is essential to gather information that is comparable from site to site. Of particular importance is the understanding of what information is needed and to what problem(s) it will be applied; otherwise, the needs of the decisionmaker will not be met. The results of scoping and the completion of a preliminary checklist or matrix can help focus the reconnaissance activities of the EA team. The Fish and Wildlife Service Manual (States et al., 1978) is useful for outlining and describing the elements of reconnaissance and baseline studies.

- The checklist was one of the first EA methods to be applied and it is still in general use, although in many different forms, both generic and project specific. The main advantage of a checklist is that it promotes thinking about the array of impacts in a systematic way and allows summarization of effects (Westman 1985). Furthermore, the use of a checklist early in the planning process can aid in determining whether the impacts of a proposed action warrant the preparation of an EIA. The simplest of checklists is a one-dimensional list of environmental factors to be considered. Various agencies have prepared such checklists for particular types of projects (Attachment 2.B, Chapter 4.1).

  There are disadvantages to the use of checklists: they may be too general or incomplete; interactions between effects are not identified; the same effect may be listed in more than one place under headings that overlap which results in "double counting"; and the large number of categories to be reviewed can distract attention from the most significant impacts. The identification of effects is qualitative and subjective thus the predictions cannot be tested empirically with precision and the content of a checklist can vary depending on the investigator (Westman 1985). Furthermore, no statements of likelihood of occurrence are made.

- Matrices are very likely the most popular and widely used impact identification methodology. One common application is in the comparison of alternative actions. Alternative actions (measures, projects, sites, designs) are listed as column headings, while the rows are the criteria that should determine the choice of alternative. In each cell of the matrix, a conclusion can be listed indicating whether the alternative action is likely to have a positive or negative effect on the indicated criterion. Very often, the conclusion is stated as a numerical value or symbol indicating the level of intensity of the effect. There is an opportunity, moreover, to apply relative weighting to the various criteria when evaluating the completed matrix (Chapter 4.3, Figure 4.3-1, Attachment 4.D).

  The evolution of an impact identification methodology from checklist to matrix is intuitively and easily accomplished. A checklist can be viewed as a single-column summary of a proposed action, with only a coarse characterization of the nature of potential environmental impacts. An environmental impacts assessment matrix provides a finer degree of impact identification by associating a set of columns (effects) with each row (environmental attribute) of the matrix (Leopold et al. 1971). As a first step, the columns that correspond with the nature of the proposed action are checked off. Then, for each column that is marked, the cells corresponding to environmental effects are examined. The interpretation of the matrix is based on the professional judgment of the individual(s) performing the EA.

  Within the Leopold matrix (Chapter 4.1), only a few of the interactions would be likely to involve impacts of such magnitude and importance that they deserve comprehensive treatment. Although the items listed represent most of the basic actions and environmental factors likely to be involved in a proposed action, not all would apply to every project. Even such a large matrix may not contain all elements necessary to make a full analysis of every project encountered. However, the coding and format are designed for easy contraction or expansion to include additional items. Preliminary trials suggest that the number of applicable interactions for a typical project usually will be between 25 and 50. An impact matrix (Chapter 4.3) is an expanded checklist that includes estimates of the relative magnitude (i.e., significance) of the environmental impacts (Figure 4.3-1).

Several variants of the Leopold matrix have been prepared; some of them have been adapted for computerized analysis (Schlesinger and Daetz, 1973). These variants may integrate the scores in groups of cells to provide a quantitative and/or graphical summary of the matrix scoring.

With the characterization of a particular action expanded to two dimensions, comparison of several alternatives requires the addition of a third dimension. This is readily accomplished both conceptually and practically. The Leopold matrix analysis can be performed on several alterative scenarios, yielding graphical summaries that can be visually or mathematically compared. The three-dimensional spreadsheet software programs now available also lend themselves to the comparison of environmental impact assessment matrices in three-dimensional format.

- Networks, also known as systems diagrams, consist of a number of linked impacts, known to result from initial actions (Figure 4.2-1); even mitigation and control measures can be illustrated. If a magnitude and importance score is assigned to each impact and the probability of occurrence of each impact is known, a final index value can be calculated for the network (Westman 1985). The advantage of a network approach is that it shows indirect impacts and the effects of change can be followed through the intermediaries. However, there are several problems associated with networks among which are the postulation of indirect effects that do not occur, obtaining reliable data on probabilities of occurrence of effects, and as with all grand index approaches, the final index value may obscure important uncertainties in the effects data (Elliot 1981).

- Overlay mapping is useful in displaying areas of environmental sensitivity, the sum of natural succession, and the development and associated landscape impacts due to multiple projects (McHarg 1969). Time series of maps from aerial photographs can be used to view cumulative impacts over space and time. A base map is prepared showing the location of the project and the boundaries of the area to be considered in the impact assessment. Additional transparent maps at the same scale are prepared for the critical environmental features of concern identified during initiation and scoping (e.g., wetlands, cultural resources, wildlife habitat, vegetative communities, protected areas). The maps are then overlaid to highlight potential impacts.

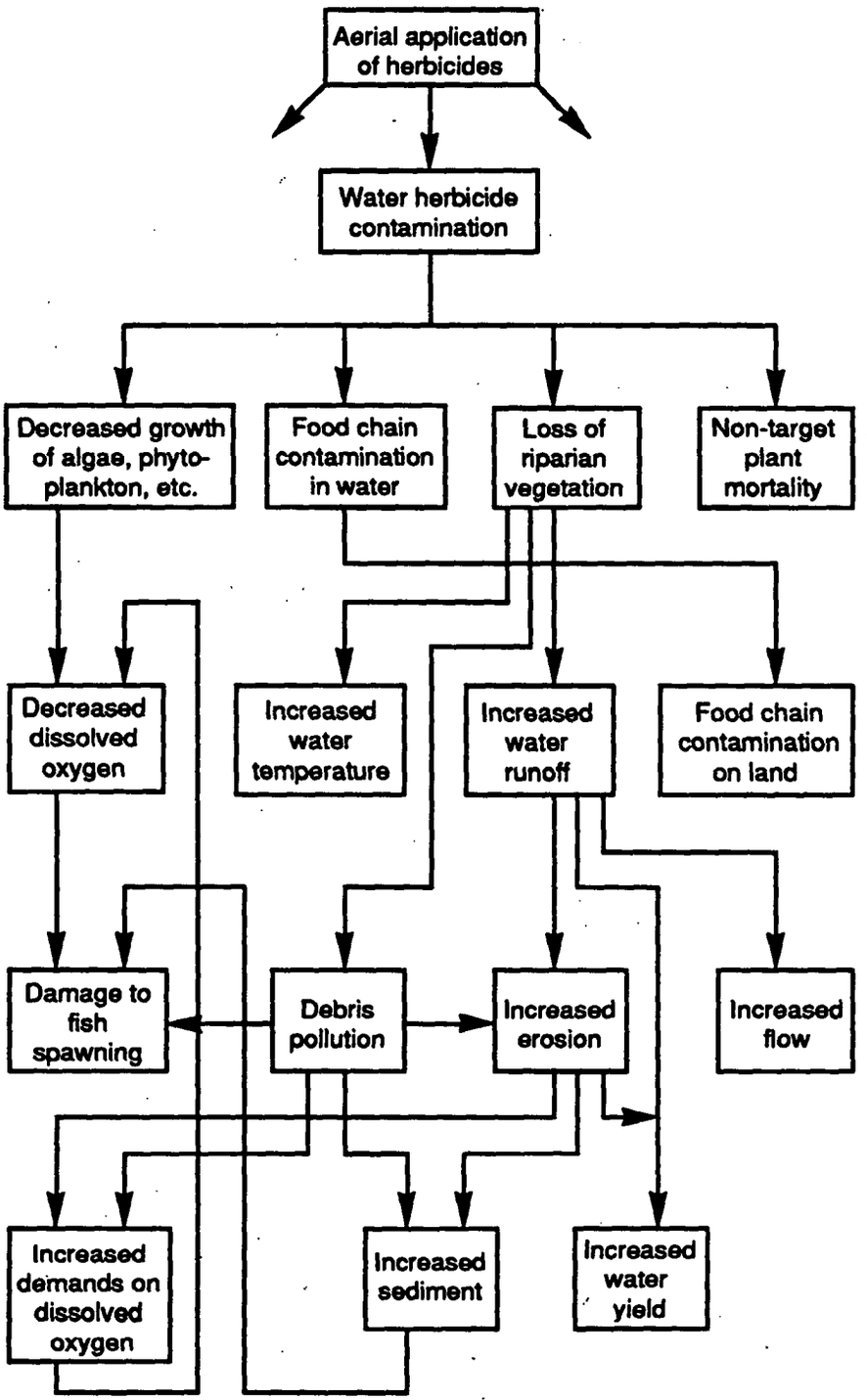


Figure 4.2-1. Example of a network to identify the potential impacts of herbicide application [Source: Thor et al. (1978)]

Geographical Information Systems (GISs) are essentially computerized graphical overlay systems (Attachment 4.E). Environmental features are mapped, and the mapping digitized and stored in a GIS data base. The mapped features can be combined to produce computer-generated displays of one or more environmental features in a specified geographical area. If GIS mapping is conducted systematically, information acquired on specific projects can be combined, and the GIS data base becomes more detailed over time. Overlay mapping is an excellent tool for showing spatial dimensions of impacts, but is less successful in dealing with other impact characteristics such as probability, time, and reversibility.

The field of environmental modeling to identify and evaluate environmental impacts has developed very rapidly due essentially to two factors (Jørgensen 1991; Chapter 4.3):

- The development of computer technology, which has made possible the handling of complex mathematical systems.
- A better understanding of pollution problems, including the application of ecology in this context.

Modeling is the most advanced EA method available but it depends on experts to know which components and processes should be included; it can be costly; and it is only as good as the available data and the assumptions that bound the analysis. The general components of modeling and types of models are discussed by Jørgensen (1991). Bregman and Mackenthun (1992) provide information on computer models for surface water quality and air quality. Attachment 4.C describes models that are useful for predicting the fate of chemicals in multimedia systems (i. e., fugacity models) as well as remediation, aquatic, soil, food chain, atmospheric, and spill models.

Luhar and Khanna (1988; Attachment 4.B) present a framework for computer-aided rapid EA that covers six environmental components (air, water, land, noise, biological, and socio-economics) and the costs of mitigation measures. The authors recognize that data availability in developing countries often is limited; thus, their models have minimal data requirements. Some computer-aided impact identification and data summarization systems are discussed by Strand et al. (1983), Riggins (1980-81), and Lein (1993).

- As described above, an impact is a change in an environmental or socioeconomic parameter. Westman (1985) limits the term impact to the effect of a human-induced action on an ecosystem. Decisionmakers and the publics are normally most concerned with major impacts (i.e., those that would occur and for which no mitigative measures are proposed or possible to decrease the level of impact), violations of standards or controversial issues (e.g., those resulting from disagreements among experts and occasionally from public concerns). It is important to remember that only those valued resources identified as having the potential of being significantly impacted need be analyzed in detail (Bureau of Land Management 1992). However, decisions made not to evaluate resources in detail must be supported by adequate information.

- Selecting appropriate geographical and temporal boundaries for impacts requires learning about the types and rates of release, movement, and transformation of materials and energy (Irwin and Rodes 1992). It means understanding ecological processes, such as bioaccumulation, that control these rates. It also means understanding the ranges of plants and animals and the life span of valued resources.

  Early in the planning process, it is important to establish geographic boundaries of potential impact(s) for proposed actions to avoid unnecessary data collection and analysis. In most cases, it is necessary to go beyond the immediate project site, especially for determination of cumulative impacts. The geographic area of analysis is likely to vary depending on the specific resource of interest. There may be physical boundaries such as watersheds, biological boundaries such as habitats, socioeconomic boundaries such as market areas or regions or political boundaries such as counties (Bureau of Land Management 1992; Irwin and Rodes 1992). A rule of thumb is to consider effects as far away as necessary for those resources identified as important during scoping. Usually the area of assessment is established as the area beyond which the influence of the project is negligible or decreasing. At a minimum, this area should be as large as the "service area" of the proposed project. At this locus of points (i.e., along the boundary line of the assessment area/volume), it should be possible to demonstrate that the impacts are clearly not significant (Bureau of Land Management 1992).

In addition to identifying the geographic area of potential impacts and valued resources, the life of the project(s) must be identified and related to the life span of the potentially affected resource. Impacts can be single, repeated, or multiple. They can occur rapidly over a matter of days or slowly over decades building to cause cumulative impacts. The past is analyzed to see if trends have been established; the future is assessed to see what effect the proposed action(s) might have on valued resources identified during initiation and scoping. The barriers to selecting spatial and temporal boundaries are usually both institutional [e.g., legal constraints (regulations) and a lack of means to set goals, determine roles, and resolve disputes among different agencies and levels of government] and technical (e.g., lack of integrated data and acceptable models, limited understanding of environmental processes, uncertainty) (Cada and Hunsaker 1990).

- Traditional impact assessment usually examines the consequences of a single source of environmental disturbance (i.e., a discrete event or project) on valued resources and neglects or gives short shrift to the problem of potential cumulative impacts.

Assessment of cumulative impact examines the consequences of multiple sources of environmental disturbance that impinge on the same valued environmental components. The characteristic "multiple" nature of cumulative impacts may arise in three ways:

- the same kind of source recurs sufficiently frequently through time;
- the same kind of source recurs sufficiently densely through space; and
- different kinds of sources impose similar consequences on a valued resource.

Identifying and evaluating potential cumulative impacts is difficult for at least four reasons (Irwin and Rodes 1992):

- the intricacies of environmental systems have only begun to be understood;
- there are seldom adequate data for environmental changes or their causes, particularly at appropriate time frames and spatial distributions;
- predictions of what will happen are inherently uncertain; and

- legal mandates and organizational interests frequently do not match the boundaries of environmental problems.

Dealing with the problems requires learning to address multiple actions or sources and additive or interactive effects at appropriate time and space boundaries (Irwin and Rodes 1992).

EPA (1992a) provides a proposed methodology to assist wetland regulators in assessing the cumulative effect of individual wetland impacts within a landscape. It is designed for situations in which time, resources, and information are limited. The approach does not provide a precise quantitative assessment of the cumulative effects within a particular area. Rather, it provides a mechanism to compare cumulative impacts between areas.

- Any environmental assessment must have defined endpoints (Suter 1989, 1990; U.S. Environmental Protection Agency 1992b; Cairns and Niederlehner 1993). Information compiled during initiation and scoping is used to help select endpoints that are relevant to decisions made about protecting the environment. Environmental assessment practitioners often distinguish between assessment endpoints and measurement endpoints. Often the assessment endpoint cannot be measured directly, so a measurement endpoint(s) is selected that can be related, either quantitatively or qualitatively, to the assessment endpoint (U.S. Environmental Protection Agency 1992b). An assessment endpoint is an explicit expression of an environmental value that is to be protected (e.g., a sport fish population). A measurement endpoint is a quantitative summary of a monitoring study, a toxicity test or other activity that reveals the effects of a proposed action on the valued assessment endpoint. For example, a decline in a sport fish population (the assessment endpoint) may be evaluated by using laboratory studies on the mortality of surrogate species, such as the fathead minnow (the measurement endpoint).

  Sound professional judgment is necessary for proper assessment and measurement endpoint selection, and it is important that both the selection rationale and the linkages between measurement endpoints, assessment endpoints, and policy goals be clearly stated.

  In order for the results of an assessment to be meaningful for the decisionmaker, endpoints should have the following characteristics:

- societal relevance (i.e., understood and valued by the public and by the decisionmaker),
- unambiguous (e.g., effects on the abundance of the Hudson River striped bass population in contrast to "ecosystem health"),
- biological relevance (e.g., effects on populations or ecosystems rather than individuals),
- assessable to prediction or measurement (i.e., if the response of an endpoint cannot be measured or estimated from measurements of similar or related responses, it can not be assessed), and
- susceptibility (i.e., the endpoint must have the potential for exposure and be responsive to the hazard).

- Identification of impacts is only the first step of the assessment phase. The predicted impacts must also be interpreted for the decisionmaker and the public in terms of their influence on the human environment. For each of the alternatives and the proposed action, the EIA should address whether the predicted impacts are:

  - beneficial or adverse,
  - direct or indirect (triggered at a future time, or different place),
  - short-term or long-term (and thus potentially cumulative), and
  - irreversible (and thus detrimental to sustainability).

  Ecological risk assessment procedures can provide insight to the likelihood that an adverse impact will occur and the magnitude of the consequences (EPA 1992b).

- Regulatory agencies should be consulted before embarking on modeling exercises because they frequently have specific models that are required or recommended for use in environmental impact analysis. The results of other models may not be acceptable unless the models have undergone rigorous validation processes.

- Although developing countries may not have adequate data and human and financial resources for elaborate EA, the use of rapid identification procedures (e.g., checklists and matrices) requires little collection of technical/ecological data, but rather a general familiarity with the region and with the nature of the proposed action (Biswas and Geping 1987). Lohani and Halim (1987) describe the application of a checklist and different types of

matrices to a proposed pulp mill project in Thailand (Part C). They conclude that checklists and matrices result in rapid identification of likely impacts and that their use depends on the expert judgment and coordination and participation of all concerned, the proponent, the EA team, the public, and the government agencies responsible for various resources (e.g., fisheries, forests, agriculture).

LINKAGES

Identification of potential impacts of a proposed action is a process that begins informally with the proponent during initiation and gains momentum during early intra-and interagency consultations and the public scoping process. Impact identification culminates during the assessment phase when the EA team describes the impacts of the proposed action and alternatives, quantifies the extent of the predicted impacts, identifies measures to mitigate the unavoidable environmental impacts, and prepares an EA report for the decisionmaker and the public.

REFERENCES

Biswas, A. K., and Q. Geping. 1987. Environmental Impact Assessment for Developing Countries. Tycooly International. 232 pp.

Bregman, J. I., and K. M. Mackenthun. 1992. Environmental Impact Statements. Lewis Publishers, Boca Raton. 279 pp.

Bureau of Land Management. 1992. Draft Guidelines for Assessing and Documenting Cumulative Impacts.

Cada, C. F., and C. T. Hunsaker. 1990. Cumulative impacts of hydropower development: Reaching a watershed in impact assessment. The Environmental Professional 12:2-8.

Cairns, J. Jr., and B. R. Niederlehner. 1993. Ecological function and resilience: neglected criteria for environmental impact assessment and ecological risk analysis. The Environmental Professional 15:116-124.

Elliot, M. L. 1981. Pulling the pieces together: amalgamation in environmental impact assessment. Environmental Impact Assessment Review 2:11-38.

Irwin, F., and B. Rodes. 1992. Making Decisions on Cumulative Environmental Impacts: A Conceptual Framework. World Wildlife Fund, Washington, D.C. 54 pp.

Jørgensen, S. E. 1991. Environmental management modelling. In: Introduction to Environmental Management (eds. P. E. Hansen and S. E. Jørgensen). Elsevier, New York. 403 pp.

Lein, J. K. 1993. Formalizing expert judgment in the environmental impact assessment process. The Environmental Professional 15:95-102.

Leopold, L. B., E. Clarke, B. B. Hanshaw, and J. B. Balsley. 1971. A Procedure for Evaluating Environmental Impact. U.S. Geological Survey Circular 645, U.S. Geological Survey, Washington, D.C.

Lohani, B. N., and N. Halim. 1987. Recommended methodologies for rapid environmental impact assessment in developing countries: Experiences derived from case studies in Thailand. In: Environmental Impact Assessment for Developing Countries (eds., A. K. Biswas and Q. Geping). Tycooly International, London.

Luhar, A. K., and P. Khanna. 1988. Computer-aided rapid environmental impact assessment. Environmental Impact Assessment Review 8:9-25.

McBrayer, J. F., S. B. Gough, R. C. Robertson, and H. E. Zittel. 1981. Identifying alternatives at a reconnaissance level. EIA Review 2:190-195.

McHarg, I. 1969. Design with Nature. Natural History, New York.

Riggins, R. E. 1980-81. Comprehensive computer-aided environmental impact analysis. Journal of Environmental Systems 10:81-91.

Schlesinger, B., and D. Daetz. 1973. A conceptual framework for applying environmental assessment matrix techniques. Journal of Environmental Science 16: 11-16.

States, J. B., P. T. Haug, T. G. Shoemaker, L. W. Reed, and E. B. Reed. 1978. A Systems Approach to Ecological Baseline Studies. U.S. Department of Interior, Fish and Wildlife Service, FWS/OBS-78/21.

Strand, R. H., M. P. Farrell, J. C. Goyert, and K. L. Daniels. 1983. Environmental assessments through research data management. Journal of Environmental Management 16:269-280.

Suter, G. W. II. 1990. Endpoints for regional ecological risk assessments. Environmental Management 14:9-23.

Suter, G. W. II. 1989. Ecological endpoints. In: Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference Document (eds. W. Warren-Hicks, B. R. Parkhurst, and S. S. Baker, Jr). EPA 600/3-89/013. Corvallis Environmental Research Laboratory, Oregon.

Thor, E. C., G. H. Elsner, M. R. Travis, and K. M. O'Loughlin. 1978. Forest environmental impact analysis - a new approach. Journal of Forestry 76:723-725.

U.S. Environmental Protection Agency (EPA). 1992a. A Synoptic Approach to Cumulative Impact Assessment, A Proposed Methodology. EPA/600/R-92/167. Office of Research and Development, Washington, DC 20460.

U.S. Environmental Protection Agency (EPA). 1992b. Framework for Ecological Risk Assessment. EPA/630/R-92/001.

Wathern, P. 1988. An introductory guide to EIA. In: Environmental Impact Assessment: Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston, 332 pp.

Impact Analysis and Prediction

Methods for impact analysis and prediction range from relatively simple matrices to sophisticated computer models (Westman 1985, ERL 1984). Choice of the various methods is determined by the EA team based on the nature of the proposed action and the needs of the decisionmaker. Often, many of the impacts of a proposed action are trivial and a decision depends upon a small subset of issues of importance. The nature of the analysis must reflect these needs.

In developing a general approach to analyzing environmental impacts, there are several fundamental questions that must be asked early in the planning process. They include:

- What effects must be predicted (i.e., what are the assessment endpoints?)
- What are the most relevant methods for analysis and prediction of environmental impacts?
- What ad hoc standards or generally-accepted criteria can be used to distinguish significant levels of environmental impacts from all possible levels of impacts?
- Are mathematical or statistical methods available for objectively estimating levels of impacts, or will subjective scoring be used at one or more stages of the assessment?
- Are there documented studies of the effects of prior similar actions?
- How can the analysis provide the information needed by the decisionmaker?
- Is the necessary time, money, and expertise available?

The term analysis refers to formal methods for predicting/estimating effects of proposed activities. Broadly, these methods can be grouped as professional judgment (e.g., Delphi technique, impact matrices, expert systems; however, it should be noted that professional judgment is applied throughout the EA process); comparison to similar projects (analog studies); field and laboratory experiments (microcosms and mesocosms); and predictive modeling. Risk assessment is part of EA (Andrews 1988) and typically involves several or more quantitative techniques to estimate the likelihood (or probability) and severity of harm to human health and the environment resulting from exposure to a risk

agent (e.g., a chemical substance, biological organism, radioactive material, or other potentially hazardous substance or activity). Risk assessment usually depends on the following distinct but related parts: source/release data, exposure assessment, dose-response data, and risk characterization (i.e., integration of the previous steps into a risk statement that includes one or more quantitative estimates of risk). The use of risk assessment in EA depends on the nature of the proposed activity, the issues, and the needs of the decisionmaker.

In a study of 140 EIAs (ERL 1984) to determine the use of formal, predefined and repeatable methods of prediction, it was found that mathematical, physical or experimental methods were used in 25 percent of the studies; in a further 15 percent, simple methods such as inventories of receptors affected (e.g., numbers of people or properties, areas of habitat) were used to describe effects. In the remaining documents, other approaches not involving formal methods were used (e.g., expert judgment, analogous studies, comparisons with standards). Informal and formal approaches to prediction were often used together in order to qualify and interpret results.

In another study (described in Wathern 1988), staff from four U.S. federal agencies were given a list of methods and asked to indicate their use within the agency. The results show that the traditional techniques (e.g. overlay mapping, habitat evaluation, and the Leopold matrix) are used more often than modeling. However, three of the agencies polled are responsible for land management activities (i.e., Bureau of Land Management, Forest Service, and Soil Conservation Service). Thus, an emphasis on habitat evaluation procedures is to be expected. However, the agencies also indicated that they often rely on their own approaches rather than existing techniques.

NEEDS

Impact analysis commonly requires 1) data about the proposed action (e.g., the construction phase and subsequent operational characteristics) and the environmental setting (i.e., baseline conditions) and 2) methods for estimating effects of:

- contaminant releases,
- physical destruction or modification of habitat,
- harvesting (either deliberate or incidental as in entrainment of larval fish), and
- socioeconomic disruption.

Canter (1977) describes traditional EA methods while Jørgensen (1988) and Suter (1993) provide more recent developments in the area of statistical and mathematical models. With the advent of computers, sophisticated multi-

compartment models (Attachment 4.C) have been developed but their use in everyday EA is limited. Most EA depends on simple single-media air and water dispersion models for estimates of pollutant concentration coupled to standards or toxicity data to estimate effects on species of interest (Bregman and Mackenthun 1992). It is important, if at all possible, to use accepted methods and models and to document their use carefully.

Jørgensen (1991) describes three important steps in establishing the credibility of computer models: calibration, verification, and validation. These steps are generally useful for other quantification methods as well.

- Calibration is an attempt to reconcile computed and observed data by systematically varying selected parameters. Calibration can be carried out by trial-and-error methods or by use of software to find the parameter values that give the best fit between observed and computed data.
- Verification is a test of the internal logic of a model. It answers the question, does the model react as expected? It is a subjective assessment of the behavior of a model.
- Validation, in contrast to verification, is an objective test of how well the model output fits the data. In this step, the modeler tests the model against a data set which is independent of all data previously used.

TOOLS

- **Professional Judgment.** Environmental assessments are based on scientific data that are frequently difficult and complex, conflicting or ambiguous, or incomplete. Analyses of such data depend on professional judgment based on scientific expertise. Professional judgment is necessary to:

  - design and conceptualize an environmental assessment;
  - evaluate and select methods and models;
  - determine the relevance of available data to the assessment;
  - develop assumptions based on logic and scientific principles to fill data gaps; and
  - interpret the ecological significance of predicted or observed effects.

  Because professional judgment is so important, specialized knowledge and experience in the various phases of environmental assessment are required. Thus, an interactive multidisciplinary

team that includes experienced biologists, ecologists and other appropriate experts (e.g., socioeconomists) is a prerequisite for a successful assessment. Other agencies that have special expertise with respect to environmental issues can also be asked to provide data for impact analysis and to participate in document preparation and review. Independent experts can be asked to conduct 'brainstorming sessions" to generate impact scenarios and to participate in panels to estimate the likelihood of impacts and to address uncertainty surrounding predictions of magnitude (Lein 1993).

If the EA team determines that objective analysis and quantification are impossible, expert opinion can be used to derive numerical estimates. One approach known as the Delphi technique (i.e., conceptual polling) solicits estimates from independent experts that are averaged with those of other experts and the median and range of the estimates are resubmitted to the group for a second round of comment. This process of iterative refinement continues until a group consensus is reached on the issue being investigated. However, it must be made clear to the public and the decisionmaker that such predictions or estimates are based on expert opinion that reflects the current range of opinion of the scientific community and are not a guarantee of correctness. Using formal professional judgment is expensive and time consuming and, therefore, should be considered only for major, potentially costly issues after available quantitative methods have failed to provide resolution.

One example of an EA methodology developed using the Delphi technique is the National Sanitation Foundation Water Quality Index (NSF-WQI) developed in the United States. The goal here was to derive a system for indexing key water quality variables and integrating the small group of variables into an indexing system. In this way, water quality data could be used in a standardized system of rating that had utility for comparisons in space and time.

- **Expert Systems.** Recently, expert systems have been developed as a tool that incorporates expert judgment, experience, and the EA process (Lein 1989, 1993). A computer program is encoded with and applies knowledge of a specific area of expertise toward the solution of problems within a subject area. It takes the general form of IF (condition) — THEN (conclusion) statements. Expert systems can be useful in screening a project for identification of

factors that might contribute to a significant primary impact (analogous to an intelligent questionnaire) and as attribute interpreters (i.e., relating project characteristics to environmental knowledge). Their use is limited for impact analysis and quantification.

- **Analog Studies.** One of the best approaches to impact analysis is reviewing the effects on the environment of similar activities and existing disturbances or pollution sources. EA documents should be reviewed for assessment methods and predicted impacts. Observational field studies of existing sites can then serve as models for similar sites exposed to similar contaminants or disturbances. Such comparisons have been termed "analog studies" by the National Research Council (1986). For example, in the assessment of whether a proposed reservoir would become eutrophic, the most credible evidence was the fact that a similar, nearby reservoir was eutrophic (Goodman 1976).

  Observational field studies provide a realism that laboratory studies or modeling lack. However, there is always uncertainty associated with the observed effects of contaminants or disturbances due to variation in the natural environment of the presumed "similar" sites. Confidence in causal relationships can be improved by carefully selecting comparable reference sites or by evaluating changes along a gradient where differences in other environmental factors are minimized. It is important to consider potential site specific factors during the analysis. Westman (1985) provides references to methods used for predicting pollutant dispersion in water and air (e.g., dye tests, toxicity texts).

  If one type of environmental disturbance is considered to be analogous to others, then relatively well-developed models and assessment approaches for one disturbance can be used to assess others (Suter 1993). For example, the effects of fishing on fish populations have been used as a model for effects of mortality from power plant cooling systems (McFadden 1977) and toxic chemicals (Goodyear 1972, Barnthouse et al. 1987, 1990). To the extent that actions resemble fishing, in that they cause mortality at different rates on different life stages, the mathematical models and computational techniques developed by fisheries scientists can also be employed in environmental assessments.

- **Impact Matrices.** An impact matrix (i.e., scaled matrix) is an expanded checklist that includes estimates of the relative magnitude

(i.e., significance) of the environmental impacts (Leopold et al. 1971, Figure 4.3-1, Attachment 4.D). Values are assigned to the identified impacts and these values can be summed to aid interpretation of the impacts of various alternatives, to evaluate the temporal phases of a project, to identify beneficial and detrimental impacts (through the use of plus and minus signs) or to describe impacts associated with spatial boundaries (site vs. region) (Canter 1977).

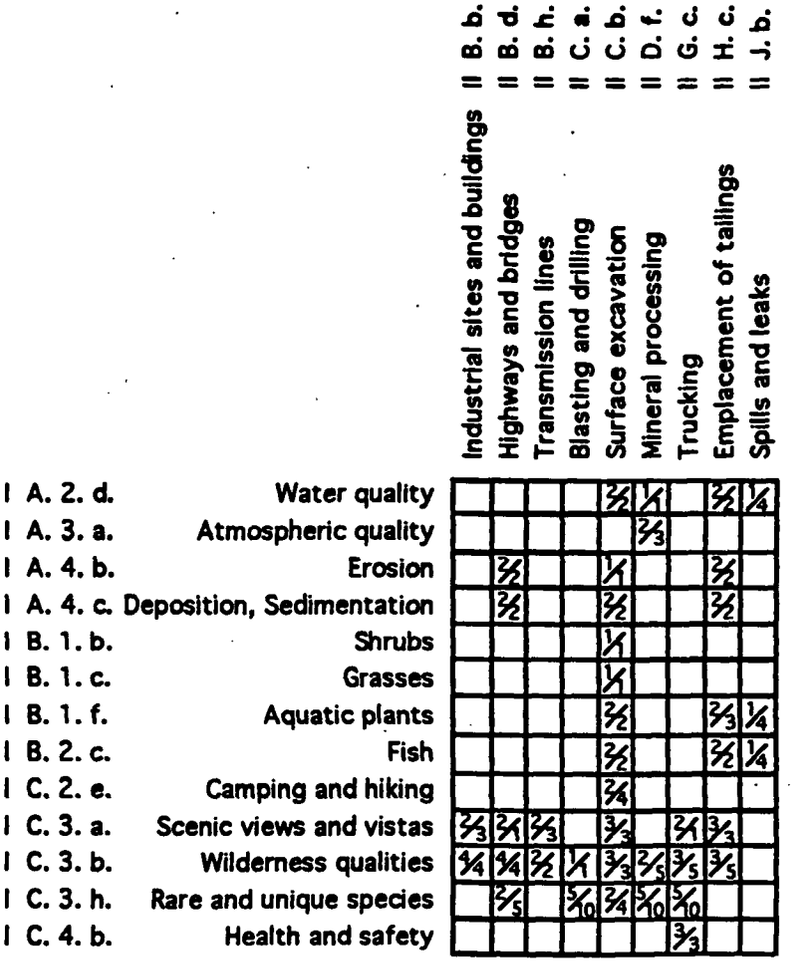


FIGURE 4.3-1. A reduced matrix for a phosphate mining lease. (Source: Leopold et al. 1971)

Since the evaluation of the relative magnitude and importance of impacts is subjective and various scales are used (e.g., one-to-ten; high, low, medium; Westman 1985), documentation of the procedure is particularly important. For example, a one-to-three scale might be described as follows:

One	—	Effects occur but are of only slight concern; slightly important effects.
Two	—	Effects of moderate concern; moderately important effects.
Three	—	Effects are of particular concern; most important effects.
Blank	—	The perturbation has no effect on the process or component.

In addition to having the same problems as checklists (Chapter 4.2), scaled matrices convey objectivity when in fact the values are subjective and generated by a very restricted group(s) (e.g., the EA team, other independent experts, or decisionmakers). The use of summation values, although they provide the decisionmaker with an easy way to compare a complex variety of impacts from a number of alternatives, obscures the relative contributions of different elements and actions. Moreover, the database is simplified enormously to generate an index. The implications of index values should be corroborated by other assessment techniques. Also, any such assessment index should be validated by field testing. Nonetheless, the use of indices derived from the consensus of experts can facilitate comparison of data from different geographical areas or from different points in time (Attachment 4.D).

- **Field and laboratory tests and experiments.** The kind of data needed for analysis of environmental effects depends on the source of the impact (e. g., contaminant, disturbance) and the environmental endpoint of interest. Effects can range from mortality and reproductive impairment in individuals and populations to disruptions in community and ecosystem function such as primary productivity. In relation to EA, field and laboratory tests are usually conducted only when available data are lacking or inadequate. It is particularly important that such tests are relevant to the endpoints selected during the identification of issues, that the quality of the data is assured, and that the need for extrapolation is minimized.

  Controlled laboratory (e.g. microcosms) and field tests (e.g., mesocosms) are often called physical models. They can provide strong causal evidence linking a contaminant or disturbance with a response and can also help discriminate between multiple sources of impact (Suter 1993, Westman 1985, Hilborn and Walters 1981).

The most common type of physical model is the laboratory test (e.g., a bean seedling in a flask of hydroponic solution as a model of the crop in the field). The objective of these microcosm studies is to isolate environmental components and processes and to subject the components to various levels of perturbation. One of the principal advantages of this approach is that it provides some control of boundary conditions so that observed variations can be attributed to the response under investigation. A disadvantage is that results of experiments under controlled conditions must be extrapolated with caution to the natural system. The EPA has developed standard microcosm protocols for toxicity testing for soil microbial communities (EPA 1987, Suter and Sharples 1984, Van Voris et al. 1985) and excised aquatic communities (EPA 1987, Giddings 1986, Perez et al. 1984). However, microcosm tests are seldom used in EA.

Field tests (i.e., mesocosms) are tests of the effects of a contaminant or disturbance in an unconfined environment conducted at approximately the same scale as the predicted effect. They are the most difficult and expensive type of test, but if properly conducted, they provide realistic evidence of impacts. However, the responses in field tests are complex and so influenced by uncontrolled variables (e.g., weather, movement of organisms) that the results may be difficult to understand and generalize. Also, they are often unreplicated and have few treatment levels because of expense and the difficulty of finding sufficiently similar sites. The only field tests that have been required by regulation are the natural pond tests formerly required by the EPA Office of Pesticide Programs and the terrestrial field tests for effects on wildlife still required by the EPA for certain pesticides (Fite et al. 1988).

- **Predictive Models.** Models are used in EA to predict the environmental consequences of an action (Attachment 4.C). They are mathematical, statistical, or conceptual expressions of the essential elements of a problem and, as such, every model contains simplifications. As a result, predictions derived from models can neither be completely accurate nor can they ever correspond exactly to reality. It is a task for specialists to develop models; however, their use by decisionmakers must be restrained by an understanding of the advantages and disadvantages of modeling. The phases associated with development of a model include:

  — defining a volume in space;

- defining the various reaction rates of processes of interest (e.g., biodegradation, hydrolysis, photolysis);
- defining the various discharges to the system;
- defining the transport rates between the various media; and
- solving the equation to obtain an expression for the substance of interest.

The use of the resulting estimates in EA involves an understanding of the tolerances of species to pollutants, the transfer and transformation of pollutants in ecological systems, and the effect of toxification of one part of the ecosystem on remaining portions (Westman 1985). In addition to the models that are described in Attachment 4.C, the reader is referred to discussions in Westman (1985), Cohrssen and Covello (1989), and Bregman and Mackenthun (1992) for information on mathematical models for predicting pollutant dispersion in air, water, and soil.

Mass balance is a fundamental concept in modeling in which a volume in space of the environment is identified and a mass or material balance equation is written for the volume (Figure 4.3-2; Mackey and Paterson 1993). The "Volume" may be water in a river, a region of the atmosphere, soil to a specific depth or even an organism. It has defined physical boundaries and, hopefully, fair homogeneity. A mass balance equation states that change in the components of a volume will equal the sum of the inputs less

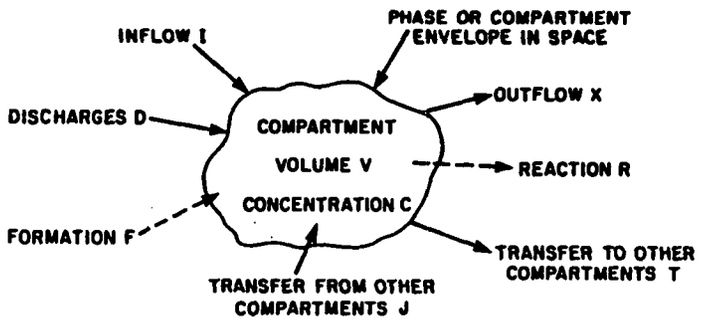


Figure 4.3-2. Fundamental mass balance equation. (Source: Mackay and Paterson 1993)

the sum of the outputs. Input terms may include flow in air and water, direct discharges, or formation of chemicals. Outputs may include flow (e.g., water from a lake) or degrading reactions or diffusion to another medium. The modeler's task is to develop quantities (in compatible units) for each of the terms in a mass balance equation.

The following discussion of predictive models is largely a paraphrase of Suter and Barnthouse (1993).

> Mechanistic (i.e., mathematical) models are what most people associate with the term "model". In this approach to EA, the principal cause-effect relationships of a proposed action are described in terms of mathematical functions and combined to yield a mathematical model capable of predicting future environmental conditions. Mathematical "models" come in all degrees of complexity, from simple variations on mass balance equations to highly complex multivariate systems. The mathematical functions may be purely deterministic, or may have strong stochastic elements contributing to the model output. Some models include statistical routines for estimating error associated with model outputs. Most commonly used mathematical models for impact assessment have been adapted for computers.
>
> It has often been argued that mechanistic models are unsuited to EA because natural systems are so complex. Approximations and simplifying assumptions always have to be made and these necessarily introduce errors and uncertainty. Nevertheless, mechanistic models are useful components of many assessment studies. Examples include predicting ecological effects of climate change, responses of landscapes to regional air pollution (Hunsaker and Graham 1991), long-term management of fisheries (Walters 1986) and remediation of PCB contamination (Limburg 1986). Where there is (as there almost always is) substantial uncertainty about the "true" nature of the mechanisms and the values of critical parameters, astute use of more than one model can provide valuable guidance in making informed management decisions (Walters 1986).
>
> Another important use of mechanistic models is to integrate complex sets of observations made in different times and

places. Ecosystem simulation models are often used for this purpose [e.g., the Narragansett Bay model of Kremer and Nixon (1978) and the forest stand composition and succession models of Shugart and West (1980) and West et al. (1980)].

Yet another use of mechanistic models is to predict variables or events that are difficult or impossible to measure from more readily measurable variables [see Christensen et al. (1976) on the effects of the operation of power plants on the abundance of fish populations]. Readers interested in learning mathematical modeling techniques should consult one of the several available textbooks on this subject, including Hall and Day (1977), Jørgensen (1988), Rau and Wooten (1980), and Swartzman and Kaluzny (1987). For water quality modeling, Thomann (1972) is an excellent text. The journal Ecological Modeling publishes a variety of papers on both theory and applications of environmental models.

Statistical models derive generalizations by using statistical techniques [e.g., regression, principal components analysis; see Snedecor and Cochram (1980) or any introductory textbook for description of these basic statistical methods] to summarize experimental or observational data. There are three distinct purposes for using statistical models in EA: hypothesis testing, description, and extrapolation. Hypothesis testing was originally developed to determine whether data from controlled studies provided sufficient support for hypothesized relationships between controlled independent variables and the observed responses of dependent variables. It is most often used in EA for comparison of contaminated and reference sites in monitoring studies. However, it can lead to conclusions of statistical significance that have no relationship to ecological significance.

The second use of statistical models is description. For example, a multivariate regression model might be used to describe the results of a pollution monitoring study by regressing concentration against distance downstream and flow rate. Similarly, a multivariate classification method such as principal component analysis might be used to distinguish the sets of natural and pollution-adapted biotic

communities within an ecosystem. This description of patterns and relationships in observational data is the major activity of statistical ecologists. The results can be used to frame hypotheses which are then tested in experimental studies, to guide further sampling, or simply to increase understanding of the system. Readers interested in multivariate analysis should consult Gauch (1982).

The third use of statistical models is extrapolation, the use of a model to statistically estimate something other than the data from which it was derived. The most familiar type of extrapolation is extrapolation of a model to conditions outside the range of the data from which the model was derived. This range extrapolation is considered bad practice but is sometimes necessary in EA. Another more useful type of extrapolation is extrapolation from a type of data that is available to a type that is desired but unavailable. For example, extrapolation techniques were used to estimate the effects that ingestion of food contaminated with chemical nerve agents would have on wild birds based on pesticide data for rats. The organophosphorous nerve agents and pesticides are similar in chemical structure and biological activity. Available data were sufficient to develop models for mallards and ring-necked pheasant (Sigal and Suter 1989).

In assessments of impacts of acidification on surface waters, statistical models have been used extensively to extrapolate from observations on subsamples of lakes and streams to impacts on regional surface water resources (Baker et al. 1990). Exercises of this kind are sometimes referred to as "empirical modeling"; they are an important part of basic field ecology.

Strictly speaking, a statistical model makes no presumption to explain observation in terms of causal relationships between the independent and dependent variables. The model simply summarizes the relationship between the variables.

- A conceptual model usually contains three elements: the variables of the ecosystem of interest; the external variables that affect the state of the ecosystem of interest; and the interrelationships between them (i.e., the processes

involved in the response of the environment to the action). A conceptual model is often the preliminary step in the formulation of a mathematical model. Figure 4.3-3 shows a conceptual diagram of the nitrogen cycle in a lake. The ecosystem variables are nitrate, ammonium (which in the un-ionized form ammonia is toxic to fish), nitrogen in phytoplankton, nitrogen in zooplankton, nitrogen in fish, nitrogen in sediment and nitrogen in detritus. The external variables are: the water inflow and outflow, the concentration of nitrogen components in the in- and outflow, the solar radiation (indicated by the arrow PHOTO) and the temperature; the latter is not shown on the diagram, but it influences all process rates. The arrows in the diagram illustrate the processes; these can be expressed by use of mathematical equations in building a mechanistic model. This conceptual model might be applied to an assessment of the aquatic impacts of a facility that would release ammonia. Such conceptual models can serve as an aid to qualitative assessments and simple quantitative assessments as well as mathematical models.

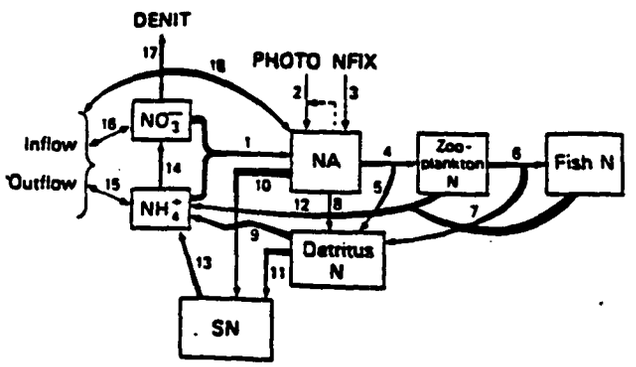


Figure 4.3-3. The conceptual diagram of a nitrogen cycle in an aquatic ecosystem is shown. The processes are: 1) uptake of nitrate and ammonium by algae, 2) photosynthesis, 3) nitrogen fixation, 4) grazing with loss of undigested matter, 5), 6) and 7) are predation and loss of undigested matter, 8) mortality, 9) mineralization, 10) settling of algae, 11) settling of detritus, 12) excretion of ammonium from zooplankton, 13) release of nitrogen from the sediment, 14) nitrification, 15), 16) and 18) input/output, and 17) denitrification.

[Source: Jørgensen, S. E. 1991. Environmental management modelling. In: Introduction to Environmental Management (eds. P. E. Hansen and S. E. Jørgensen) Elsevier, New York. 403 pp.]

- **Specialized Analysis and Prediction Methods.** As discussed above, there is no universal method for analysis and prediction of environmental impacts. Experimental testing is the scientific ideal but not generally feasible except on small scales. Thus, alternative methods have been developed to assess specific types of problems. This section describes some, but by no means all, of the recent methods used in EA.

  - **Habitat Evaluation Methods.** Because habitat includes all the components, both biotic and abiotic, necessary for the survival of a species (e.g. food, cover, water, breeding areas), knowing the general habitat requirements of a species allows determination of the potential value of an area for wildlife. (See EPA 1993 for discussion of habitat issues relevant to environmental assessment.) This information is useful in predicting effects of physical disturbance or destruction on fish and wildlife populations. For example when habitat is destroyed, the loss of a wildlife species will approximately equal the sum over habitat types of the wildlife density in a habitat type times the area of that habitat lost. This assumes that the species of interest is effectively immobile or that habitat is limited.

    An approach that allows the user to apply a value systematically to a habitat was developed by the U.S. Fish and Wildlife Service (FWS) (Farmer 1980, 1981) in cooperation with various conservation groups and state and other federal agencies. Called Habitat Evaluation Procedures (HEP), the technique is designed to provide a consistent means of assessing project development impacts by: 1) assigning a quantitative index value for existing habitat conditions; 2) determining the difference between index values of existing conditions and conditions that will result from a proposed project; and 3) demonstrating, in habitat-value units gained or lost, the beneficial or adverse impacts anticipated as a result of projected development. This habitat evaluation procedure provides a framework for determining habitat quality for specific fish and wildlife species and has been extended in an attempt to consider pollution effects (U.S. Department of Interior 1987). The FWS has programmed the models to be used interactively on microcomputers.

An investigator choosing to evaluate a particular geographical area can select appropriate endpoint species from a master list, and use the habitat requirements of these species to generate a sublisting of environmental variables that must be analyzed or quantified. After these environmental variables are measured or evaluated in field studies, the habitat information can be entered into the interactive program.

The HEP output reports each habitat type in terms of its Habitat Suitability Index (HSI), scaled from 0.0 to 1.0. These HSIs are computed for each of the endpoint species and, as a weighted mean, for the total area being evaluated. The investigator can also examine intermediate model outputs and perform a sensitivity analysis of the input variables. The HSIs and the areas of the habitats can be combined (by simple multiplication) to yield Habitat Units (HUs) for each habitat category and for a series of scenarios (target years) with varying combination of land use.

The HEP outputs can be used to assess environmental impacts by comparing the HUs available to each endpoint species in pre-action and several post-action scenarios. Additionally, if the areas of certain habitats are to be created or enhanced through mitigation, the effects of such changes can be compared with the unmitigated scenario.

Atkinson (1990) describes a Simplified Habitat Evaluation (SHE) technique for biological impact assessment. SHE is based on the theory of diversity and an assumption that as the biological quality of an area increases so does its diversity. A study of 132 habitat-based methods showed that measurements of diversity obtained from SHE are highly correlated to HEPs. Moreover, SHE can be easily adapted to digital remote sensing imagery and the data can be analyzed with a computerized SHE.

Landscape Mapping/Geographic Information Systems. Sets of landscape characteristics/attributes (e.g., sensitive habitat, cultural resources, slope, soils) can be used alone or in combination to assess the suitability or vulnerability of an area for various uses. Typically each attribute of

interest is separately mapped and relevant maps are overlaid on a baseline map. Mapping has evolved from hand-drawn transparency maps (McHarg 1969) to computerized mapping systems, sometimes attached to automatic systems of data input from satellite photos (Westman 1985). Collections of automated spatial data on landscape attributes are called geographic information systems (GIS) and their application in EA is increasing. Their usefulness depends on the nature of the proposed action, the availability of computerized data, and the EA objectives. GIS systems can incorporate economic, ecological, and aesthetic criteria into the process of comparing alternatives. Decisions are then based on how closely each plan comes to achieving specific goals (Jensen and Gault 1992; Attachment 4.E).

Hopkins (1977) compares major approaches to land suitability mapping and Westman (1985) provides three examples of the application of computerized systems to the study of land resources [the Boston Metropolitan Landscape Planning Model (METLAND), the Australian CSIRO South Coast Study (SIRO-PLAN), and the Rasmussen et al. (1980) technique for selecting road paths through forest]. Westman (1985) notes the following limitations to GISs:

- In the process of constructing quantitative or economic indexes of landscape value, much information is lost, information is extrapolated beyond the empirical data base, and sources of statistical error are compounded.

- The spatial interdependence of landscape units is often not accounted for (i.e., the landscape attributes reflect the structural rather than the dynamic features of the environment).

- Natural ecological boundaries are usually not recognized (e.g., in relation to species dispersal, water-or airshed boundaries). Hence dispersal of air or water pollutants are typically modeled separately, as is movement of species between landscape units.

Ecological Risk Assessment. Ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more contaminants and/or disturbances (e.g., chemical, physical or biological agents, construction activities) (EPA 1992, Suter 1993). The process involves identifying hazards such as the release of a toxic chemical to surface waters that support fisheries, and using measurement, testing, and mathematical or statistical models to quantify the relationship between the initiating event and the effects. Ecological risk may be expressed in a variety of ways. While some ecological risk assessments may provide true probabilistic estimates of both the adverse effect and exposure elements, others may be deterministic (i.e., parameters are assumed to be constant and accurately specified) or even qualitative in nature. In these cases, the likelihood of adverse effects is expressed through a semiquantitative or qualitative comparison of effects and exposure.

Ecological risk assessments can help identify environmental problems, establish priorities, and provide a scientific basis for regulatory actions (Cohrssen and Covello 1989). The process can identify existing risks or forecast risks of chemical, physical or biological agents or other activities not yet present in the environment. However, while ecological risk assessments can play an important role in identifying and resolving environmental problems, risk assessments are not a solution for addressing all specific environmental problems. For example, for protection of habitats and endangered species, professional judgment and the mandates of a particular statute will be the driving forces in making decisions.

Models of interest for ecological risk assessment are categorized into two classes: exposure models and effects models.

Exposure models simulate the movement and transformations of toxic contaminants in the environment. Processes generally simulated in transportation and fate models include the physical movement of particles and dissolved materials, chemical transformations, and exchanges between major compartments (e.g., air, water,

soil) of the environment. A detailed account of the use of fate models in risk assessment can be found in Mackay and Paterson (1993). Attachment 4.C summarizes some of the available exposure models (e.g. multimedia, remediation, aquatic, soil, fish uptake and food chain, atmospheric, and spill models) which can be used for exposure estimation.

Food web models are a special subclass of fate models often used to simulate (1) exchanges between biotic and abiotic components of the environment and (2) transfer of contaminants from prey to predators (Suter 1993). The emphasis in food web models is on the biological components of the environment, especially the movement of materials through grazing, predation, and human harvest. Models of DDT and PCB bioaccumulation (Harrison et al. 1970, Thomann and Conolly 1984) and of contaminant movement through food chains (Baes et al. 1987, Lipton and Gillett 1991) are excellent examples of this type of model.

Effects models simulate the effects of stress on biota. This is by far the most diverse category of models of interest in environmental assessment (Suter 1993). The "stresses" that have been modeled include human exploitation, environmental contamination on both local and regional scales, and, more recently, climate change resulting from increasing atmospheric carbon dioxide. Organism-level effects models include toxicodynamic models (Mancini 1983, Kooijman and Metz 1984, Lassiter 1985, Lassiter and Hallam 1990) that relate the risk of death of organisms to the uptake and internal concentration of contaminants. Models of energetics and growth (Kitchell et al. 1977, Rice et al. 1983) are also relevant to environmental assessment but have not been extensively applied to date.

The population-level models of current or potential use in environmental assessment include the many models developed for management of fish and wildlife populations. Logan (1986) and Barnthouse et al. (1987, 1989, 1990) have provided examples of the use of fisheries-derived models in contaminant risk assessment. Although such models have not yet been used to assess risks of contaminants to wildlife populations, Emlen (1989) has

reviewed the available wildlife population models and discussed their potential uses.

Community-level and ecosystem models are the most diverse of ecological effects models. These models may be site-specific (Kremer and Nixon 1978) or generic (O'Neill et al., 1982). Spatial scales considered range from microcosms (Rose et al. 1988) to regions or landscapes (Dale and Gardner 1987). Suter and Bartell (1993) discuss the reasons why ecosystem-level testing and ecosystem models have not fulfilled their promise as tools for EA. Among the reasons is the lack of clear goals. At the ecosystem level, many endpoints have been used but none have the endorsement of the regulatory agencies or the scientific community. This problem is analogous to that of not having indicators for assessment of sustainability (Chapter 1).

A few integrated exposure/effects models that permit changes in biotic compartments (e.g., flora, fauna) to affect the fate of chemical contaminants have been developed (Bartell et al. 1988). Such models are applicable principally to cases in which (1) biota are a major sink for contaminants (true only rarely), and (2) contamination is sufficient to cause major disruption of the biota.

Human Health Risk Assessment. The goal of human health risk assessment is to estimate the severity and likelihood of harm to human health occurring from exposure to a risk agent (e.g., a chemical substance, biological organism, radioactive material, or other potential substance or activity). Although U.S. regulations require assessment of the impacts of proposed activities on the public health and welfare, such assessments are often lacking or inadequate in EA. Difficulties associated with health assessment in EA are similar to those associated with assessment of impacts on natural resources (i.e., lack of data and knowledge regarding dose/response relationships) and proponent concern about referring to the health impacts of a project in terms of morbidity, disease incidence, mortality, or projected death rates (Giroult 1988).

Human health risk assessment consists of the following related steps (Cohrssen and Covello 1989):

- Source/Release Assessment - estimates the amounts, frequencies, and locations of the introduction, release, or escape of risk agents (e.g., toxic chemicals) from specific sources (e.g., manufacturing plants) into occupational, residential, or outdoor environments.

- Exposure Assessment - provides quantitative data on individuals, populations, or ecosystems that are, or may be, exposed to a risk agent; the concentrations of the risk agent; and the duration and other characteristics of exposure.

- Dose-Response Assessment - provides quantitative data on the specific amounts of a risk agent that may reach the organs or tissues of exposed individuals or populations and attempts to estimate the percentage of the exposed populations that might be harmed or injured and, where relevant, the characteristics of such populations (for example, sensitive subgroups such as children or the elderly).

- Risk Characterization - integrates the results of the previous steps into a risk statement that includes one or more quantitative estimates of risk.

Although the approach to human health and ecological risk assessment is conceptually similar, human health assessment considers effects on individuals of a single species and has a well-defined set of values to be protected that can be generally applied.

- **Economic-Demographic Assessment Models.** Economic-demographic models integrate economic, demographic, public service, and fiscal projections that are essential for EA of broad planning efforts. Models of this general type have been used for macrostructural international analysis (Sanderson 1978) and in the projection of the impacts of resource development (Leistritz and Murdock 1981). These models have recently been adapted to project changes in key economic and demographic indicators for smaller areas such as counties or individual towns (Leistritz et al. 1990). Output from the models includes projections of:

- demographic factors such as total population and population by age and gender;
- economic factors such as business volume, employment by type, personal income;
- public service demands for housing, school enrollments, medical and criminal justice service needs; and
- public costs and revenues by type and net fiscal balances by jurisdiction.

ISSUES

- The lack of reliable baseline data is one of the major problems for quantitative EA. It has made objective evaluation of changes in environmental quality difficult and often impossible. Moreover, acquiring baseline data is generally one of the most expensive and time-consuming activities in the EA process.

- Most studies of man-made impacts focus on structural responses of individual organisms. These components are relatively sensitive and are easy and inexpensive to measure; however, linkages of these parameters to adverse impacts on biological populations, communities, and ecosystems are mostly lacking. Measurements of effects at the higher levels of organization are confounded by natural variability, long response times, climatic variation, pathogens, and other factors. In addition, the lack of replication and of true control areas creates severe problems for design of monitoring programs and testing of hypotheses concerning effects (Sigal and Suter 1987, Jørgensen 1991).

- A mathematical model represents the synthesis of knowledge and data and thus is dependent on the depth of understanding of the particular system being modeled, the expertise of the modeler, and the quality of the available data. A model cannot fill gaps in knowledge or data. However, it can provide new understanding about the reactions and properties of a system (Jørgensen 1991). Generally, an ecologist, an environmental scientist, or an environmental engineer with some knowledge of mathematics and computer science is a better fit to developing and using ecological and environmental models than a mathematician with some knowledge of ecology and environmental science (Jørgensen 1991). However, the very best development and use of environmental models is carried out by a team representing all the relevant

disciplines, such as ecology, environmental engineering, mathematics, and computer science.

- The major types of uncertainty in EA are uncertainty in impact prediction and uncertainty in relation to decisionmaking (De Jongh 1988). The extent of the uncertainty in predictions about direct and indirect changes in the environment depends on the data and the methods used. Decreasing uncertainty in prediction usually involves more sophisticated methods, additional expertise, more resources, and almost invariably more information about the proposed activity, the local environment, and the behavior of possible environmental contaminants. Most predictive methods involve either a mathematical, physical, or conceptual model of the environment. The sources of uncertainty in the development and application of models include the following (De Jongh 1988):

  - data collection (i.e., accuracy in measurement and sampling and the inherent variability of environmental data);
  - structural error (i.e., simplification of ecological processes, incorrect assumptions about functional relationships, imprecise spatial and temporal resolution);
  - numerical error (i.e., approximations in numerical solutions);
  - use outside the range of circumstances for which a model was developed and calibrated; and
  - simple human mistakes.

  Approaches to estimating uncertainty in modeling include sensitivity analysis and Monte Carlo error analysis (De Jongh 1988). Sensitivity analysis is a technique for identifying the variable or parameter within a model that causes the largest change in model output per unit variance in input. Monte Carlo analysis is a simulation approach that estimates the variance in model output resulting from the estimated variance in the input parameters. Methods for reducing uncertainty in prediction are summarized by Environmental Resources Limited (1985).

  The uncertainty in decisionmaking is the result of politics and subjective choices made during the EA process (De Jongh 1988). These include, but are not limited, to:

  - political sensitivity of the proposed action;
  - the choice of alternatives to be investigated;
  - the choice of impacts to be studied and their relative value;

- definition of the limits and constraints of an assessment; and
- confidence in impact predictions.

Management approaches to resolving uncertainty related to decisionmaking in the EA process include decision analysis (Figure 4.3-4), amalgamation (i.e., the pulling together of many impact variables into a few valuative indices; see Elliot 1981), better guidelines for the application of EA, and better communication between the proponent and the public and the assessment team and the decisionmaker (De Jongh 1988).

DECISION ANALYSIS

Decision analysis provides a consistent method for structuring and clarifying the decision problem. Expert opinion is used to derive numerical estimates for subjective considerations when objective probabilities are not available. Decision analysis rests upon two assumptions. First, there are incomplete data; secondly, the decisionmaker will be influenced by the likelihood of events occurring and the values associated with the possible consequences. One of the main tools in decision analysis is the "decision tree", in which different actions, along with their likely consequences, resulting from alternative decisions are shown systematically in graphical form.

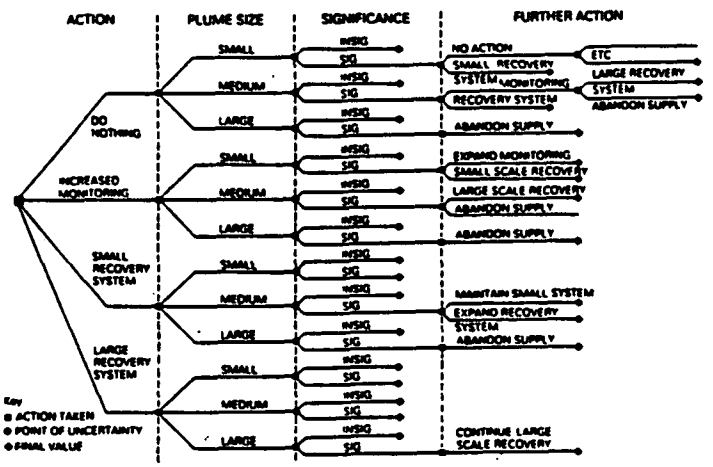


Figure 4.3-4.

A decision tree for the problem of groundwater contamination. (Source: DeJongh 1988)

- There are no procedures for the systematic integration of the environmental components of a study with the social and economic aspects. It is possible in some instances to construct ecological-economic models, but such models are not yet sufficiently well developed to give reliable results (Jørgensen 1991, Kjeldsen-Kragh 1991).

LINKAGES

Impact analysis is linked to all of the EA elements. During initiation and scoping, alternatives and issues requiring in-depth analysis are identified. Any cross-media (e.g., effects of air pollutants on water quality) and cross-impact (e.g., effects of wetland loss on waterfowl) linkages are determined and the assessment endpoints are identified. Other applicable laws and regulations (e.g. for permits) are identified and reviewed for any specific requirements for analysis related to the proposed action and the issues of interest. The result of impact analysis should be a succinct, comparative presentation of information about the proposed alternatives for use by the decisionmaker and the public. It identifies areas where monitoring and/or mitigation are needed. Thus, it forms the basis for post-decision analysis and follow-up.

REFERENCES

Andrews, R. N. L. 1988. Environmental impact assessment and risk assessment: learning from each other. In: Environmental Impact Assessment, Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston, Massachusetts. 332 pp.

Asher, S. C., K. M. Lloyd, D. Mackay, S. Paterson, and J. R. Roberts. 1985. A Critical Examination of Environmental Modeling - Modeling the Fate of Chlorobenzenes Using the Persistence and Fugacity Models. National Research Council of Canada, Report Number NRCC 23990.

Atkinson, S. F. 1985. Habitat-based methods for biological impact assessment. The Environmental Professional 7:265-282.

Atkinson, S. F. 1990. A simplified habitat evaluation for use with remote sensing data. The Environmental Professional 12:122-130.

Baes, C. F. III, C. T. Garten, Jr., and V. R. Tolbert. 1987. Long-Term Problems of Land Contaminated by Nonradioactive Hazardous Chemicals: Sources, Impacts, and Counter Measures. ORNL-6239. Oak Ridge National Laboratory. (Available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.)

Baker, J. P., D. P. Bernard, S. W. Christensen, M. J. Sale, J. Freda, K. Heltcher, P. Scanlon, P. Stokes, G. Suter, and W. Warren-Hicks. 1990. Biological Effects of Changes in Surface Water Acid-Base Chemistry. State-of-Science/Technology. Report 13. National Acid Precipitation Program, Washington, D.C.

Barnthouse, L. W., G. W. Suter II, and A. E. Rosen. 1989. Inferring population-level significance from individual-level effects: an extrapolation from fisheries science to ecotoxicology. In: Aquatic Toxicology and Environmental Fate: 11th Volume (eds., G. W. Suter, II and M. A. Lewis). ASTM STP 1007. American Society for Testing and Materials, Philadelphia, Pennsylvania.

Barnthouse, L. W., G. W. Suter II, and A. E. Rosen. 1990. Risks of toxic contaminants to exploited fish populations: influence of life history, data uncertainty, and exploitation intensity. Environmental Toxicology and Chemistry 9:297-311.

Barnthouse, L. W., G. W. Suter II, A. E. Rosen, and J. J. Beauchamp. 1987. Estimating responses of fish populations to toxic contaminants. Environmental Toxicology and Chemistry 6:811-824.

Bartell, S. M., R. H. Gardner, and R. V. O'Neill. 1988. An integrated fate and effects model for estimation of risk in aquatic systems. In: Aquatic Toxicology and Hazard Assessment: 10th Volume (eds., W. J. Adams, G. A. Chapman, and W. G. Landis). American Society for Testing and Materials, Philadelphia, Pennsylvania.

Bonazountas, M., and J. M. Wagner. 1984. SESOIL - A seasonal soil compartment model. Arthur D. Little Co., Cambridge, Massachusetts.

Bonazountas, M., A. Brecker, and R. G. Vranka. 1988. Mathematical environmental fate modeling. Chapter 5. In: Environmental Inorganic Chemistry, (eds., I. Bodek, W. J. Lyman, W. F. Reehl and D. H. Rosenblatt). Pergamon Press, New York.

Bregman, J. I., and K. M. Mackenthun. 1992. Environmental Impact Statements. Lewis Publishers, Inc., Boea Raton, Florida. 279 pp.

Brown, D. S., and J. D. Allison. 1987. MINTEQAI Equilibrium Metal Speciation Model: A User's Manual. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Brown, D. S., and A. Silver. 1986. Chemical spill exposure assessment. Risk Analysis 6:291-298.

Burns, L. A., D. M. Cline, and R. R. Lassiter. 1981. Exposure Analysis Modeling Systems (EXAMS): User Manual and System Documentation. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Canter, L. W. 1977. Environmental Impact Assessment. McGraw-Hill Book Company, New York. 331 pp.

Carsel, R. F., C. N. Smith, L. A. Mulkey, J. D. Dean, and P. Jowise. 1984. User's Manual for the Pesticide Root Zone Model (PRZM). EPA-600/3-84-109. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Chalmers, J. A., and E. J. Anderson. 1977. Economic-Demographic Assessment Manual: Current Practices, Procedural Recommendations and a Test Case. U.S. Bureau of Reclamation, Denver.

Christensen, S. W., W. Van Winkle, and J. S. Mattice. 1976. Defining and determining the significance of impacts: concepts and methods. In: The Biological Significance of Environmental Impacts (eds., R. K. Sharma, J. D. Buffington, and J. T. McFadden). NCR-CONF-002, U.S. Nuclear Regulatory Commission, Washington, D.C.

Clark, K. E., F.A.P.C. Gobas, and D. Mackay. 1990. Model of organic chemical uptake and clearance by fish from food and water. Environmental Science and Technology 24:1203-1213.

Cohen, Y. 1986. Pollutants in a Multimedia Environment. Plenum Press, New York.

Cohrssen, J. J., and V. T. Covello. 1989. Risk Analysis: A Guide to Principles and Methods for Analyzing Health and Environmental Risks. U.S. Council on Environmental Quality, Executive Office of the President. 407 pp. Available from: The National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. NTIS Order Number PB89-137772.

Connell, D. W. 1989. Bioaccumulation of Xenobiotic Compounds. CRC Press, Boca Raton, Florida.

Dale, V. I., and R. H. Gardner. 1987. Assessing regional impacts of growth declines using a forest succession model. Journal of Environmental Management 24:83-93.

De Jongh, P. 1988. Uncertainty in EIA. In: Environmental Impact Assessment (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Dickson, K. L., A. W. Maki, and J. Cairns (eds.). 1982. Modeling the Fate of Chemicals in the Environment. Ann Arbor Science Publishers, Ann Arbor, Michigan.

Elliot, M. L. 1981. Pulling the pieces together: amalgamation in environmental impact assessment. Environmental Impact Assessment Review 2:11-38.

Emlen, J. M. 1989. Terrestrial population models for ecological risk assessment: a state-of-the-art review. Environmental Toxicology and Chemistry 8:831-842.

Enfield, G. C., R. F. Carsel, S. Z. Cohen, T. Phon, and D. M. Walters. 1982. Approximating pollutant transport to groundwater. Ground Water 20:711-727.

Environmental Resources Limited (ERL). 1984. Prediction in Environmental Impact Assessment. EIA Publication Series No. 17. The Hague: Ministeries of Housing, Physical Planning and Environment and of Agriculture and Fisheries.

Environmental Resources Limited (ERL). 1985. Handling Uncertainty in Predictions. EIA Publication Series No. 19. The Hague: Ministries of Housing, Physical Planning and Environment and of Agriculture and Fisheries.

Farmer, A. 1980. Habitat Evaluation Procedures (HEP). ESM 102. Division of Ecological Sciences, U.S. Fish and Wildlife Service, Washington, D.C.

Farmer, A. 1981. Standards for the Development of Habitat Suitability Index Models. ESM 103. Division of Ecological Sciences, U.S. Fish and Wildlife Service, Washington, D.C.

Fite, E. C., L. W. Turner, N. J. Cook, and C. Stunkard. 1988. Guidance Document for Conducting Terrestrial Field Studies. U.S. Environmental Protection Agency, Washington, D.C.

Gauch, H. G., Jr. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press. New York. 298 pp.

Giddings, J. M. 1986. A microcosm procedure for determining safe levels of chemical exposure in shallow-water communities. In: Community Toxicity Testing (ed. J. Cairns, Jr.). American Society for Testing and Materials. Philadelphia, Pennsylvania.

Gilliland, M. W., and P. G. Risser. 1977. The use of systems diagrams for environmental impact assessment: procedures and an application. Ecological Modeling 3:183-209.

Giroult, E. 1988. WHO interest in environmental health impact assessment. In: Environmental Impact Assessment, Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Goodman, D. 1976. Ecological expertise. In: Boundaries of Analysis, An Enquiry into the Tocks Island Dam Controversy (eds., H. A. Feiveson, F. W. Sinden, and R. H. Socolow). Ballinger, Cambridge, Massachusetts.

Goodyear, C. P. 1972. A simple technique for detecting effects of toxicants or other stresses on a predator-prey interaction. Transactions of the American Fisheries Society 101:367-370.

Green, R. H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley & Sons, New York. 257 pp.

Hall, C. A. S., and J. W. Day. 1977. Ecosystem Modeling in Theory and Practice. John Wiley & Sons, New York.

Harrison, H. L., O. L. Loucks, J. W. Mitchell, D. F. Parkhurst, C. R. Tracy, D. Watts, and V. J. Yannacone, Jr. 1970. Systems studies of DDT transport. Science 170:503-508.

Hetrick, D. M., and L. M. McDowell-Boyer. 1983. User's Manual for TOXSCREEN: A Multimedia Screening-Level Program for Assessing the Potential Fate of Chemicals Released to the Environment. Draft report. Oak Ridge National Laboratory, ORNL/TM-8570, Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency, Washington, D.C. Contract No. W-7405-eng-26.

Hilborn, R., and C. Walters. 1981. Some Pitfalls of Environmental Baseline and Process Studies. Report 3. Cooperative Fisheries Research Unit, University of British Columbia, Vancouver.

Hopkins, L. D. 1977. Methods for generating land suitability maps: a comparative evaluation. Journal of the American Institute of Planners 43:386-400.

Hunsaker, C. T., and R. L. Graham. 1991. Regional ecological assessment for air pollution. In: Air Pollution: Environmental Issues and Health Effects (eds., S. K. Majumdar, E. W. Miller, and J. Cahir). Pennsylvania Academy of Sciences, Easton, Pennsylvania.

Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59.

Jørgensen, S. E. 1991. Environmental management modeling. In: Introduction to Environmental Management (eds., P. E. Hansen and S. E. Jørgensen). Elsevier, New York. 403 pp.

Jørgensen, S. E. 1991. Ecological aspects. In: Introduction to Environmental Management (eds., P. E. Hansen and S. E. Jørgensen). Elsevier, New York. 403 pp.

Jørgensen, S. E. 1988. Fundamentals of Ecological Modeling. Elsevier, New York. 389 pp.

Jørgensen, S. E. (ed.). 1984. Modelling the Fate and Effect of Toxic Substances in the Environment. Elsevier, Amsterdam.

Jury, W. A., W. F. Spencer, and W. J. Farmer. 1983. Behavior assessment model for trace organics in soil. Journal of Environmental Quality 12:558-564.

Kitchell, J. F., D. J. Stewart, and D. Weininger. 1977. Applications of a bioenergetics model to yellow perch (Perca flavescens) and walleye (Stizostedion vitreum vitreum). Journal of the Fisheries Research Board of Canada 34:1922-1935.

Kjeldsen-Kragh. 1991. Environmental economics. In: Introduction to Environmental Management (eds., P. E. Hansen and S. E. Jørgensen). Elsevier, New York. 403 pp.

Klein, W., W. Kordel, A. W. Klein, D. Kuhnen-Clausen, and W. Weiss. 1988. Systematic approach for environmental hazard ranking of new chemicals. Chemosphere 7:1445-1462.

Kooijman, S. A. L. M., and J. A. J. Metz. 1984. On the dynamics of chemically stressed populations: the deduction of population consequences from effects on individuals. Ecotoxocology and Environmental Safety 8:254-274.

Kremer, J. N., and S. W. Nixon. 1978. A Coastal Marine Ecosystem: Simulation and Analysis. Springer-Verlag, New York.

Lassiter, R. R. 1985. Design criteria for an predictive ecological effects modeling system. In: Aquatic Toxicology and Environmental Fate: Ninth Volume, ASTM STP 921, (eds., T. M. Posten and Purdy). American Society for Testing and Materials, Philadelphia.

Lassiter, R. R., and T. G. Hallam. 1990. Survival of the fattest: implications for acute effects of lipophilic chemicals on aquatic populations. Environmental Toxicology and Chemistry 9:585-596.

Lein, J. 1989. An expert system approach to environmental impact assessment. International Journal of Environmental Studies 33:13-27.

Lein, J. K. 1993. Formalizing expert judgment in the environmental impact assessment process. The Environmental Professional 15:95-102.

Leistritz, F. L., S. H. Murdock, and R. C. Coon. 1990. Developing economic-demographic assessment models for substrate areas. Impact Assessment Bulletin 8:49-65.

Leistritz, F. L., and S. H. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Westview Press, Boulder, Colorado. 286 pp.

Leopold, L. B., F. E. Clarke, B. B. Hanshaw, and J. R. Balsley. 1971. A procedure for evaluating environmental impact. Circular 645. U.S. Geological Survey, Washington, D.C.

Limburg, K. E. 1986. PCBs in the Hudson. In: The Hudson River Ecosystem, (eds., K. E. Limburg, M. A. Moran, and W. H. McDowell). Springer-Verlag, New York.

Lipton, J., and J. W. Gillett. 1991. Uncertainty in ocean dumping health risks: influence of bioconcentration, commercial fish landings and seafood consumption. Environmental Toxicology and Chemistry 10:967-976.

Logan, D. T. 1986. Use of size-dependent mortality models to estimate reduction in fish populations resulting from toxicant exposure. Environmental Toxicology and Chemistry 5:769-775.

Mackay, D., and S. Paterson. 1993. Exposure Assessment: Mathematical Models of transport and fate. In: Ecological Risk Assessment (ed. G. W. Suter II). Lewis Publishers, Inc., Chelsea, Michigan.

Mackay, D., S. Paterson, G. Cheung, and W. B. Neely. 1985. Evaluating the environmental behavior of chemicals with a level III fugacity model. Chemosphere 14:335-374.

Mackay, D., 1979. Finding fugacity feasible. Environmental Science and Technology 13:1218-1223.

Mancini, J. L. 1983. A method for calculating effects on aquatic organisms of time varying concentrations. Water Research 17:1355-1362.

McFadden, J. T. 1977. An argument supporting the reality of compensation in fish populations and a plea to let them exercise it. In: Assessing the Effects of Power-Plant-Induced Mortality on Fish Populations (ed., W. Van Winkle). Pergamon, New York.

McHarg, I. 1969. Design with Nature. Natural History, New York.

McKone, T. E., and D. W. Layton. 1986. Screening the potential risks of toxic substances using a multimedia compartment model: estimation of human exposure. Regulatory Toxicology and Pharmacology 6:359-380.

National Research Council. 1986. Ecological Knowledge and Environmental Problem-Solving: Concepts and Case Studies. National Research Council, National Academy Press, Washington, D.C.

O'Neill, R. V., R. H. Gardner, L. W. Barnthouse, G. W. Suter, S. G. Hildebrand, and C. W. Gehrs. 1982. Ecosystem risk analysis: a new methodology. Environmental Toxicology and Chemistry 1:167-177.

Organization for Economic Cooperation and Development (OECD). 1989. Compendium of Environmental Exposure Assessment Methods for Chemicals. Environment Monographs, No. 27, OECD, Paris.

O'Neil, R. V., B. S. Ausmus, D. R. Jackson, R. I. Van Hook, P. Van Voris, C. Washburne, and A. P. Watson. 1977. Monitoring terrestrial ecosystems by analysis of nutrient export. Water, Air, and Soil Pollution 8:271-77.

Perez, K. T., E. W. Davey, N. F. Lackie, G. M. Morrison, P. G. Murphy, A. E. Soper, and D. L. Winslow. 1984. Environmental assessment of a phthalate ester, di(2-ethylhexyl) phthalate (DEHP), derived from a marine microcosm. In: Aquatic Toxicology and Hazard Assessment: Sixth Symposium (eds. W. E. Bishop, R. D. Cardwell, and B. B. Heidolph). American Society for Testing and Materials, Philadelphia, Pennsylvania.

Rasmussen, W. O., R. N. Weisz, P. F. Folliott, and D. R. Carder. 1980. Planning for forest roads — a computer-assisted procedure for selection of alternative corridors. Journal of Environmental Management 11: 94-104.

Rau, J. G., and D. C. Wooten. 1980. Environmental Impact Analysis Handbook. McGraw-Hill Co., New York. 630 pp.

Rice, J. A., J. E. Breck, S. M. Bartell, and J. F. Kitchell. 1983. Evaluating the constraints of temperature, activity and consumption on growth of largemouth bass. Environmental Biology of Fishes 9:263-275.

Roberts, J. R., M. S. Mitchell, M. J. Boddington, and J. M. Ridgeway. 1981. A screen for the relative persistence of lipophilic organic chemicals in aquatic ecosystems -- an analysis of the role of a simple computer model in screening. Part I. Report Number NRCC 18570. National Research Council of Canada, Ottawa, Canada.

Rose, K. A., G. L. Swartzman, A. C. Kindig, and F. B. Taub. 1988. Stepwise iterative calibration of a multi-species phytoplankton-zooplankton simulation model using laboratory data. Ecological Modeling 42:1-32.

Sanderson, W. C. 1978. Economic-Demographic Models: A Review of Their Usefulness for Policy Analysis. Technical Paper 4. Rome, Italy: Food and Agriculture Organization of the United Nations.

Senes Consultants. 1989. Contaminated Soil Cleanup in Canada, Volume 5, Development of the AERIS Model, Final Report prepared for the Decommissioning Steering Committee.

Shugart, H. H., and D. C. West. 1980. Forest succession models. BioScience 30:308-313.

Sigal, L. L., and G. W. Suter II. 1989. Potential effects of chemical agents on terrestrial resources. Environmental Professional 11: 376-384.

Sigal, L. L. and G. W. Suter, II. 1987. Evaluation of methods for determining adverse impacts of air pollution on terrestrial ecosystems. Environmental Management 11:675-694.

Snedecor, G. W., and W. G. Cochran. 1980. Statistical Methods. The Iowa State University Press, Ames, Iowa. 507 pp.

Suter, G. W. II, and L. W. Barnthouse. 1993. Assessment concepts. In: Ecological Risk Assessment (ed. G. W. Suter II). Lewis Publishers, Inc., Chelsea, Michigan.

Suter, G. W. II, and S. M. Bartell. 1993. Ecosystem level. In: Ecological Risk Assessment (ed. G.W. Suter II). Lewis Publishers, Inc., Chelsea, Michigan.

Suter, G. W. II. 1993. Ecological Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 538 pp.

Suter, G. W. II, and F. E. Sharples. 1984. Examination of a proposed test for effects of toxicants on soil microbial processes. In: Toxicity Screening Procedures Using Bacterial Systems (eds. D. Liu and B. J. Butka). Marcel Dekker, New York.

Swartzman, G. L., and S. P. Kaluzny. 1987. Ecological Simulation Primer. MacMillan Publishing, New York.

Thomann, R. V. 1989. Bioaccumulation model of organic chemical distribution in aquatic food chains. Environmental Science and Technology 23:699-707.

Thomann, R. V., and J. P. Conolly. 1984. Model of PCB in the Lake Michigan lake trout food chain. Environmental Science and Technology 18:65-71.

Thomann, R. V. 1972. Systems Analysis and Water Quality Management. McGraw-Hill, New York.

U.S. Environmental Protection Agency (EPA). 1987. Toxic Substances Control Act Test Guidelines; Proposed Rules. Federal Register 52:36334-36371.

U.S. Environmental Protection Agency (EPA). 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001.

U.S. Environmental Protection Agency (EPA). 1993. Habit Evaluation: Guidance for the Review of Environmental Impact Assessment Documents.

U.S. Department of Interior. 1987. Type B technical information documents PB88-100128--PB88-100169. Washington, D.C.

Van Voris, P., D. A. Tolle, and M. F. Arthur. 1985. Experimental Terrestrial Soil-Core Microcosm Test Protocol. EPA 600/3-85-047. National Technical Information Service, Springfield, Virginia.

Walters, C. J. 1986. Adaptive Management of Renewable Resources. Macmillan, New York.

Wathern, P. 1988. An introductory guide to EIA. In: Environmental Impact Assessment, Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston. 332 p.

West, D. C., S. B. McLaughlin, and H. H. Shugart. 1980. Simulated forest response to chronic air pollution stress. Journal of Environmental Quality 9:43-49.

Westman, W. E. 1985. Ecology, Impact Assessment and Environmental Planning. John Wiley & Sons, New York. 532 pp.

ATTACHMENT 4.C

SUMMARY OF FATE MODELS USED IN ENVIRONMENTAL ASSESSMENT

- **Summary of Fate Models used in Environmental Assessment.** (Source: Mackay, D., and S. Paterson. 1993. Exposure assessment: mathematical models of transport and fate. In: Ecological Risk Assessment (ed. G. W. Suter, II). Lewis Publishers, Inc., Chelsea, Michigan)

Summary of Fate Models used in Environmental Assessment. (Source: Mackay, D., and S. Paterson. 1993. Exposure assessment: mathematical models of transport and fate. In: Ecological Risk Assessment (ed. G. W. Suter, II). Lewis Publishers, Inc., Chelsea, Michigan)

This attachment provides a list of some of the models that can be used for exposure estimation. It is not a comprehensive list. The reader should consult Mackay and Paterson (1993) for additional information about this list. Reviews of available models are also found in Cohen (1986), OECD (1989), Dickson et al. (1982), and Jørgensen (1984). See references to Part 4.3 for citations.

- MULTIMEDIA MODELS

  A series of fugacity-based (i.e., fate) models has been developed in the last decade at the University of Toronto by Mackay and co-workers (Mackay, 1979, Mackay and Paterson, 1993, Mackay et al., 1985). They vary in complexity from a simple equilibrium distribution of a conservative chemical, to steady state and time varying descriptions of the fate of reactive compounds. These models are primarily useful for predicting the fate of chemicals in multimedia systems.

  GEOTOX. GEOTOX (McKone and Layton, 1986) is a comprehensive multimedia compartmental model which calculates chemical partitioning, degrading reactions and diffusive and non-diffusive interphase transport. The concentrations estimated for various environmental compartments are subsequently combined with appropriate human inhalation and ingestion rates, and absorption factors to calculate exposure. It treats an environment representative of the South Eastern United States, consisting of the following compartments: air (gas), air (particles), biomass, upper soil, lower soil, groundwater, surface water and sediments.

  Enpart (Environmental Partitioning Model). Enpart (OECD, 1989) is one of a set of models developed by the EPA as a first level screening tool for new and existing organic chemicals of possible concern. It is a fugacity-based model which estimates the steady-state equilibrium or dynamic partitioning of organic chemicals among environmental compartments. It identifies dominant pathways and data gaps and estimates the chemicals' persistence and bioconcentration potential.

  Toxscreen. Toxscreen (Hetrick and McDowell-Boyer, 1983) is a time-dependent multimedia model, developed by the EPA to assess the potential for environmental transport and accumulation of chemicals released to the air, surface

water or soil. It is modular in concept and incorporates intermedia transfer processes. It is intended as a screening tool to assess the human exposure potential of organic chemicals.

Environmental Exposure Potentials (EEP). EEP (Klein et al., 1988) is a fugacity-based equilibrium multi-compartment model used by member states of the European Community to determine exposure potential of new organic chemicals. The methodology is applied to chemicals being imported or produced in quantities of 1 metric ton per year or more.

SIMPLESAL. SIMPLESAL (OECD, 1989) is a spreadsheet-based multimedia fugacity compartmental model which can be used to estimate steady state or time-dependent concentrations of organic compounds as well as heavy metals. It determines dominant environmental pathways and processes for contaminants and was designed for use in The Netherlands as a screening tool to predict results of various scenarios for emission control of new and existing chemicals such as benzene, cadmium, lindane and copper. It considers compartments of air, water, suspended solids, aquatic biota, sediment and soil.

- REMEDIATION MODELS

AERIS. AERIS (Senes Consultants, 1989) is a multimedia risk assessment model that estimates environmental concentrations and subsequently human exposure in the vicinity of contaminated land sites. It is intended for use at sites where redevelopment is being considered. The model is novel in that is runs within a user-friendly expert system programming environment. An "intelligent" preprocessor interrogates the user about the redevelopment scenario to be assessed, assisting the user where necessary, or supplying default values.

- AQUATIC MODELS

Persistence. The persistence model (Roberts et al., 1981; Asher et al., 1985) was developed for the National Research Council of Canada as a screening method to estimate the fate of various organic chemicals but especially pesticides which are released into the aquatic environment. It considers four compartments: water, catch-all (representing suspended solids, invertebrates or other components of water systems excluding fish), sediment, and fish. It calculates both a steady-state or fixed solution and a time-dependent solution. Default environments for the model are a Standard Pond and a Standard Lake simulating a small, eutrophic pond and a deep oligotrophic lake. Removal pathways include photodegradation, volatilization, and hydrolysis in water; biodegradation in fish; and microbial degradation in suspended solids and sediments.

EXAMS - Exposure Analysis Modeling System. EXAMS (Burns et al., 1981) is an interactive mass balance model developed at the EPA Research Laboratory in Athens, Georgia, which predicts the fate of organic contaminants in stratified surface waters as a result of continuous or intermittent releases. It is widely used by EPA and other environmental agencies in the U.S.

EXWAT. EXWAT (OECD, 1989) is a steady state model, developed in Germany, to describe chemical fate in water bodies. It is a simple approach suitable for application to continuous single point sources. It is intended for use as a screening tool to assess comparative hazards of existing chemicals in the Rhine River. It is also a submodel of the multimedia E4CHEM system (Exposure and Ecotoxicity Estimation for Environmental Chemicals), an exposure and hazard assessment model developed in Germany for priority setting within OECD.

Inorganic Chemical Models (e.g., metals and phosphorus). Modeling of inorganic compounds in the aquatic and other environments proves to be more difficult in the sense that the chemical properties and speciation tend to be unique, thus the generalizations which apply to organic chemicals do not usually apply. Bonazauntas et al. (1988) have reviewed fate models for such chemicals.

Speciation Models, e.g., MINTEQAI. MINTEQAI (Brown and Allison, 1987) is an example of an equilibrium metal speciation model applicable to metallic contaminants in surface and groundwaters. It is thus quite different in purpose from the mass balance models discussed earlier. It calculates the equilibrium aqueous speciation, adsorption, gas phase partitioning, solid phase saturation states, and precipitation-dissolution of 11 metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc). It contains an extensive thermodynamic base and is designed to make minimal demands on the user.

- SOIL MODELS

Several models have been developed to describe chemical fate in soils. Notable are SESOIL [a Seasonal Soil Compartment Model, OECD, (1989)], Bonazountas and Wagner (1984), PRZM (Pesticide root zone model) by Carsel et al. (1984), PESTAN (Pesticide Analytical Model) by Enfield et al. (1982), and the "Jury" Model by Jury et al. (1983).

- FISH UPTAKE AND FOOD CHAIN MODELS

Because of the importance of the human exposure route via fish consumption, considerable effort has been devoted to estimating chemical concentrations in fish. Contaminants may enter fish via the gills (bioconcentration) and, especially in the

case of hydrophobic chemicals, by way of food (biomagnification). These pathways are the subject of discussion in recent examples by Thomann (1989), Clark et al. (1990) and the text by Connell (1989).

- ATMOSPHERIC MODELS

Numerous air dispersion models with general or limited geographic applicability have been developed with the objective of deducing ground level concentrations, and hence exposures, from stack emissions. Most texts or handbooks on air pollution contain full descriptions of such models. Models range from simple application of Gaussian dispersion equations to complex, multi-source models containing allowances for depositing particles and topographic features of the terrain. The use of such models is often written into legislation as a means of translating desired ground level concentrations into acceptable stack emission rates.

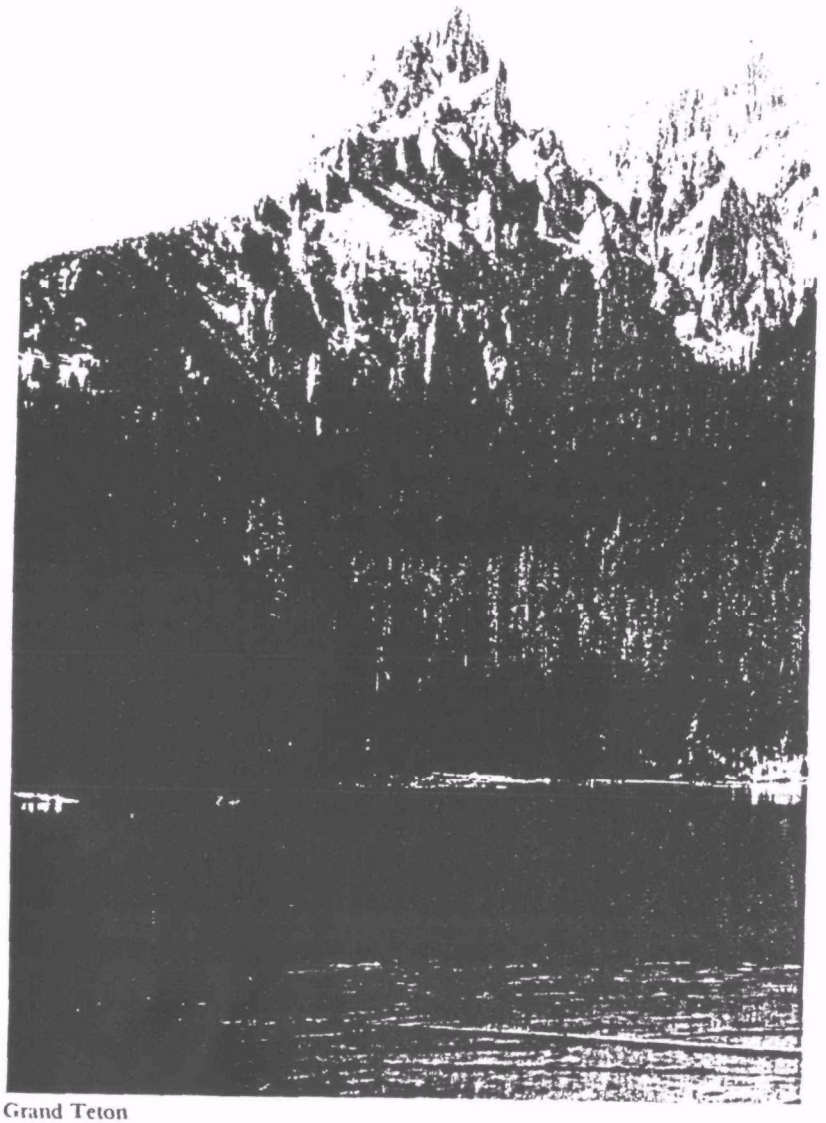
- SPILL MODELS

Several models are available that deduce the fate of chemical spills. These are often used to provide guidance for spill response personnel. An example is the POSSM (PCB On-site Spill Model) described by Brown and Silver (1986). Most regulatory agencies and many industries concerned with the marine environment (e.g., the Coast Guard) have available models which can describe the movement and fate of spills of materials such as oil, when subject to variable winds and currents.

ATTACHMENT 4.D

PROBLEMS ASSOCIATED WITH AMALGAMATION OF DATA

- Elliot, M. L. 1981. Pulling the pieces together: amalgamation in environmental impact assessment. Environmental Impact Assessment Review 2:11-38.



U.S. Dep't. of the Interior

Grand Teton

Pulling the Pieces Together: Amalgamation in Environmental Impact Assessment

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It may seem counterintuitive, but the more effectively environmental impacts are specified, the more difficult the problem of choosing among project or policy options becomes. Impact specification, if done well, should cause decision makers to consider tradeoffs they had not previously considered. The more impacts enumerated in an environmental assessment, the richer the array of tradeoffs. The more obvious the tradeoffs, the more complex the task of evaluation.

To facilitate the evaluation task of the decision maker, environmental analysts have experimented with a wide variety of environmental impact statement (EIS) presentation techniques. The traditional presentation technique of listing all potential impacts is of little use to either decision makers or public interest groups. Many analysts, therefore, have attempted to meet the information needs of the EIS reader by summarizing and by directly comparing policy or project options based on the significance of the impacts.

In the absence of scientific and political consensus about what constitutes a desirable environment, analysts have found this task of *pulling the pieces together* rather difficult. Scientifically, many quali-

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ties of the environment most relevant to public policy are those least amenable to direct measurement, and many changes in qualities that are measurable are not easily predicted. Politically disparate sectors of the community perceive and value the same impacts differently. Taken together, EIS data (particularly forecasts and evaluations) are frequently scientifically inconclusive and value-laden.

EISs, however, can be informative without being completely objective or value-free. To reconcile competing social goals, policy-makers require information that discriminates between policy choices. The simplification of environmental data can be misleading unless it simultaneously clarifies the potential impact of *each* alternative. If an EIS is to reveal rather than obscure the choices available, the assumptions behind the methods of data manipulation must be examined carefully.

This article, then, is about ways of manipulating EIA data—ways that are analytically correct and ways that are faulty. More specifically, the article focuses on how analysts convert disassociated sets of predicted impacts (many of which are difficult to quantify) into comprehensive indices of environmental quality. I am calling this process *amalgamation* because the term best captures the pulling together of many impact variables into a few evaluative indices for presentation in an EIS.

To help us better understand the problems associated with amalgamation, the EIA process used for the Jackson, Wyoming, wastewater treatment plant will be described first. This process is typical of the twenty-one environmental impact assessment processes studied at the Massachusetts Institute of Technology (MIT) last summer,[1] with one important exception: the Jackson EIS is presented in a concise format that employs a comprehensive method for amalgamating and evaluating impacts. The Jackson story is illustrative of how and why amalgamative methods are used, as well as how an EIS fits into the decision-making process. Using the case, we will look at a wide range of amalgamative methods, and conclude with lessons that can be drawn from the discussion.

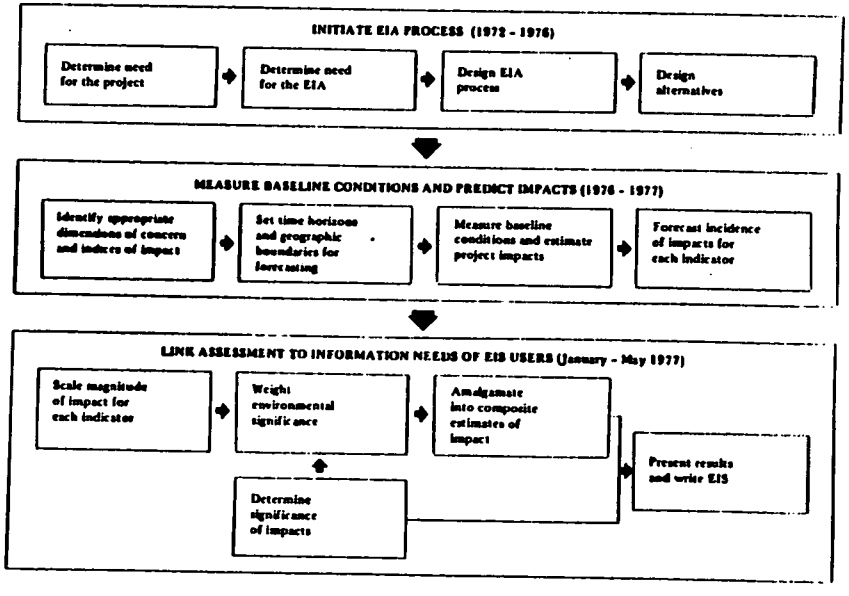
THE JACKSON EIA PROCESS: KEY ANALYTIC PROBLEMS

Jackson is a rapidly growing city in the foothills of the Teton mountain range.[2] The town is largely surrounded by federal land. Since 1972, the town's wastewater treatment plant had been out of compliance with state and federal regulations. The town could only grow south, and so proposed to locate a new plant six miles to the south of the town line, which would accommodate all future private development in the Jackson-South Park area. Simultaneously, Teton County was preparing a comprehensive plan and zoning restrictions, which were expected to severely limit growth in South Park. The county therefore argued that Jackson should upgrade its existing plant to accommodate town growth only.

Because the wastewater treatment plant was to be built with federal moneys on a wildlife preserve, an EIS was required. In addition, the U.S. Environmental Protection Agency (EPA) saw the EIA process as an opportunity to intervene in the dispute. EPA suggested seven alternatives for the treatment of the wastewater. These included two process methods (a mechanical treatment plant and a stabilization pond) at four sites, including Jackson's original proposal for construction of an aerated lagoon in the South Park Elk Feedground. Jackson preferred the feedground site because it would serve all future development by gravity flow, thereby lowering operating and maintenance costs. The state-owned site also preserved the limited tracts of private developable land for other uses. EPA, on the other hand, recognized the severe growth pressure that a sewage treatment plant and interceptor line could create on previously unserviced land and was sympathetic to the county's efforts to manage future growth on the uniquely scenic county land.

In 1976, the EPA Region VIII staff of the Environmental Impact Assessment Branch launched into the EIA process (Fig. 1). While this article focuses on the latter stage of this process, even in the initial stages analysts faced several key problems common to the assessment of large-scale projects.[3] Outer limits of impacts were diffi-

Figure 1. Steps followed in the environmental impact assessment process of the Jackson wastewater treatment plant project.



cult to [redacted] since the project had multiple effects, data on environmental condi[redacted] were not specifically collected for the assessment, and institutional boundaries did not always coincide with the location of impacts. Alternatives had to be generated even though guidelines for selecting appropriate alternatives did not exist. Since environmental conditions change even in the absence of any project, appropriate baseline conditions had to be estimated. Expensive models and measurements were required to precisely and accurately predict the magnitude and distribution of those impacts that could be quantified. EPA and two engineering consulting firms found that the effect of wastewater treatment on water quality and estimates of capital and maintenance costs could be quantified, but that most other impacts could only be qualitatively described.

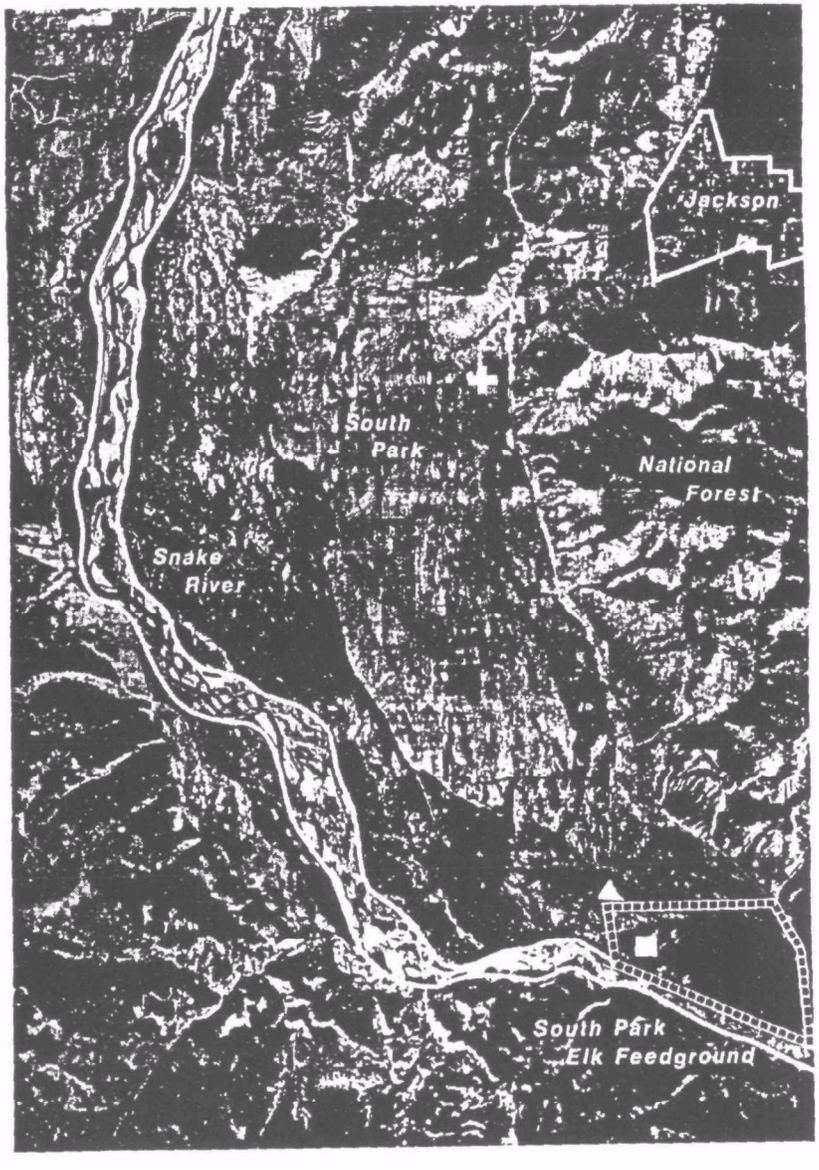
The analysts then entered the final stage of the EIA process, the stage on which this article concentrates. In this stage, the environmental information collected and analyzed is linked with the informational requirements of political decison makers. The analysts knew that the administrator of EPA Region VIII would not wade through disaggregated data on fish saved, elk herds redirected, and growth induced.[4] Tradeoffs among the EIS alternatives would not be obvious if predicted impacts were listed without distinction as to their environmental significance. To focus attention on the most important tradeoffs, predicted impacts (such as changes in dissolved oxygen and turbidity) were *amalgamated* along fewer dimensions of concern (such as water quality), with each impact and dimension of concern being *evaluated* as to its significance.

Environmental analysts such as Eugene Odum of the Institute of Ecology,[5] Charles Solomon of the U.S. Army Engineer Waterways Experiment Station,[6] and Norbert Dee of Battelle Columbus Laboratories[7] have attempted to devise standard methods for amalgamating many impact variables into a few, more comprehensible indices. Other analysts, such as Wes Wilson of EPA in our Jackson case study, have created more individualized methods to be applied to a specific EIA. Each of these methods can be judged in part by its validity and clarity. This article, without discussing all methods, discusses the basis for devising or evaluating an amalgamative method.[8] Before specifically describing the amalgamative method employed in the Jackson EIS, let us first consider the problems with amalgamtion generally.

PROBLEMS IN AMALGAMATION

While amalgamation can greatly assist decision makers and the interested public to better understand tradeoffs, it is open to misleading mathematical manipulations, which can cause problems. In the EIA processes we studied,[9] virtually all EISs were presented without any attempt to amalgamate the hundreds of bits of information, or were amalgamated in a manner that could easily lead to faulty or overly confident conclusions.

Jackson Area of Teton County, Wyoming



✚ Existing Wastewater Treatment Plant Located on Flat Creek
△ South Park Site
□ Elk Feedground Site

Amalgamation is difficult because it requires that the significance of impacts be evaluated. The significance of impacts can be determined only if a common basis for comparing the magnitude of predicted effects can be developed. A common basis for significance in turn presupposes both scientific consensus on theory and political consensus on value. Neither is readily available, particularly when environmental impacts are being compared to the nonenvironmental costs and benefits of the proposed project. Thus, great care must be taken to maintain the original data's uncertainty and diversity when amalgamating data in an EIS.

Amalgamation involves the compression of information. Amalgamation makes data more comprehensible by reducing detail, that is to say, by discarding some information and reorganizing what remains. The result of amalgamation is a summary judgment about how estimated impacts of a project will affect some dimension of environmental quality. Consequently, proper techniques for amalgamation will depend on both how the impacts were first measured and how environmental quality is defined. These are problems of scaling and weighting, of magnitude and significance.

Because environmental quality cannot be directly measured, analysts must rely on indicators of environmental quality that can be measured or estimated. Each measure, however, is tailored to the indicator in question. Consider the Jackson example. The EPA analysts estimated flood damages and capital construction in dollars, BOD and phosphorus load in milligrams per liter, the elks' wintering habitat and agricultural land in acres, and growth pressures in "significance" of effect. How can Jackson's Elk Feedground stabilization pond proposal be compared to the alternative that upgrades the existing wastewater treatment plant? How can dollars and milligrams be compared to acres and unquantified "pressures" when a hundred indicators and measurements must be considered?

Proper amalgamation of several impact indicators into one dimension of concern requires consideration of both magnitude (scaling) and significance (weighting). The magnitude of an impact is the measured or predicted change in the environment. The effect of Jackson's wastewater treatment plant on dissolved oxygen (DO), for example, can in principle be estimated with some degree of certainty. The magnitude of changes in DO for each alternative can be directly compared. On the other hand, magnitudes of DO and phosphorus cannot be directly compared or aggregated. To aggregate DO and phosphorous into a single dimension of concern (water quality), a common *scale of magnitude* must be applied to each impact variable and a *model of significance* must be used to *weight* the relative importance of each variable. Only then can the magnitudes of the two variables be combined. Thus, the analyst must consider issues of both scaling and significance in any process of amalgamation that starts with more than one impact variable. These issues are not easily

resolved since great uncertainty remains within the environmental sciences, and public interests frequently disagree on definitions of environmental quality.

SCALING THE MAGNITUDE OF IMPACTS

Scaling is based on the *levels* of measurement used to predict the magnitude of each variable. There are four levels of measurement: nominal, ordinal, interval, and ratio. Nominal measurements offer the least precise information and ratio the most precise. Amalgamation is valid only if the new composite scale is no more precise than the least detailed data scale. Rescaling data using inappropriate mathematical functions or assigning nominal scaled data to ordinal or ratio scaled dimensions of concern may lead to significant errors in amalgamation.

Nominal Scales

The least flexible level of measurement, the nominal scale, assigns data into categories. For example, the Jackson EIS categorizes land use into residential, agricultural, wildlife, and commercial zones. Nominal data can be reclassified into other nominal scales, but no mathematical operation can be performed. Nominal data can also be assigned to ordinal scales if the desirability of each category can be rated or ranked. If preferences among categories cannot be determined, the nominal data cannot be compared.

Nominal scales require the least amount of quantification and measurement and hence are used to classify variables that are difficult to quantify. EISs are filled with lists of varieties of wildlife, yet rarely provide bird counts, nor indicate preferences for trumpeter swans over peregrine falcons. Likewise, changes in land use, displacement of archaeological sites, rare and endangered species, natural hazards, and many cultural and political patterns are either listed or classified, but not quantified.

Nominally scaled data can only be amalgamated by combining precise classifications of bald eagles and snail darters into composite classes of birds and fish. Consequently, nominally-scaled impacts are frequently dropped from amalgamations. An inherent bias is introduced when unquantified or imprecisely quantified data is overlooked. Summaries that highlight unquantified data can usefully accompany presentations of more quantified amalgamation techniques.

Figure 2 shows an informational display technique used in several EISs to summarize nominal data. The display technique combines verbal descriptions with analytic quantifications and allows all forms of data to be summarized in one table. Obviously, as the number of variables and alternatives increases, these tables can become very complex (see Fig. 4). In addition, comments are needed to communicate the potential significance of each variable. Despite its

Figure

An example of information organization used in the Haverhill, Massachusetts, Resource Recovery Plant EIS. The original chart included three additional alternatives. The information is presented inconsistently. Biological impacts are ranked, noise impacts are rated, air quality is described, and economic impacts are quantified. How do all these impacts relate to each other? Certainly more consistency was possible, and a comment column could have related the significance of each impact group to the other impacts. (From M. Schippereit, E. Williams, and H. Yaffee, "Site Evaluation for the Northeast Massachusetts Resource Recovery Project," MITRE Corporation, August 1977.)

	#1 Lowell	#3 Methuen	#6 Newburyport
Steam Markets			Bixby Int'l. Starensier Inc.
Air Quality	Surrounded by residential areas. Impact would be in Downtown Lowell given the prevailing westerly winds. Acceptable, but a relatively poor choice.	Near Lawrence but should not impact significantly on the City due to the prevailing winds. Near the N.H. border, but will have little impact in N.H. for the same reason. Also, residential area adjacent to site.	Impact would be in Newburyport population center, east and generally downwind of the site. Air quality in the area is good and should not be downgraded. Acceptable, but a relatively poor choice.
Noise Impacts Noise, DEQE	Moderate Impact	Minor Impact	Minor Impact
Water/Wetlands/ Hydrogeology (Wetlands, DEQE) (Water Pollution Control, DEQE) (Water Resources)	[Potential Involvement with Wetlands. Prot. Act Small] (No Problems) (#6 - Lagoon Requires Draining)	[Potential Involvement Small] (Drainage Would Apparently Recharge Wetlands or Go to Spickett River) (#1 - Moderately Favorable)	[————] (Least Favorable) (#6 - Salinity)
Biological Impacts Fisheries & Wildlife	#1 - Acceptable	#2 - Acceptable	#7 - Least Acceptable
Socio-Economic Impacts	Full Value Savings = $1.70 Unemployment Rate = 6.6%	Full Value Savings = $2.80 Unemployment Rate = 7.9%	Full Value Savings = $6.90 Unemployment Rate = 8.0%

someness, tabular formats are one of the few vehicles available for summary presentations of nominally scaled data. The ability to highlight key ideas and to keep the table short and neat makes the summary more useful to decision makers.

Ordinal Scales

Ordinal, or discrete, scales are comparative: one alternative's impacts are judged to be significant or insignificant, or to be greater than, equal to, or less than those of other alternatives. The Jackson EIS, for example, found that the Elk Feedground location would be a more significant catalyst to growth than other alternatives. The EIS did not precisely quantify the additional growth by forecasting numbers of new homes or loss of agricultural land.

Ordinal data are not measures of absolute magnitude, only relative magnitude. In the absence of a standard scale with known intervals and a common zero-point, analysts are likely to assign different scores to the same conditions. Even if analysts could reliably assign the same score, a rating of "excellent" or "very significant" is not a specific amount better than "satisfactory"—neither is a ranking of first over a ranking of second or third. The summation of ordinally scaled data is therefore arbitrary because different scales will lead to different summary points as shown in Figure 3. Algebraic operations such as addition are therefore invalid. Unfortunately, however, EIA analysts frequently summarize ordinal data by adding the rankings.

Impacts can be scaled ordinally using either rankings or ratings. To order alternatives relative to the impact of other alternatives—by labeling them first, second, beter or worse—is to *rank* those alternatives. To order alternatives relative to a scale of significance that is independent of other alternatives being considered—deducing whether an impact is slight or very serious—is to *rate* those alternatives. Rankings are generally poor amalgamation techniques. Unless one alternative clearly dominates other options, rankings (such as those used in Fig. 3) provide little information about the seriousness of impacts or the tradeoffs needed to make a decision. On the other hand, ratings incorporate the analyst's judgment about the significance of effects and present the decision maker with a greater understanding of the tradeoffs. Ratings are generally preferable to rankings.

The most frequently used approach to amalgamating ordinal data is the frequency distribution. Statements such as "85 percent of Florida residents prefer visits to Disney World over visits to the Everglades" are easy to grasp. However, the amount of information they provide is limited, and amalgamation beyond frequency distributions is difficult.

Caution must be used in assessing whether an impact is being scaled ordinally. Paired comparisons are an obvious variation of ranking techniques (and hence cannot be added together), yet EIS preparers have amalgamated paired comparisons into overall rankings.[10] A more subtle misuse of ordinal data can be found in the McHarg map overlay technique.[11]

Visual displays have been developed to array ordinal data, as is shown in Figure 4. These displays, while rich in detail, are difficult to comprehend. Small geometric shapes swim in and out of the reader's

focus. Simpler presentations, such as shown in Figures 2 and 8, are easier to read because they summarize information at a less detailed level. The proper choice of detail will of course vary among impact assessments, but in general an overly difficult table only creates confusion. If a table contains complex, detailed information, the preparers should consider breaking the table into several charts and highlighting important impacts with comments.

Figure 3. Summary chart from the New York Southern Tier Expressway EIS. The original chart compared eleven alternatives by ranking each alternative within each problem and impact area, and then adding the ranks for a total score. These ranks and scores are shown for four alternatives as the numbers outside the parentheses. Consider what would happen if we used this scoring method to rank only these four alternatives. The results of the new ranking are shown in bold type within the parentheses. We note that concept 6 now ranks behind concept 10 and that concept 2 ranks behind concept 9. Why did this happen? Also note that environmental impacts is only one of seven classes of problems and impacts. Concept 6, which ranked first out of eleven alternatives, ranked tenth in environmental impacts. In poker a chart like this would be called a stacked deck. (Department of Transportation, Federal Highway Administration, *Southern Tier Expressway Study*, Albany, New York, September 1977.)

	Concept 2	Concept 6	Concept 9	Concept 10
	Improve all rail services	Completion of Southern Tier Expressway	Increased bus services	Industrial development programs
PROBLEMS:				
Improve depressed economy	6 (5)*	1 (1)	10 (4)	4 (2)
Improved depressed employment and income	7 (5)	2 (2)	9 (4)	1 (1)
Improve community services	10 (4)	4 (2)	8 (3)	2 (1)
Improve travel safety	8 (5)	5 (1)	7 (2)	10 (4)
IMPACTS:				
Economic	5 (3)	1 (1)	10 (4)	4 (2)
Social	5 (3)	6 (4)	3 (2)	1 (1)
Environmental	3 (2)	10 (4)	1 (1)	9 (3)
TOTAL PROBLEMS AND IMPACTS	44 (21)	27 (15)	48 (20)	31 (14)
RANK	6th (4th)	1st (2nd)	10th(3rd)	4th (1st)

* Light numbers score all eleven original alternatives. Bold numbers rescore four of the alternatives.

Figure 4. Summary chart from the United Kingdom North West Water Authority Regional Water Resource Studies report. The three alternatives displayed here are examples of the fifteen contained in the original. Summary charts of this complexity provide little understandable information for decision makers and the public. (North West Regional Water Resources Studies, *Environmental Appraisal of Four Water Resource Schemes*, Report of the Environmental Impact Study, United Kingdom, November 1978.)

Scheme Reservoir Area, Depth, Length, Breadth, Vol. / Intakes and Aqueducts / Regulated River Abstraction	Environmental Issues						
	Ecology	Landscape	Agriculture	Recreation	Transport	Local Economy	Community
Borrowbeck 210 Ha 61 m 5.6 km 10 km 65,000 ml	■▼	■▼	●▼	■▼▲	●/▼	●▼	
Low Borrowbridge: Brigflatts pipeline/tunnel	⊖▼	○▼	○▼				⊖▼
Lune below Low Borrowbridge/Halton	■/▼			●/▼			
Hellifield 640 ha 19 m 7.2 km 1.8 km 90,000 ml	●▲▼	■▲▼	■▼	■▲▼	□▼	■▲▼	■▼
None: Direct Impoundment				■▼			
Ribble below Hellifield/Minton or Sambrebury	■▼	■▼	●▼	●/▼			
New Dam 460 ha 75 m 7.1 km 1.5 km 140,000 ml	■▼	■▼	●▼	○▼	○▼	●▲▼	■▼
Low Borrowbridge - tunnel; Brigflatts - pipeline/tunnel	○▼	○▼	○▼				○▼
Lune - below Low Borrowbridge/Halton	■/▼			●/▼			

■ Strategic long term irreversible
□ Strategic long term reversible
● Local long term irreversible
⊖ Local long term reversible
○ Short term reversible
▲ Beneficial
▼ Adverse
? Area of uncertain impact

Interval and Ratio Scales

Interval, or continuous, scales are quantitative. Intervals between units of measurement are constant. Ten exceeds nine exactly as much as two exceeds one. However, the zero point is arbitrary. Measurements of the dissolved oxygen deficit of Jackson's Flat Creek is an example of an interval scale. While at any point in time an assessor can estimate the deficit, to do so he or she must arbitrarily select a point of zero deficit. The zero point depends on the aquatic life, mechanical features, and temperature of the stream. A deficit of two is not twice as big as a deficit of one, since by redefining the zero point the two and one may be transformed into a five and four. Only mathematical operations that do not affect the relative differences between units can be employed. division or multiplication by a constant, addition, subtraction, integration, and differentiation fulfill this require

ratio scales are also quantitative. In addition to constant intervals between units, ratio scales also have nonarbitrary zero points. The total amount of phosphorus released into Flat Creek is a ratio-scaled measurement. The zero point is fixed at the point of no release. All mathematical operations, including multiplication by a variable, power functions, and log transformations, are analytically justifiable in ratio scales.

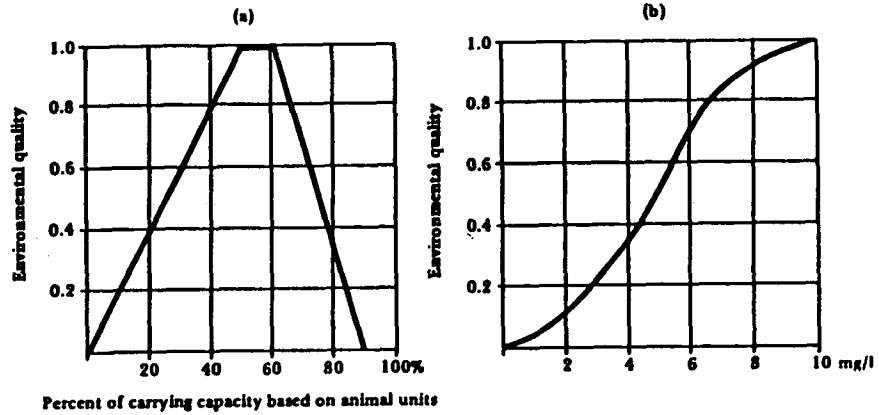
Analysts typically quantify a number of environmental conditions using interval and ratio scales; water and air quality indicators, project costs, and engineering data are common examples. Each indicator quantifies the *magnitude*, not the *significance*, of impact. Attributes are measured along interval or ratio scales that are tailored to each impact. For example, area can be measured in square miles, hectares, or acres. Two different attributes cannot therefore be amalgamated by simple addition. Addition would allow a characteristic measured in large absolute numbers (e.g., square miles) to dominate the comparison and would be arbitrary since a simple linear rescaling of the units (from square miles to acres) could reverse the apparent comparative value of two alternatives. Amalgamation requires the creation of a *common* scale, a scale consistent with judgments about the relative significance of the variables and along which both attributes can be measured.

Two approaches to the unequal interval problem have been developed by environmental analysts:[12] standardized proportions and quality scaling. Proportions are calculated using a standard level selected by the analyst. The standard can be a target level (possibly established by environmental regulations) or the highest value of each dimension that is forecasted among the alternatives. The latter is not a reliable method since the inclusion of a new alternative can change the rank order of the original alternatives. Without theory to set target levels, the standardized proportion method is arbitrary.[13]

To create standardized proportions, the value of each forecast is divided by the standard level. The Oak Ridge Air Quality Index (ORAQI), for example, amalgamates forecasts of the concentrations of five air pollutants by converting each of them to proportions of federal standards, adding the five scores, and then rescaling the resulting index to range between ten for "unpolluted" and a hundred for "completely polluted" air.[14] The standardized proportions method assumes that environmental quality decreases linearly as impacts increase. The assumption is questionable since many environmental impacts have threshold or synergistic effects.

Impacts can also be standardized using a postulated quality scale. The Battelle environmental evaluation system for water-resource development uses this procedure.[15] Each dimension is calculated and converted into a rating, which varies from zero (poor environmental quality) to one (good environmental quality). As shown in Figure 5, the value of the rating may vary nonlinearly or

Figure 5. Examples of environmental value functions from the Battelle environmental evaluation system: (a) terrestrial carrying capacity for browsers and grazers; (b) dissolved oxygen, assuming 9 mg/l as saturation. How would you evaluate these functions? Consider the discussion of dissolved oxygen in the section titled Preferences. (N. Dee et al., *Environmental Evaluation System for Water Resource Planning*, Final report prepared by Battelle-Columbus for the Bureau of Reclamation, January 31, 1972.)



nonmonotonically relative to observed measures. The impact of an action on the quality of the environment is measured as the change in the score along each dimension before and after the decision.

These standardized methods of rescaling introduce specific notions of "goodness." The ORAQI index is set against external targets. Battelle standardizes a measure of quality against which the impacts are scored. Notions of "goodness" cannot be determined solely from scales of magnitude. They emerge from explicit (or implicit) judgments about the significance of a variable. Combining several variables into a common dimension of concern requires not only careful scaling of magnitudes (as discussed in this section) but also careful estimation of significance.

EVALUATING THE SIGNIFICANCE OF IMPACTS

Preferences

The amalgamation of impacts produces an overall ranking of *preference*, not a composite measure of *impact*. This distinction is important. Amalgamation of several impact variables into a common index involves judgments about the relative importance of each variable.

These judgments, once injected into the EIA process, are indicative of a preference for specific qualities of the environment.

Consider the following example. Dissolved oxygen (DO) is an important indicator of water quality. Yet, not all groups equally prefer the qualities that a high DO level indicates.[16] While complete oxygen depletion creates a lake unfit for either fish or humans, high levels of DO do not necessarily make the water more inviting. Ecologists may be equally concerned with nutrient levels that could create algal blooms when DO is increased. Swimmers will equally avoid disease-carrying organisms, toxic chemicals, and turbidity. Boaters are concerned with visual and olefactory qualities of water and with material floating on the surface. Industrial users actually prefer a low DO level because pipes rust in the presence of oxygen. Thus, many indicators may be used to measure water quality and each is likely to be important to different groups. Environmental impacts can be scientifically estimated against some standard of quality, but a standard of quality cannot be set except as a function of what individuals or groups prefer or value.

Preferences also depend on risk. The evaluation of significance is therefore complicated by the environmental analyst's frequent inability to prove causal relationships or accurately estimate changes in baseline conditions. The greater or more uncertain a risk, the more significant an impact may be evaluated. Unfortunately, few assessment techniques are explicit about risk and uncertainty.

Formal techniques for determining the relative significance of probable environmental impacts must be logically consistent with the types of scales along which the impacts are measured. Different techniques can be used to incorporate judgments about significance into nominal, ordinal, interval, and ratio scales. Because, as we have seen, some mathematical operations are valid only for interval or ratio scaled data, techniques applicable to ratio scales are not necessarily applicable to nominal scales and vice versa. In the EIA process, techniques for determining significance generally fall into the two categories of screening and weighting methods.

Screening

Screening consists of "knocking out" alternatives that exceed a preset level of impact along a particular dimension. The preset level may be derived from a legal standard or from an analysis of the political realities in a given situation. For example, an oil refinery site that threatens an endangered species of bird might immediately be eliminated no matter how attractive other aspects of the site were. Exclusionary screening is inexpensive and requires relatively simple data.

Nominal scales can be used for screening purposes. If dimensions of impact can be ordered by significance, alternatives can be screened by the most important dimension first, the next most important second, and so on until the number of alternatives has been narrowed.[17] Thus, we may exclude from consideration all sites that are located in marshlands or in residential zones. Ordinally scaled data can also be evaluated using screening methods. Project or policy objectives can be arrayed in order of significance. Options are then rated against each objective. The results of such evaluations can be displayed in a matrix such as is shown in Figure 6. Alternatives can then be compared to each other, although not against an objective standard. A set of noninferior options can be selectd by retaining alternatives that dominate other alternatives across all dimensions.

Figure 6. Summary table in site screening used in the TAPCO LNG Plant and Pipeline EIS. Fourteen sites were evaluated on this chart. All but three received a "very poor" in at least one factor and were screened out by this criterion. Screening can oversimplify the decision making process. Option 12c is equal to or superior to 4a and 12b in all but one impact area, yet this option was screened out while the others were retained. A more reliable but less discerning method of screening is by dominance. Option 1 could be eliminated since in no impact area is it better than option 2a. (Tenneco Atlantic Pipeline Company et al., *Draft Environmental Impact Statement for the TAPCO Project*, U.S. Federal Power Commission, 1977.)

Impact Area	Screening Criteria	1 St. John Bay of Fundy, Canada	2a Orom Island, Machias Bay	4a Sears Island, Penobscot Bay	12b Quonset Point-Davisville, Narragansett Bay	12c Melville, Narragansett Bay
Disruption to Other Land Uses	Size of site Nature of adjacent uses Location of major recreational areas	○	○	○	●	●
Disruption to Other Shipping Activities	Ship traffic	○	○	◑	◑	◑
Presence of Factors Affecting Safety	Shipping accidents Channel and berth depths Channel width Length of approach channel Configuration of channel Hazards of obstructions Ship traffic volume	◔	○	◔	◑	◔
	Accidents at land facility Seismic conditions Exposure to storm tides and floods	◔	○	◑	●	◔
Consequences of Accidents	Population density Proximity of incompatible facilities	◔	○	◑	●	◑
Presence of Factors Affecting System Outage	Exposure to waves Exposure to winds Visibility conditions	◕	◔	◔	◔	○
Environmental Impact	Critical environmental areas Pipeline construction distance	●	●	●	◑	◑
Economic Cost	Dredging volume Pipeline construction distance Ship transit time Ship to tank distance	●	●	●	◑	◔

Key

○ Excellent
◔ Good
◑ Fair
◕ Poor
● Very poor

ening can be used to eliminate obviously unacceptable alternatives, but it should be used with care. Screening can easily oversimplify reality. Nominal scales assume homogeneity within categories and step-function differences between categories. Important differences, however, could be hidden within categories. Moreover, statistical uncertainties that surround environmental analysis and possibilities of mitigating impacts by altering project designs can make the distinction between screened and unscreened alternatives dubious. Figure 6 demonstrates the problems of oversimplification more fully.

In general, it is best to remove only those alternatives dominated by other alternatives unless there is sufficient reason to act otherwise. Screening should not be used as a presentation device when the unscreened alternatives will not be further analyzed. Such screening unnecessarily simplifies the alternatives presented to the decision maker and to the public.

Weighting

Amalgamation of several variables into a composite dimension of concern is a common EIS presentation technique. Amalgamation requires judgments about the relative weight (or significance) of each variable's contribution to the dimension of concern. Weights are not necessarily quantitative; ordinal comments such as "variable A is the most important factor to consider in evaluating the alternatives" also weight the significance of impacts. However, weights cannot be used in amalgamation unless they are quantitative since amalgamation requires the mathematical manipulation of data. In like manner, the impact factors being weighted must also be quantitative (that is, interval or ratio scaled).

The most commonly developed evaluation systems are based on weighting-summation models. These models take the general form of

$$U(F) = \sum_{i=1}^{n} w_i f_i$$

where

- $U(F)$ = desirability or utility, either along a composite dimension of concern (such as water quality) or along an overall index of environmental quality,
- w_i = the i^{th} weight, and
- f_i = the i^{th} impact factor.

Because the EIA process rarely produces ratio scaled data, several restrictions apply to the weighting-summation model. Interval scaled variables cannot be multiplied by a second variable. Such multiplications are unreliable since by moving the arbitrary zero point of the interval scale, the rank of alternatives can be changed. Models of interaction and nonlinearities require multiplication of two variables and are therefore invalid for interval scaled data. Ecological and preference interaction models cannot be incorporated, nor can nonlinear risk aversion models. Since environmental preferences are frequently the product of interacting factors, and decison makers are rarely risk neutral, the linearity assumption is usually invalid.

Along the same line of reasoning, the weights must always be ratio scaled. Weights are multiplied by variable impact scores and are unreliable if scaled with an arbitrary zero point. Yet few methods for determining significance are careful about setting the zero point. Nonarbitrary zero points of desirability are created by answering the question: "Is the ratio of points X and Y a correct indicator of the ratio of desirability of those two factors?" More concretely, "Do I really prefer a factor scored at four twice as much as another factor (or alternative) scored at two?"

Despite the logical difficulties associated with the weighting summation model, methods based on this model are often used in amalgamation. The weighting of impacts usually proceeds as a variant of the process shown. The magnitude of variables is standardized, the significance of variables is weighted, the two are multiplied, and all products are added to produce a composite index. The resulting index is *not* an impact magnitude; it has no independent value and can only be used to compare different alternatives similarly indexed. Absolute differences between alternatives are lost in the index.

This reduction of absolute data to a relative index may not help decision makers who must later incorporate nonenvironmental factors into their decisions. Nonenvironmental data will not be similarly indexed, and cannot be easily compared. Tradeoffs once incorporated into a weighted-summation analysis may be difficult to trace. Neither decision makers nor the public may be aware of the consequences of particular weights. Furthermore, significance, as a measure of preference, can only be determined from the viewpoint of a particular class of people. In the absence of social theories for analytically combining different viewpoints, amalgamation across groups is not possible. Amalgamation across viewpoints is a political problem. Therefore, to amalgamate only into dimensions of concern (such as air or water quality) is generally preferable. Where differences of preference exist within a dimension of concern, an analysis of the sensitivity of the index to different assumptions should be provided.

There are a number of methods for selecting weights, some more theoretically valid than others. Ranking and rating are the least precise of these methods; decision analysis is among the most precise. The methods fall into two categories: client explicated methods that query various groups about what they value, and observer derived methods that use multiple regressions of observed behavior to calculate weights. Hobbs and Voelker provide an excellent review of these weighting schemes.[18]

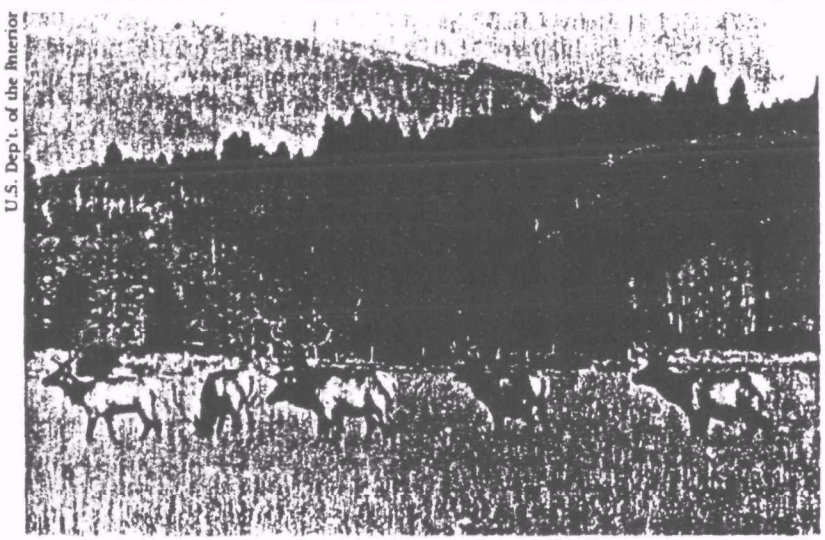
THE JACKSON WASTEWATER TREATMENT PLANT REVISITED

The environmental analysts who produced the Jackson EIS approached the problem of presentation with care. Most importantly, they wrote a clear, concise draft EIS of two hundred pages. But the EPA project manager felt that an explicit comparison of the alternatives was needed to convince the EPA Regional Administrator to reject the town's proposal.[19] The evaluation matrix and rating system shown in Figures 7a and 7b were therefore included in the draft EIS. The matrix is both a professional judgment about potential impacts and a politically motivated summary statement about preferred alternatives. The draft EIS was designed to assist EPA in the partisan debate between Jackson and Teton County. The evaluation matrix, while a creative attempt to deal with the problem of amalgamation, underlines the difficulties of this operation. Before moving to the next section, take a few minutes to examine the matrix in Figure 7a. Can you see what the difficulties are?

Problems with the EIA Matrix

Perhaps as you examined the matrix you noticed that mathematical operations are used incorrectly. The rating system and the weights are treated as if they are interval scales. The mathematical operations of addition and multiplication are employed. However, scales that assign variables into minor, significant, or major impact classes are ordinal, not interval. The addition or multiplication of ordinal data is misleading. A single impact that results in major long-term and extensive adverse damage is likely to be more significant than five minor adverse impacts over limited areas. Yet both will yield ratings of five when added.

Of equal importance, the matrix is dominated by EPA's opposition to growth in rural South Park. The lowest scores were invariably given to options that opened the most land to development. Jackson's proposal received the lowest scores becaue the Elk Feedground site would induce the most growth. The impacts of urbanization are repeatedly incorporated into the matrix as separate impact areas; induced development cost, loss of agricultural productivity, regulatory/legal, aesthetic values, adherence to the planning process, growth inducement, and growth regulation are all alternative concepts for the same urbanization effects. These seven impact areas account for one-third of the impact variables and approximately two-thirds of the points scored negatively by the proposal. By repeatedly incorporating these variables and scoring them as they did, the EPA analysts were showing their clear displeasure with the possible urbanization of South Park. The town council of Jackson, on the other hand, felt that a desirable South Park environment was an urban environment. Clearly this conflict of *values* is buried in the EIS evaluation matrix.



U.S. Dep't. of the Interior

The terrain of South Park and the Elk Feedground is open, flat rangeland. In the early 1970s, the county government sought to preserve the agricultural and wildlife character of the area, while the town council favored its development.

Aftermath of the Jackson Draft EIS

In July 1977, three months after the EIS draft was released, Jackson's town council announced its approval of a new South Park site for the wastewater treatment plant—on private lands immediately north of the Elk Feedground and the former site. The EPA matrix (see South Park Road option shown in Fig. 7a) shows this site to be the second to worst alternative. The council majority gave little consideration to alternatives suggested in the Draft EIS. The council wanted the plant constructed as far south as possible to serve future development in South Park by gravity flow interceptor lines.[20]

Four options, which according to the Draft EIS were the second, third, fourth, and fifth best alternatives, were eliminated from further consideration. The expansion of the existing plant alternative (scoring best in the EIS and preferred by EPA and the county) and the southern South Park alternative (scoring sixth in the EIS and preferred by the town council) received continued attention. During the summer of 1977, EPA Region VIII staff became increasingly aware of Jackson's commitment to urbanization. Early efforts by EPA project officer Wes Wilson failed to open discussion; town officials considered Wilson biased toward the county's preservationist position.

EPA's role in the dispute changed markedly with the Se[illegible]ber 1977 appointment of Alan Merson as Regional Administrator [illegible]PA

Figure

A simplified version of the Jackson EIS Environmental Evaluation Matrix. The original matrix included evaluations of four alternatives not shown in this figure. (U.S. Environmental Protection Agency, Region VIII, *Draft Environmental Impact Statement, Jackson Wastewater Treatment System, Town of Jackson, Wyoming*, Denver, Colorado, May 1977.)

	Elk Feedground Site	Expand Existing Site	South Park Road Site	No Action	Weighting Factor
NATURAL ENVIRONMENTAL VALUES					
Air Quality (localized)	1/0/1	3/-1/1	-1/-2/-1	0/-2/-2	1
Water Quality (surface)	3/3/-2	3/6/-1	3/3/-2	3/-9/-1	3
Water Quality (ground)	0/4/-2	0/2/-1	0/4/-1	0/-4/-2	2
Wildlife	-3/-10/-2	0/0/0	-1/-4/-1	0/0/0	2
Fisheries	1/0/-1	1/4/1	1/0/-1	-1/-4/-1	2
Vegetation and Habitat	1/-6/-2	0/0/0	0/-4/-1	0/0/0	2
Rare and Endangered Species	1/-1/0	0/0/0	0/0/0	0/0/0	1
Natural Hazards	1/-3/-2	1/-1/0	0/-2/-2	0/0/0	1
TOTAL	-13	10	-5	-19	
ECONOMIC VALUES					
Local Capital Cost	2/-4/0	-1/-2/0	-1/-4/0	0/-6/-3	2
O & M Cost	1/-2/0	-1/-6/0	-1/-2/0	0/0/0	2
Induced Development Costs	0/-6/-3	0/-2/-1	0/-6/-3	0/0/0	2
Individual Cost	-1/-2/0	-1/-2/0	-1/-2/0	0/-6/-3	2
Loss of Ag. Productivity	0/-6/-3	0/0/0	-1/-6/-3	0/0/0	2
TOTAL	-22	-12	-22	-12	
SOCIAL-CULTURAL VALUES					
Historic-Archaeological	-1/-3/-2	0/-1/-1	-1/-3/-2	0/0/0	1
Public Acceptability	-3/-3/-4	-1/-1/0	-1/-2/-1	-2/-4/-2	1
Regulatory/Legal	-1/-6/-2	1/4/1	-1/-2/-1	-2/-6/-4	2
Cultural Pattern (life style)	0/-4/-3	0/2/1	0/-4/-3	-1/-2/0	2
Aesthetics Values	-1/-6/-2	1/0/1	0/-4/-3	-2/-4/0	2
Recreational Values	-1/-2/-1	1/1/0	1/0/-1	0/-1/-1	1
TOTAL	-24	6	-16	-17	
LAND USE PLANNING VALUES					
Adherence to the Planning Proc.	0/-6/-3	0/6/3	0/-6/-3	0/-6/-3	2
Growth Inducement	0/-6/-3	0/6/3	0/-6/-3	0/0/0	2
Growth Regulation	0/-6/-3	0/6/3	0/-6/-3	0/-1/-1	2
TOTAL	-18	18	-18	-7	

Figure 7b. The ordinal rating system used in the Jackson EIS.

±5	Major long term, extensive effect.
±4	Major effect, but characterized as either short term or of limited extent.
±3	Significant effect; either long term covering a limited area, or short term covering an extensive area.
±2	Minor effect, but of a long term or extensive nature.
±1	Minor effect over a limited area.
0	No effect.

To construct the evaluation matrix, impact variables were scaled into dimensions of concern using the rating system shown in 7b. The system was developed by EPA and their consultants and is based on an ordinal scale. What does this imply for amalgamation? The ratings were judgments of significance produced by the analysts. Primary and secondary impacts were rated for each environmental impact variable. The evaluation matrix presented in 7a shows these ratings in the upper and lower corner of each box. The grey box shown in 7a indicates a primary impact of -3 and a secondary impact of -2. The relative importance of the environmental impact variable to the decision-making process is weighted from 1 (little significance) to 3 (extraordinary signifance) in the last column. The weight for "wildlife" is 2. The weighting factor is multiplied by the sum of the primary and secondary impacts to produce a weighted score for each alternative. Thus, the grey box shows us that the proposed Elk Feedground Site received a Wildlife score of -10 because 2[(-2)+(-3)] equals -10. The specific impact categories (i.e., wildlife) are then added to produce a sum for the general value category (i.e., natural environmental values). These sums are then compared. This evaluation matrix, while a creative attempt to deal with amalgamation, underlines the difficulties of this operation. Before returning to the text, examine the matrix carefully. Can you see what the difficulties are?

Region VIII. Former administrator Green had been following staff advice to threaten withdrawal of 201 funds if Jackson did not agree to expand its existing plant. Merson was reluctant to threaten Jackson without first exploring other possibilities with town and county officials. He also sensed that an EPA-mandated action would only delay compliance, and he realized the political costs to EPA of a noncomplying plant in a scenic, heavily-visited area such as Jackson Hole.

Finally, Merson also believed that South Park would develop rapidly, the county plan notwithstanding. Merson feared that Flat Creek's water quality would suffer if South Park development was served by package plants and individual septic systems.

Recognizing that serious differences still remained between the two parties, Merson in mid-December 1977 hired Andrew Briscoe, of the planning firm Briscoe, Murray, Muphis, and Lamong (BMML), to negotiate a settlement between the town and county. On April 13, 1978, an agreement to accept the South Park site was reached. The agreement specified plant size and design capacity, empowered the county to limit annual out-of-town sewer hookups as part of its comprehensive plan, and required the town to base out-of-town hookup policies on a specified set of customer classes, and sewage hookup fees on a "full-cost pricing" system—both policies subject to EPA review and approval.

Like so many projects, agreement on the Jackson wastewater treatment plant required negotiations and compromise. The draft EIS provided much of the analysis on which negotiations were eventually based, but it did not clarify the issues nor incorporate different viewpoints. The impacts predicted in the EIS were amalgamated based only on the EPA analysts' judgments of significance. EPA's judgment was too narrow. It did not allow for uncertainty (such as whether South Park would develop with or without the proposed wastewater treatment plant) nor for alternative values (such as the town council's urbanization preference), and it employed invalid operations to manipulate data (such as addition of ordinal data). The EPA analysts, working hard to produce a concise EIS, fell into several of the traps common to most EISs that use amalgamation. These traps, while common, are not inevitable. The next section will review the discussion on amalgamation, and suggest ways of using it to produce more accurate and informative EISs.

SUGGESTIONS ON THE USE OF AMALGAMATION

As the Jackson case makes quite clear, alternatives are eventually chosen not by optimization but by the interaction of interest groups. Confrontation, negotiation, mediation, and compromise are the final arbiters.[21] For a political decision, well-structured information on a range of alternatives is needed. Since amalgamation simplifies details as well as interprets the data, amalgamate only to the extent that it facilitates comparisons of policy options. Selective use of amalgamation to highlight significant problem areas and tradeoffs among interest groups is an important aid to decision makers. Indescriminate use of amalgamation, however, obscures problems and hides tradeoffs.

Amalgamation implicitly involves value judgments. Whenever impacts are rescaled and combined into more concise dimensions of concern, describe the original impacts in the units in which they are measured in a second summary chart. An attempt at displaying impacts to facilitate comparisons is shown in Figure 8. Also, describe

Figure 8. Framework presentation incorporated in the Leitch Standing Advisory Committee's report. The proposal being examined is a road bypass for the United Kingdom city of Berwick. The Leitch report contained four additional alternatives not presented here. A number of tables similar to this one were made for other interest groups such as travellers, shopkeepers, users of facilities, and various public agencies. The comment column, while useful, fails to give a clear idea about how significant the impacts might be. (Department of Transport, Standing Advisory Committee on Trunk Road Assessment, United Kingdom, 1979.)

Group 2: Occupiers Sub group	Effect	Units	Modified Blue	Modified Green	Comments
Residential	Properties demolished	Number	13	3	Properties demolished on Blue route are Circa 1900.
	Noise	Number of houses experiencing an increase of:			The changes in noise are difference between the forecast for each option for 1998 and the existing levels. The units are dB(A)L_{10} 18 hr. 6 am—midnight.
		more than 15 dB	0	1	
		10–15 dB	22	27	
		5–10 dB	52	52	
		Number of houses experiencing a decrease of:			
		more than 15 dB	0	12	
		10–15 dB	138	248	
		5–10 dB	266	142	
	Visual obstruction	Number of properties within 500m of centre line.			
		Subject to:—			
		Severe	3	4	
		Significant	8	6	
		Slight	15	21	
	Visual intrusion		Least intrusion	River crossing visible from town	Report of Landscape Advisory Committee is relevant
	Severance				
	a. Relief to existing severance		Most effective	Effective	
	b. Imposition of new severance		Some new severance	Greatest new severance	
	Disruption during construction		Slight	Slight	
Farming		Number of Farms affected by land take	12	10	
	Land take	Hectares of land:			
		Grade II	6.8	10.5	Based on MAFF land Classification. Compensation included in Group 6
		Grade III	25	19.5	
Space a. Morton Golf Course (area 46 hectares)	Land take	Hectares	0	5.7	Effect on Users appears in Group 3
b. Low Road Methodist Chapel (area 28 hectares)	Land take	Hectares	0.6	0.6	Effect on Users appears in Group 3

the form for amalgamation. When individual impacts are displayed in tabular form, present the significance of each individual impact in the same table. A column for comments may be usefully employed to indicate the importance of individual impacts.

Give special care to the summary of nominal (named or categorized) data. Such data cannot be amalgamated (since they are not quantified), and thus are easily forgotten. Make certain that attention is focused on unquantified values in summary tables.

Avoid amalgamating interval or ordinal data into nominal scales. If criteria are established to judge the significance of an impact, indicate the extent to which the criteria are exceeded. Simple yes/no scoring is of limited use to decision makers.

Express ordinal scales alphabetically (A, B), verbally ("significant," "slight"), or symbolically (! , ?). Avoid the use of numerical scales because they create the temptation to add the rankings across categories. Since ordinal scales do not account for the absolute magnitude of individual impacts, any mathematical manipulation is inappropriate. Frequency distributions are the most common method of amalgamation.

Ordinal scales that rate the relative difference between impacts, rather than simply ranking their order of importance, are generally preferable. More information is contained in the statement "Alternative A has a serious effect on water quality while Alternative B has no effect" than in the statement "Alternative A has a more serious effect on water quality than does Alternative B."

When using interval data, take care to differentiate between magnitude and significance. The magnitude of a specific impact may be a poor measure of community preference or ecological vulnerability. Amalgamation of interval data can be accomplished if the relative significance of several variables can be weighted. Since weighting implicitly involves value judgments, explicitly identify the process of arriving at weights. The views of affected parties are important sources of value identification. When expert judgment is employed, identify the expert along with his or her affiliation and the basis for making the evaluation. Avoid the temptation to over-amalgamate.

Clearly indicate the degree of uncertainty in professional or community judgments in the body of the EIS and in the summary. Highlight uncertainty, interactive effects, or lack of data and their possible repercussions. Show differences in impacts over time when impacts accumulate, when projects are staged, or when environmental conditions change. Demonstrate the implications of giving greater weight to one type of impact over another. Also show the sensitivity of the analysis to changes in the assumptions.

Finally, careful analysis is a necessary but not sufficient criterion for writing an effective EIS. There are a vast number of methods for determining significance and for amalgamating. The most effective are those that not only use techniques that are valid and reliable, but also explicitly examine the range of values that exist in our communities.

ACKNOWLEDGMENTS

The case studies of twenty-one assessments from which material was drawn for this article were prepared for Environmental Resources Limited of London. Special thanks to my four colleagues Lawrence Susskind, Julie Wondolleck, and John Horberry of MIT and Alan Weinstein of the University of Wisconsin at Milwaukee, to Steven Hill for his help in researching the Jackson, Wyoming, case, and to Michael Bever and Rebecca Packard for their helpful comments.

NOTES

1. A team of five U.S. researchers examined twenty-one U.S. and Canadian environmental impact assessments (see Acknowledgments). An additional sixteen case studies were conducted in France, Germany, Norway, Sweden, and the United Kingdom by Environmental Resources Limited. A more complete description of the study can be found in Environmental Resources Limited (ERL), *Environmental Impact Assessment: Studies on Methodologies, Scoping and Guidelines, Final Report* (Prepared for the Ministry of Health and Environmental Protection of the Netherlands by ERL, London, January 1981).
2. The Jackson, Wyoming, case study is based on the following sources: Steven Hill, "201 Grants for Municipal Wastewater Treatments: Mediating an Intergovernmental Dispute in Jackson, Wyoming" (Draft paper prepared for the U.S. Environmental Protection Agency through a project at MIT, July 1980); Steven Hill, personal communication, 1980; Phil Hocker (Sierra club spokesman and head of "Citizens for the Plan"), personal communication, 1980; U.S. Environmental Protection Agency (EPA), Region VIII, *Draft Environmental Impact Statement, Jackson Wastewater Treatment System, Town of Jackson, Wyoming*, EPA-908/5-77-002, May 1977. U.S. EPA, Region VIII, *Final Environmental Impact Statement, Jackson Wastewater Treatment System, Town of Jackson, Wyoming*, EPA-908/5-79-001 B, February 1979. U.S. EPA, Region VIII, *Record of Decision: Jackson Wastewater Treatment System, Town of Jackson, Wyoming*, EPA-908/5-79/001 C, April 1979; Wes Wilson (Project Officer, EPA Region VIII), personal communication, 1980.

3. For a discussion of the key analytic problems found in the EIA process, see Craig Miller and Michael Bever, *Assessing the Environmental Impacts of Resource Recovery Facilities* (Laboratory of Architecture and Planning, MIT, Cambridge, 1978), and Lawrence Bacow, "The Technical and Judgmental Dimensions of Impact Assessment," *Environmental Impact Assessment Review* 1, no. 2 (June 1980): 109-24.

4. Wes Wilson, personal communication, 1980.

5. Institute of Ecology, *Optimum Pathway Matrix Analysis Approach to the Environmental Decision Making Process* (Institute of Ecology, University of Georgia, Athens, Georgia, 1971). Eugene Odum et al., "Totality Indices for Evaluating Environmental Impact" in *Environmental Impact Assessment*, ed. Marian Blisset (Lyndon B. Johnson School of Public Affairs, University of Texas, Austin, Texas, 1976).

6. Charles Solomon, et al., Water Resources Assessment Methodology (WRAM): Impact Assessment and Alternative Evaluation" (U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, February 1977).

7. Norman Dee et al., "An Environmental Evaluation System for Water Resource Planning," *Water Resources Research* 9, no. 3 (June 1973): 523-35.

8. More detailed discussions of specific amalgamative methods are available to the interested reader. A recent study by the author produced an inventory of thirty different methods for amalgamating impacts and determining their significance. The best known include Battelle's Environmental Evaluation System, Holling's Adaptive Environmental Assessment, the Institute of Ecology's Optimum Pathway Matrix Analysis, Leopold's Matrix Procedure, Hill's Goal-Achievement Matrix, McHarg's Overlay Technique, and the U.S. Army Corps' Water Resource Assessment Methodology. Three good discussions of these and other methods can be found in (a) Brian Clark, Ronald Bisset, and Peter Wathern, *Environmental Impact Assessment: A Bibliography with Abstracts* (New York: Bowker, 1980); (b) Donald McAllister, *Evaluation in Environmental Planning* (Cambridge, Mass.: The MIT Press, 1980); and (c) Robert Nichols and Eric Hyman, *A Review and Analysis of Fifteen Methodologies for Environmental Assessment* (Center for Urban and Regional Studies, University of North Carolina, Chapel Hill, February 1980). An excellent but more specialized discussion is offered by B. Hobbs and A. Voelker, "Analytical Multiobjective Decision Making Techniques and Power Plant Siting: A Survey and Critique," Draft ORNL-5288 (Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1977).

9. See Note 1.

10. The Economic Evaluation for the U.K. Bristol Area Transport Study makes paired comparisons across seven dimensions of concern, then identifies the preferred alternative by examining the pairs. This ranking of all alternatives based on the ranking of many pairs is invalid unless one alternative clearly dominates in all dimensions. Otherwise, the dimensions must be weighted, and weighting cannot be incorporated into ordinal data. See Jamieson MacKay and Partners, *Strategic Environmental Evaluation Technique—Bristol Study, Part 1, Application of the Methods.* (United Kingdom, 1975.)

11. The McHarg Overlay Technique is based on an overlay of map transparencies, each map dealing with specific environmental and land-use characteristics. Each of these characteristics is shaded differently to represent three degrees of "compatibility with the highway." By using overlain maps, one of which is the proposed route, a comprehensive picture showing the spatial distribution and intensity of impacts can be obtained. However, this method requires that all data be converted to ordinal scales. Considerable information contained in interval or ratio scales can be lost by such a conversion. Once all measures are scaled ordinally, the tonal variation with respect to each environmental parameter and the comparative color densities for the scales of the different transparencies must be determined. The former is an implicit judgment about scaling the magnitude of individual environmental parameters, the latter about weighting the relative importance of different environmental parameters. Since these judgments are not explicit, they tend to be subjective. Moreover, the process of overlaying the maps is equivalent to visually adding the parameters. As this article points out, ordinally scaled parameters cannot be added or weighted because the scales associated with the various parameters are in different units of measure. Additions and weightings are valid only if a standard point of reference and fixed intervals are set for the full range of parameters, and this is not possible with ordinal data. See Ian McHarg, "A Comprehensive Highway Route-selection Method," Highway Research Record, No. 246 (Highway Research Board, Washington, D.C., 1968), and McHarg, *Design with Nature* (Garden City, N.Y.: Natural History Press, 1969.)

12. A third alternative can be noted, but is of limited use in environmental impact assessment. Data can be standardized using standard deviations when a large number of alternatives are being compared. For each dimension, the difference between the observed measurement of that characteristic and the mean is calculated. This difference is divided by the

standard deviation. The resulting "z-score" can be added to z-scores of other characteristics because each characteristic is expressed in terms of standard deviation from a mean. Z-scores can be amalgamated. Social impacts are frequently derived in this fashion. The means and standard deviation methods do not directly indicate goodness, but provide instead a statistically stable tool to meas-ure differences by internal comparisons. Since environmental impact statements usually assess a limited range of alternatives, internal comparisons are not likely to be helpful.

13. Standardized proportions are unreliable. The inclusion of a new alternative can change the rank order of two previous alternatives. Consider a simple water quality index based on toxic ammonia and total phosphorus. We compare two alternatives with ammonia values of .007 and .012 and phosphorus values of .01 and .005 milligrams per liter respectively. We divide by the largest values (.012 and .01) and add. Alternative 1 equals (.007/.012) M (.01/.01) M 1.6. Similarly, alternative 2 equals 1.5. Now, if we include a new alternative with an ammonia value of .02 and a phosphorus value of .05, the new largest values are .02 and .05, and the standardized proportions for alternatives 1, 2, and 3 are 0.55, 0.7, and 2.0 respectively. Alternative 1 and 2 have changed order.
14. Lyndon Babcock and Niren Nagda, "Indices of Air Quality" in *Indicators of Environmental Quality*, ed. W. Thomas (New York: Plenum Press, 1972).
15. Dee. See Note 7.
16. Bruce Ackerman et al., *The Uncertain Search for Environmental Quality* (New York: The Free Press, 1974).
17. N. Georgescu-Rogen, "Choice, Expectations, and Measurability," *Quarterly Journal of Economics* 64 (1954).
18. Hobbs and Voelker. See Note 8.
19. See Note 2, especially personal commuication with Wilson.
20. Steven Hill, "201 Grants for Municipal Wastewater Treatments," p. 24. See Note 2.
21. Lawrence Susskind et al., *Resolving Environmental Disputes: Approaches to Intervention, Negotiation, and Conflict Resolution* (Laboratory of Architecture and Planning, MIT, Cambridge, 1978).

Table 3. Resource Discipline Impacts

Resource Discipline	Individual Impact Assessment	
	Ground Disturbance	Public Accessibility
Biological Resources	Wildlife Botanical	Wildlife Botanical
Cultural Resources	Known Sites Predictive Model	Known Sites Predictive Model
Earth Resources	Soil Erosion Water Resources	
Land Uses	Parks, Recreation, and Preservation Existing and Planned Land Uses Agricultural Lands Military Operating Areas	
Visual Resources	Views from Residences Views from Sensitive Recreation Areas Views from Sensitive Travel Routes Scenic Quality Impacts	

Table 4. Alternative Routes

A	B	C	D	E	F	G	
Construction							**Access Levels**
16.8	16.8	16.8	16.8	16.8	22.0	16.8	Agricultural lands
202.7	206.9	199.9	211.4	187.8	210.5	199.9	Existing access with spur roads
118.8	96.3	117.2	103.9	96.7	119.8	117.2	New access roads in flat (0-8%) terrain
98.7	115.5	97.8	105.1	98.8	93.3	97.8	New access roads in rolling (8-35%) terrain
40.9	45.5	40.1	42.9	43.7	37.4	40.1	New access roads in steep (35-65%) terrain
Natural Environment							**Wildlife**
1.3	1.4	1.3	1.3	1.3	1.3	1.3	Ferruginous hawk nest buffers
39.1	39.1	39.1	39.1	39.1	39.1	39.1	Desert tortoise habitat
62.3	37.7	34.2	68.1	60.8	34.9	34.2	Sage grouse (leks or winter range)
22.8	31.4	24.4	20.0	22.8	24.4	24.4	Crucial big game habitat
72.6	87.3	72.6	72.4	72.6	66.6	72.6	Crucial nesting habitat
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	Sensitive fish species
76.6	109.0	78.4	96.0	92.6	78.4	78.4	Federally-listed or candidate species
77.9	67.2	70.4	93.5	72.4	73.9	70.4	Other sensitive species

and maps were collapsed into the five resource disciplines: visual, biological, cultural, land use, and earth resources. The process of collapsing the data involved GIS operations that overlaid several residual impact maps from each resource to create a single integrated map that represented the maximum or worst-case impacts for that resource discipline. For example, the higher biological impacts always took precedence over the lower impacts in the same location. The impact values of high, moderate, and low for each of the twenty-two individual impact assessments were developed using the same criteria. As an example, a high impact for cultural resources was considered to have a parallel effect to high impact to soils.

The collapsed biological resource impact map was derived using the GIS from the four individual impact assessments done for biology (Table 3). In addition, the GIS produced summary reports of the resource discipline impacts for each of the alternative routes. These summaries will be used in selecting the environmentally-preferred alternative.

As a tool to assist the selection of preferred alternative routes for each resource discipline (e.g., biological resources), the GIS was queried to select the least impact route. An impedance model was developed to identify the "path of least resistance" for each resource discipline by adding up impacts (e.g., impedance) along alternative route segments until it arrived at its destination point. The results of the impedance models were used to construct eleven alternative routes from the numerous alternative corridor segments.

These alternative routes will be compared in the EIS. The summarized alternative route comparison data, supplemented by the results of the impedance models, will be used to select an environmentally-preferred alternative route in the EIS. Table 4 shows examples of construction disturbance expected and some of the critical wildlife resources that would be crossed for seven of the alternative routes (A through G). Similar summary data tables were produced for each of the resource disciplines. The summary data are displayed in a format to facilitate comparing the alternatives.

SUMMARY

The application of GIS technology has been instrumental in the management of the voluminous data gathered for the studies of this transmission line project. The development of the capability to model the potential impacts associated with the construction and operation of a transmission line provided planners with the data needed for a strong siting process, and provided decisionmakers with the best information available to assist them in the selection of a preferred alternative route for this project.

Environmental planners are charged with integrating the activities of man into a fragile and sensitive environment. The advanced technologies of GIS are available to manage large databases and to perform comprehensive impact assessments. The GIS is a tool that is gaining widespread acceptance and credibility with industry, environmental interests, and land managers; it can be utilized effectively to perform detailed analysis, as well as to provide the much-needed consistency to environmental documentation. Coupled with other advanced technologies, like remotely-sensed data and other large databases, GIS is a powerful tool for the information age.

The value to our society of utilizing these types of automated tools is to incorporate the increasing volumes of data and information into the decision-making process. Credible methodologies applied by environmental planners and close observation by agencies and activists are the irreplaceable human elements. An intimate sense of what is credible, needed, and sustainable should be the heart and soul of planning, environmental, and development missions. As data management and analysis tool, GIS can help guide those missions into the future.

REFERENCES

40 *Code of Federal Regulations* Parts1500-1508.

Howald, K.J. 1990. GIS Analyzes Powerline Corridor. *GIS World* 3(5): 46-49.

Public Law 88-552. 1964.

(USDI) U.S. Department of Interior. 1990. Southwest Intertie Project EIS/PA Cultural Resources Impact Assessment Report (unpublished document). Boise, ID.

(USDI) U.S. Department of Interior. 1989a. Southwest Intertie Project Public and Agency Scoping Notebook (unpublished scoping document). Boise, ID.

(USDI) U.S. Department of Interior. 1989b. Southwest Intertie Project Transmission Line Regional Environmental Report (unpublished scoping document). Boise, ID.

(USDI) U.S. Department of Interior. 1986. Visual Resource Contrast Rating. BLM Manual Handbook 8431-1. Washington, DC.

ATTACHMENT 4.E

GEOGRAPHIC INFORMATION SYSTEMS

- Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14: 50-59.

ELECTRIFYING THE IMPACT ASSESSMENT PROCESS

James Jensen
Gregory Gault
Dames and Moore

Abstract. Advanced technologies are being brought to bear on the Environmental Impact Statement (EIS) and Plan Amendment (PA) for the Southwest Intertie Project, a high-voltage transmission line project proposed in Idaho, Utah, and Nevada. Dames and Moore is conducting the third party EIS/PA for the USDI Bureau of Land Management, USDA Forest Service, USDI National Park Service, and the USDI Bureau of Reclamation. The project involves the use of a geographic information system (GIS). To supplement conventional types of data collection, two types of satellite imagery and digital terrain data were read into the GIS. Thematic Mapper satellite imagery was used to identify various agricultural land types, vegetation associations, wetlands, riparian areas, urban areas, water bodies, etc. The GIS used these data to evaluate ground water disturbance potential and potential effects from increasing public accessibility into remote areas. Project visibility, visual contrast, and visual management classes also were modelled using the GIS. Impact assessment and mitigation planning, including maps and data reporting for each of the 1,800 miles of alternatives were developed using the GIS, which also was used to assist the identification and selection of the environmentally-preferred routing alternative.

The GIS and other advanced technologies have been demonstrated to play an increasingly important role in managing public lands, and in making sound resource planning decisions. This project illustrates the importance of these technologies, and points to the future of NEPA as a credible resource planning and decision process.

INTRODUCTION

Since 1970, the National Environmental Policy Act (NEPA) and the implementing regulations (40 CFR 1500-1508) have provided the mandate for environmental considerations in the federal decision-making process. Environmental Impact Statements (EISs) and Environmental Assessments (EAs) are prepared routinely by federal agencies to evaluate alternatives to a proposed action, to document the environmental consequences, and to show clearly what rationale was used to determine the preferred alternative among proposed actions, alternatives to a proposed action, or no action.

In its 20-year history, NEPA has matured into a more sophisticated planning mandate and decision-making tool for federal agencies due to several factors: (1)litigation interpreting the intent of NEPA and Council of Environmental Quality (CEQ) regulations, (2)higher environmental standards of the federal agencies, (3)higher public environmental consciousness, (4)more significant technology brought to bear in providing decisionmakers with more complete information.

This paper illustrates with a case study the utility of a geographic information system (GIS) to assess the potential environmental impacts and to compare alternative routes for a major regional transmission project for an EIS.

PROJECT DESCRIPTION

The Southwest Intertie Project is a 500 kilovolt (kV) transmission line proposed to originate from southern Idaho and extend southward to the Las Vegas, Nevada, area. A second portion of the project will extend from roughly the midpoint of the north-south segment (near Ely, Nevada) to Delta, Utah (Figure 1). The total project length is about 1,140 kilometers (700 miles). For over 25 years, the need for the project to provide reliable power and regional power exchange has been recognized by the utility companies in the western United States and in the Congress (PL 88-552, 1964).

The EIS is being prepared for the United States Department of Interior (USDI) Bureau of Land Management, the federal lead agency. Cooperating agencies include the United States Department of Agriculture (USDA) Forest Service, USDI National Park Service, the USDI Bureau of Reclamation, and the USDI Bureau of Indian Affairs.

The project was conducted in two major phases:

- Phase 1 - regional studies to identify alternative corridors
- Phase 2 - corridor studies for the EIS

The Phase 1 work involved an area of approximately 97,500 square kilometers (60,000 square miles) in southern Idaho,

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Figure 1. Regional Study Area

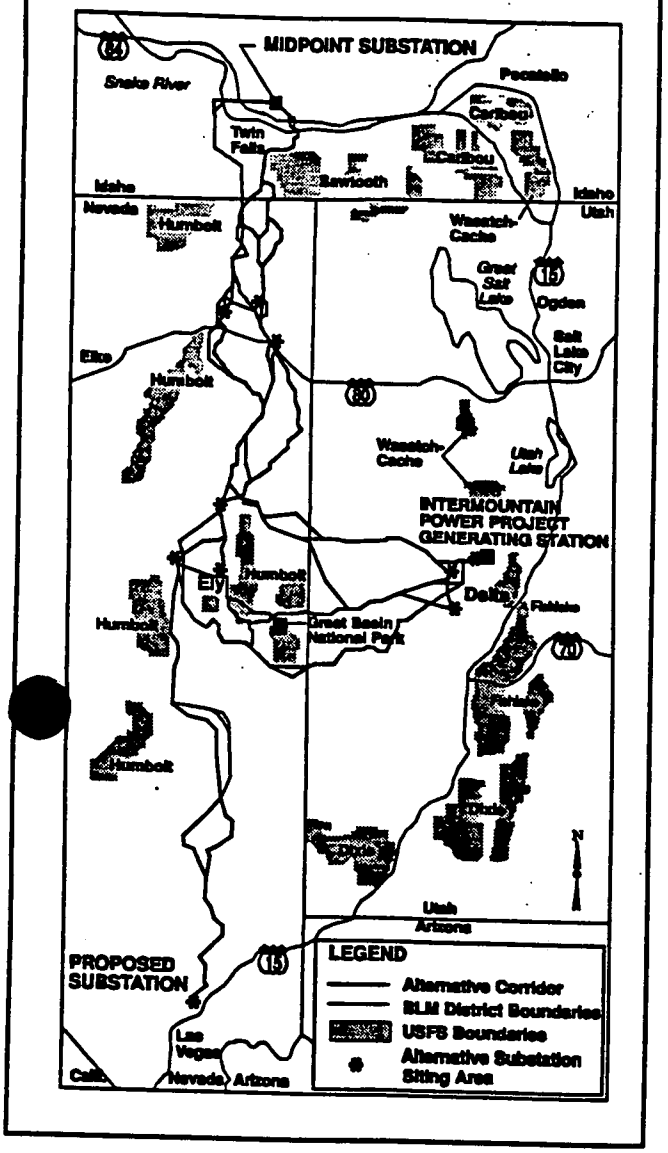
western Nevada, and eastern Utah (USDI, 1989b). The purpose of the regional study was to identify alternative corridors that would be considered "reasonable and feasible" for routing transmission line alternatives (Figure 2).

GEOGRAPHIC INFORMATION SYSTEMS DATABASE

A database was constructed using a GIS at 1:500,000 scale. Secondary, or existing data, in the form of documents and maps, were collected and input into the GIS system through digitizing or through reading digital data from tapes. In addition, United States Geological Survey (USGS) digital elevation mapping and remotely-sensed data (Multi-Spectral Scanner imagery) complemented the environmental database. Data were organized and arranged by distinct types, forms, or categories into files or layers for use in modeling and data reporting.

The remotely-sensed data used in the Phase 1 studies were classified into land cover types (e.g., agricultural lands, vegetation types, etc.) using an image processing system (Howald, 1990). Once compiled, the GIS database was used to identify opportunities and constraints based on environmental and engineering parameters that could affect transmission line routing.

Figure 2. Alternatives for Detailed Studies



The Phase 1 regional study results were presented at a series of public scoping meetings held during the beginning of the Phase 2 EIS studies (USDI, 1989a). From over 4,900 kilometers (3000 miles) of alternative corridors identified during the Phase 1 studies, about 2,900 kilometers (1800 miles) of alternative corridors were carried forward into Phase 2 for detailed study as "reasonable and feasible" transmission line routing alternatives.

The regional database then was enhanced for the corridor studies (Phase 2) by retaining the secondary data from the P[redacted] studies and modifying these data to accommodate the re[redacted]d scale required for the Phase 2 studies. Refined Phase 1 data were supplemented with additional detailed data from resource field studies, collected and mapped at 1:100,000 scale. Detailed data were mapped within a six-mile wide corridor centered on the assumed centerline of alternative routing corridors. The individual GIS data layers mapped for the corridor studies are listed in Table 1.

IMPACT ASSESSMENT MODELS

The purposes of assessing the potential environmental impacts of placing a transmission line along each of the alternative routes are to document environmental effects and to determine the alternative route that has the lowest overall impact (i.e., environmentally-preferred alternative), for the decision-making agency. The GIS was used as a tool to estimate and document potential environmental consequences and to provide summary information to the public and the agencies to assist the decision-making process. The key word for using advanced technology in the NEPA process is "tool." Because GIS lacks the ability to understand complex, interrelated environmental systems or issues, it should not replace traditional methodologies used on many linear projects to assess impacts and compare alternative routes, which generally are considered by professionals and public and agency reviewers as credible and defensible. Conversely, it should be used to facilitate consistency in applying impact assessment methodologies and documenting their results in a thorough and defensible EIS document.

To determine potential impacts, it is necessary to determine what types of impacts are expected. For example, most resource impacts from a transmission line project on public lands in the western United States can be determined by asking three questions: (1)How will ground disturbance from construction and operation affect sensitive resource features or values? (2)How will increased access from new roads constructed in remote areas affect sensitive resource features or values typically protected by their remoteness? and (3)What direct or indirect effects will the presence of transmission line structures have?

Modelling the Affected Environment

To answer these predictive questions, it was necessary to develop several "pre-impact assessment" models to establish the magnitude of change that would occur in the environment from the introduction of a 500kV transmission line. Most modelling of potential impacts was done using two basic pre-impact assessment models: (1)the ground disturbance model and (2)the public accessibility model.

Based on five slope categories that considered the estimated mileage of road needed to access tower construction sites and the estimated size of construction areas at tower sites, a set of assumptions called access levels was developed. These access levels provided the basis with which the pre-impact assessment models measured the potential change in the environment, per mile of transmission line constructed.

By using components of the GIS database (Table 1), other capabilities of the GIS, and the two basic pre-impact assess-

Table 1. GIS Inventory Data Base

Data Layer	Comments
Residences and Other Structures	Locations interpreted from satellite imagery
Transportation and Access	Existing highways and paved and unpaved roads
Parks, Recreation, and Preservation	Wilderness areas, national parks, state parks, other public and private recreation facilities
Land Uses	Transmission lines, pipelines, mines, wells, corrals, and other surface uses
Miltary Air Space	Military flight research and training areas (to 100 feet above the ground)
Range Allotments	Public land areas used for livestock grazing
Wildlife	Threatened and endangered species, other sensitive species, and sensitive habitat
Botany	Rare and sensitive plants and their habitat
Scenic Quality Classes	Federal agency classification of landscape aesthetics
Visual Resource Management Classes	Federal agency designations for the management of the visual landscape
Soils	Erosion and structural load characteristics, Prime/Unique farmland designations
Water Resources	Rivers, perennial and intermittent streams, other waterbodies, floodplain areas, high water table
Cultural Resources	Known archaeological/historical sites
Land Cover	Classified from Thematic Mapper (TM) data
Terrain/Elevation	USGS Digital Terrain data and mapping

ment models mentioned above, several other pre-impact assessment models were developed:

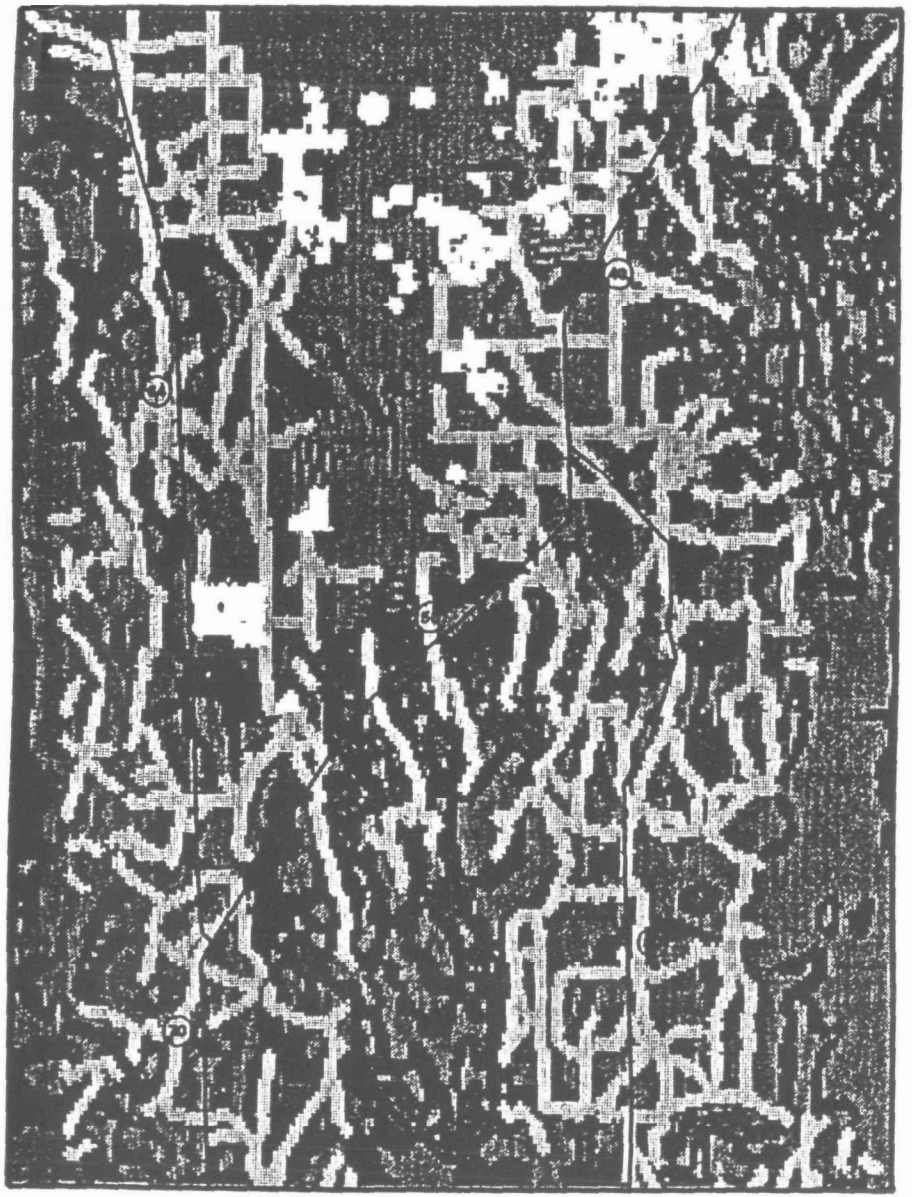
- visibility from sensitive viewpoints (e.g., residences, parks, recreation areas, scenic overlooks)
- visual contrast from vegetation removal, changes in landform from road construction, and presence or absence of structures such as buildings or other transmission lines
- cultural resources predictive model (USDI, 1990)
- buffers for critical habitats for some sensitive plant and wildlife species locations (e.g., distance or zone around the nesting site of a threatened or endangered raptor species, which generally is considered necessary to protect the nest)
- slope categories

The data and mapping that resulted from the pre-impact assessment models were used as the basis for determining the specific locations and severity of resource impacts. These pre-impact assessment models are described in more detail below.

Ground Disturbance Model - The project will utilize existing unpaved roads and will require the construction of some new access roads for construction crews to place tower footings, erect towers, and string the conductors. Where no access roads exist, new roads will have to be built. Also, some existing roads will need to be upgraded to support construction equipment and vehicles. In either case, some ground disturbing activities will be necessary to construct and operate the transmission line.

The ground disturbance model combined the GIS database layers of land cover, slope categories, and transportation listed in Table 1 to quantify and map the area of potential land disturbance into five levels of magnitude. The level of distu

Figure 3. Ground Disturb[illegible] Model



GROUND DISTURBANCE

LEVEL

1
2
3
4
5

(40) LINK DESIGNATION

0 2 4 8 Miles

Southwest Intertie Project

bance varies depending upon the presence or absence of existing roads, the terrain that might require grading, and the circuitous routing for grade limitations. Figure 3 illustrates the ground disturbance levels.

Public Accessibility Model - This model estimated the degree of remoteness of areas along each of the transmission line routing alternatives. The primary assumption of developing this model was that impacts could occur to certain resources if new access roads are constructed and maintained in largely remote areas. Legal or illegal hunting could endanger sensitive plant or wildlife species and increase pressure on game species. Cultural resources (e.g., early-man sites) may be more susceptible to vandalism or damage due to the cumulative impacts (e.g., repeated damage from vehicle tire tracks) by public land users (USDI, 1990).

The public accessibility model utilized the transportation layer of the GIS database in conjunction with the results of the ground disturbance model. The model estimated the increase in the area accessible by roads in remote areas expressed in terms of five percentage values. Several of the impact assessments models used these values to predict the potential impacts associated with increased access. Figure 4 illustrates the five levels of access.

Visibility - This model was constructed using the digital terrain data and selected land uses (e.g., residences, parks, scenic overlooks, highways) that were considered to be sensitive viewpoints. Mapping of viewsheds was generated through a GIS operation that "looks out" from these viewpoints over the digitally-modeled terrain of the project study area. The resulting maps represented visibility as distance thresholds of visual perception (0-500 meters, 500-1500 meters). These maps later were utilized by GIS impact models to determine the potential visual impacts of the construction and operation of the transmission line.

Visual Contrast - Visual contrast is a measure of visible change in the landscape (USDI, 1986). The visual contrast model was developed by combining the results of two other pre-impact assessment models. The first of these models was created to predict the contrasts that would result from vegetation removal and changes in landform. This model used the landcover and terrain database layers in conjunction with the ground disturbance model to determine the contrast from ground disturbing activities. The second model, structure contrast, was created from elements of the land use database layer (e.g., existing structures, transmission lines) and the proposed project description (e.g., types of new towers proposed). Mapping of visual contrast represented the level of change in the characteristic landscape. Visual impacts were determined through an evaluation of how visual contrasts were perceived from sensitive viewpoints.

Cultural Resources Predictive Model - The locations of most cultural resources (prehistoric, ethnohistoric, and historic) in the western U.S. are not known or recorded, except where specific surveys have been conducted. To assist in determining where sensitive cultural resources likely may be found, a cultural resources predictive model was developed. The model includes the landcover, terrain, and water resources database layers. The probability of finding culturally-sensitive sites was estimated by a model that evaluated several key environmental factors, such as proximity to water, presence of specific vegetation types, and elevation.

Sensitive Habitats - The GIS buffering capability was applied to establish zones of potentially sensitive habitats associated with known habitat locations. For example, a buffer of 812 meters (1/2 mile) was used around known locations of sage grouse leks or spring strutting grounds to include potential nesting habitat. Similarly, ferruginous hawk nests, bald eagle nests, and other sensitive wildlife habitat or botanical locations were buffered to establish a zone where potential disturbances from the construction or operation of the transmission line could be assessed.

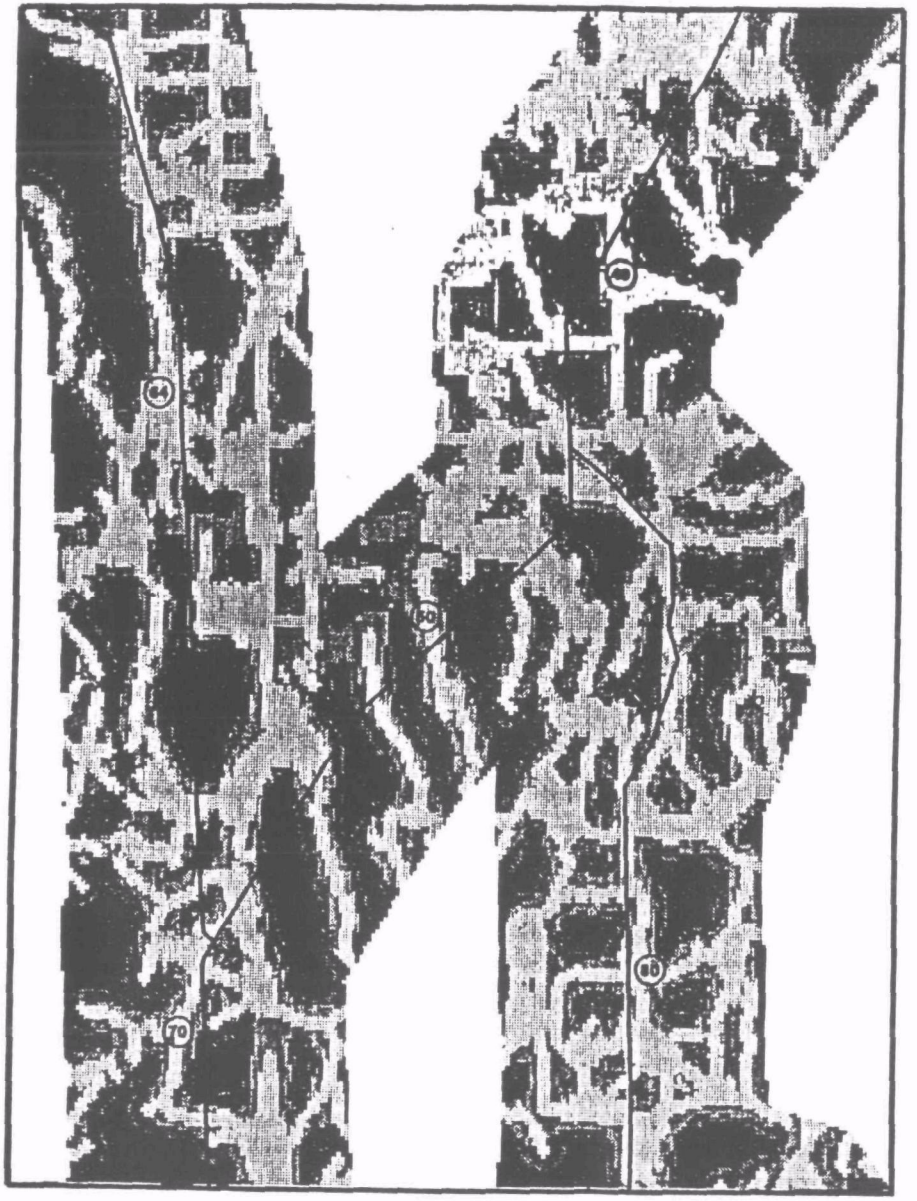
Slope - Five slope categories were mapped using the 1:250,000 scale USGS digital elevation mapping. The slope categories were selected based upon degree of soil erosion potential, construction difficulty, and other environmental and construction parameters. These categories were important in the development of the access levels for use in the ground disturbance and public accessibility pre-impact assessment models, described previously.

Combining the results of the pre-impact assessment models with the selected layers of the GIS database, the impact assessment models performed three functions: (1)estimated the potential initial impacts of placing a transmission line in the landscape, (2)facilitated the application of selective mitigation measures based on the severity of the predicted impacts, and (3)estimated the residual impacts.

Residual impacts, those expected to remain following mitigation, were used to determine potential significant effects. The impact assessment models combined the specific locations, quantities, and magnitudes of predicted project disturbances determined by the pre-impact assessment models (described earlier) with the geographic locations of environmental resource features or values provided by the GIS database layers. Based on the sensitivity or susceptibility to disturbances (e.g., ground disturbance and public accessibility), the impact assessment models estimated the effects on resource features or values. Potential impacts were assessed in increments of 162 meters (0.1 mile) along the centerline of each alternative transmission line corridor, a unit of measurement easily understood by the general public.

A series of matrices was applied by the impact assessment models that assigned impacts to specific resource features and values based on the level of ground disturbance. For example, a sage grouse lek and the adjacent nesting area

Figure 4. Public Accessibility Model



PUBLIC ACCESSIBILITY

PERCENT CHANGE
IN ROAD DENSITY

- 0 - 5
- 5 - 10
- 10 - 40
- 40 - 100

(40) LINK DESIGNATION

0 2 4 8 Miles

Southwest Intertie Project

would be disturbed when crossed by the assumed centerline of a routing alternative. If the ground disturbance is expected to be low, the potential to disturb sage grouse habitats would be minimal. Minimal ground disturbance would be the case if the alternative route parallels an existing road or similar linear land-use feature.

Similarly, a series of matrices was applied by the impact assessment models that assigned impacts to specific resource features and values (e.g., cultural, wildlife, and botanical resources) based on the level of potential increase in public access. For example, ferruginous hawks are less likely to be disturbed during sensitive nesting periods or shot illegally if they are in inaccessible or remote areas. Where areas of significant change in accessibility coincide with sensitive resource features or values, potentially significant effects are likely to result.

The next step in the process of determining and documenting potential impacts was to recommend mitigation that would be effective in reducing initial impact levels. A standard set of mitigation measures was developed for the project. Matrices were used to apply mitigation measures to specific locations and to specific types of impacts. For example, one might expect impacts upon big game species, such as pronghorn antelope or elk, during their sensitive breeding or fawning periods, but these impacts can be eliminated effectively by applying the mitigation measure of avoiding construction during these sensitive periods.

The final step in the automated impact assessment process was to determine residual impacts, or those impacts expected to remain following mitigation. A matrix again was applied to determine the level of residual impact. The specific location and quantified severity of residual impacts were documented in printed tabular reports and illustrated in impact maps generated by the GIS. Both the maps and tabular reports document impacts on an increment of approximately 162 meters (0.1 mile) along each of the 2,900 kilometers (1800 miles) of alternative routes. An example of the tabular report for ground disturbance impacts related to wildlife resources is illustrated in Table 2.

Preliminary maps were generated for each step in the impact assessment process, initial impacts, mitigation, and residual impacts, to verify modeling operations and to assure data integrity. A total of 22 impact assessment models was developed to evaluate the ground disturbance, public access, or visual effects of a transmission line on the resources in the layers of the GIS database (Table 1). The results of each of the individual impact assessments were compiled to summarize impacts and determine an environmentally-preferred alternative.

SELECTING AN ENVIRONMENTALLY-PREFERRED ALTERNATIVE

Because of the inherent difficulty in comprehending the voluminous data generated by the twenty-two individual impact assessments, the data from the tabular impact reports

Table 2. Ground Disturbance Impacts to Wildlife

Mile Post From	To	Length	Access Level	Resource Theme	Initial Impact	Mitigation Measures	Residual Impact	Comments
Route Link 167								
0.0	0.1	0.1	Level 2	Sage grouse lek	4	30	4	crosses within 1/4 mile of lek
0.1	1.3	1.2	Level 2	Sage grouse lek	4	30	3	crosses edge of 1/2 mile habitat buffer
1.3	1.5	0.2	Level 2	Sage grouse lek	4	30	4	crosses within 1/4 mile of lek
1.5	1.7	0.2	Level 2	Sage grouse lek	4	30	3	crosses edge of 1/2 mile habitat buffer
1.7	2.3	0.5	Level 4	Sage grouse lek	4	30	3	crosses edge of 1/2 mile habitat buffer
2.3	2.6	0.3	Level 4	Background	1	0	1	

Determination of Significance

Significance is that characteristic of an impact that determines its degree of influence on a decision. In the U.S., significance is described in terms of context and intensity. The significance of an action will vary within the context of the action (e.g., local vs. global scale) and the intensity (i.e., magnitude) of the impact. Generally accepted criteria for determination of significance are described below.

Significance is a key factor in (1) determining the appropriate level of EA for a proposed action, (2) deciding on measures that avoid or mitigate predicted impacts, and (3) choosing among alternative actions. If potential impacts are thought to be significant, the EA review generally results in a formal EA document (i.e., an EIS in the U.S.). When, as a result of the EA process, predicted impacts are shown to be significant and treatable, mitigation measures must be included in the EIS and in a public record of decision. However, the choice of alternatives is a management decision that is based on many factors including government policy, applicable laws and regulations, agency mission and objectives, as well as public values and biological significance.

The significance of a proposed action is considered at both the beginning and the end of the EA process. In the beginning, the proponent determines the appropriate level of EA review and documentation based on screening the proposed action. When a proposed action is precedent-setting, unique, and/or the potential impacts are unknown or thought to be significant or the ability to mitigate effects is unknown, a formal EA document is appropriate. The public plays a role early in planning (i.e., during scoping) in determining the significance of issues and the choice of alternatives for analysis. Determination of significance at the end of the EA process involves evaluation of the predicted impacts for each of the alternatives and, as described above, ultimately rests with the decisionmaker. Explicit procedures, which identify the values of the public and the significance of the effects of the alternatives on each value, provide a better basis for rational analysis, decisionmaking, and public acceptance of the proposed action.

In the U.S., the NEPA review and documentation process is predicated on the significance of proposed federal actions. Elsewhere (e.g., the United Kingdom), a significant impact is considered one for which the developer should

seek some form of mitigation. Significance is determined by reference to legal or accepted standards as far as possible, but if no standard is available, the EA team evaluates significance basing their determination on clearly described ad hoc criteria.

NEEDS

It is the job of the EA team to identify, clarify the options and trade-offs, and summarize the potentially significant impacts for the decisionmaker. For this, criteria are needed to determine significance of effects of an action on a particular entity and also a method is needed for scaling effects for each criterion.

- Criteria for significance upon which decisions are based include the:

  - value of the potentially affected entity. Particularly important are public health and safety, threatened and endangered species, and important geographic areas (e.g., historic sites, park lands, prime farmlands, wetlands, wild and scenic rivers, ecologically critical areas);
  - magnitude of the effect (severity);
  - nature of the effect;
  - spatial extent of the effect;
  - duration of the effect;
  - predicted degree of recovery;
  - political repercussions;
  - public concern; and
  - legal mandates.

  Furthermore, actions or effects that are likely to be highly controversial, involve unique or unknown risks, or establish an important precedent are also considered to be significant.

- Determination of significance requires predicting change (Part 4.3). These impact predictions are, along with societal values, the major input to significance determinations. The input must be good if the output is to be good. Ideally, change should be compared against thresholds of concern, some of which may be legally mandated and others which may be levels or states of valued components determined by the public, the decisionmaker, or the EA team. However, because all alternatives may be above the threshold or all may be below the threshold, it is necessary to at least estimate relative magnitudes of effects in order to compare significance.

Burton, I., J. Wilson, and R. E. Munn. 1983. Environmental impact assessment: national approaches and international needs. Environmental Monitoring and Assessment 3:133-150.

Cohrssen, J. J., and V. T. Covello. 1989. Risk Analysis: A Guide to Principles and Methods for Analyzing Health and Environmental Risks. Council on Environmental Quality, Washington, D.C. 407 pp. Available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

Conover, S. A. M., K. W. Strong, T. E. Hickey, and F. Sander. 1985. An evolving framework for environmental impact analysis I. methods. Journal of Environmental Management 21:343-358.

Elliot, M. L. 1981. Pulling the pieces together: amalgamation in environmental impact assessment. Environmental Impact Assessment Review 2:11-38.

Federal Environmental Assessment Review Office (FEARO). 1986. Initial Assessment Guide. Federal Environmental Assessment Review Office. Ottawa, Ontario. 36 pp.

Giroult, E. 1988. World Health Organization interest in environmental health impact assessment. In: Environmental Impact Assessment, Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Haug, P. T., R. W. Burwell, A. Stein, and B. L. Bandwiski. 1984. Determining the significance of environmental issues under the National Environmental Policy Act. Journal of Environmental Management 18:15-24.

Hirsch, A, 1980. The baseline study as a tool in environmental impact assessment. In: Biological Evaluation of Environmental Impacts, The Proceedings of a Symposium. Fish and Wildlife Service. FWS/OBS-80/26.

Hollick, M. 1986. Environmental impact assessment: an international evaluation. Environmental Management 10:157-178.

James, T. E. Jr., S. C. Ballard, and M. C. Devine. 1983. Regional environmental assessments for policy making and research and development planning. Environmental Impact Assessment Review 4:9-24.

Leistritz, F. L., and S. H. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Westview Press/Boulder, Colorado. 286 pp.

Murdock, S. H., F. L. Leistritz, and R. R. Hamm. 1986. The state of socioeconomic impact analysis in the United States of America: limitations and opportunities for alternative futures. Journal of Environmental Management 23:99-117.

Richmond, H. M. 1981. A framework for assessing health risks associated with national ambient air quality standards. The Environmental Professional 3:225-233.

Schaffman, P. 1986. Assessing the assessors: toward "risk aware" courts. Environmental Impact Assessment Review 6:331-343.

Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250.

Tomlinson, P., and S. F. Atkinson. 1987. Environmental audits: a literature review. Environmental Monitoring and Assessment 8:239-261.

U.S. Environmental Protection Agency. 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001.

Westman, W. E. 1985. Ecology, Impact Assessment, and Environmental Planning. John Wiley & Sons. New York. 532 pp.

Traditionally, the emphasis in EA has been on the biophysical environment. However, human concerns about project-environment interactions and the associated risk have contributed to the development of socioeconomic impact assessment (Murdock et al. 1986). Numerous computerized models are available that quantitatively integrate social, economic, demographic, public service, and fiscal impacts (Leistritz and Murdock 1981), but the models are most appropriate for large-scale development activities and are rarely integrated with biological analyses.

- The task of evaluating an EIA and communicating the conclusions to the public and the decisionmakers is complex. It is the responsibility of the EA team to summarize and highlight the key findings, including discussion of those issues determined not to be significant.

  Except for exceedance of standards set by government regulations (e.g., National Ambient Air Quality Standards), the description of significance is largely judgmental, subjective, and variable. Conover et al. (1985) present a system to rate impacts as negligible, minor, moderate or major impacts (Attachment 4.F). Haug et al. (1984) present a system that ranks thresholds of potential impacts on the basis of legal factors, principles of sound resource use, and human preferences. These are described as having highest, very high, high, moderate, or low priority (Attachment 4.F). FEARO (1986) described the need to determine thresholds of concern (i.e., a maximum or minimum number or other value for an environmental impact or resource use which, if exceeded, causes it to take on new importance) based on statistical, ecological, social, and safety and health significance.

  Terms used to describe the significance of project-induced changes can and should be simple and clearly defined (e.g., major, short-term, local, regional). In the absence of clear definitions, such terms are subject to a wide range of interpretation.

TOOLS

- Comparison of predicted levels of pollutant emissions or effluents to legally mandated thresholds (e.g., against national ambient air quality standards) can identify exceedances that would clearly result in significant impacts. However, generally, predicted impacts are not those related to exceedances of set standards

because the reason for such excursions would be mitigated during project design.

- Coordination of surveys and studies required by executive orders and other environmental review laws (e.g., U.S. Fish and Wildlife Coordination Act, National Historic Preservation Act, and the Endangered Species Act) with the preparation of the EIA document can ensure that protected resources are identified early on and factored into the decisionmaking process. (Part D summarizes some of the U.S. environmental laws written to protect specific resources.)

- In addition to legally mandated thresholds, Haug et al. (1984) discusses functional, normative, controversial, and preference thresholds (Attachment 4.F). Sometimes an environmental impact will not be a concern if it is small or if it occurs in an already disturbed area. However, the significance of such concerns is usually determined by the affected public. If possible, negotiating a threshold of concern for an environmental impact or resource use which, if exceeded, will cause the impact or use to take on new importance, usually resolves the conflict (Attachment 6.A). Although establishing numerical values for such thresholds is often impossible, identification of the concern aids the decisionmaker, helps to establish monitoring needs or criteria for mitigation, and satisfies the public.

- Risk assessment provides information that can be useful in weighing alternatives and analyzing trade-offs, especially when answers are not obvious and available information in ambiguous and uncertain. However, neither health risk assessment nor ecological risk assessment (Part 4.3) determines significance. The significance of an estimated risk is determined by the decisionmaker.

- Professional standards (e.g., general usage and engineering standards) based on population ratios (e.g., hospital beds/1000 population, recreation acres/1000 population) are often used for projecting needs for social services. These standards should be used cautiously because they vary widely from one information source to another and they are unlikely to be applicable to areas (particularly rural areas) that are dissimilar to the areas for which they were developed (Leistritz and Murdock 1981). On the other hand, the standards are widely used and accepted, easy to apply, and some of the standards are based on analytical analyses.

- Public opinion and the level of controversy associated with a proposed action help to identify and to determine the relative significance of environmental impacts. Useful input requires that the public be informed on the proposed action, alternatives, and major potential impacts, and encouraged to participate in the EA process, particularly during scoping and document review. However, it has been documented that public meetings do not naturally attract the representative cross-section of society that would provide a balanced input to the EA process (Thompson 1990). Thus, values and significance are probably determined by groups of self-selected people.

ISSUES

- The technical interpretation of significance is based on impact assessment techniques that exist on a continuum from those that simply summarize to those that also evaluate impacts (Part 4.3). Westman (1985) notes that all of the quantitative assessment techniques can be criticized from one or another perspective: either they summarize too much or not enough; attempt to quantify based on inadequate (subjective) data or remain too qualitative; are arbitrary and incomplete in their selection of impacts to include or are too exhaustive; and take away too much judgment from decisionmakers or leave too much to be decided. However, he notes that the need for evaluation is inescapable. In the absence of explicit evaluation, implicit evaluation is performed by decisionmakers. The job of the EA team is to choose methods whose assumptions and data requirements are appropriate to the task and to remind the decisionmaker of the assumptions and limitations of the evaluation methods being used (Westman 1985). Even the use of legally-set standards to determine significance can be misleading. Standards are compromise figures based on scientific information on species tolerance to toxic substances, primarily from single-species bioassays and, to a lesser extent, from field studies. A panel of experts determines the recommended "standard" based on available literature. Thus, even legally set standards are only crude guides to acceptable levels of protection (Westman 1985).

- Some recent papers on the value of EA methods suggest that the accuracy of prediction in EA leaves much to be desired (Thompson 1990, Attachment 4.G; Tomlinson and Atkinson 1987; Bisset 1988; Elliot 1981, Attachment 4.D; Hollick 1986). There is uncertainty associated with determinations of significance that are

predictive methods. Comparison of proposed actions to similar ongoing activities is suggested as a way to reduce the level of uncertainty.

- Public perception of the significance of an issue is influenced by (1) the existence of competing demands for the resource in question, (2) differences in human values regarding the relative worth of resources, and (3) the availability of knowledge and level of understanding of the costs, benefits, and risks related to the issue (Westman 1985). Ensuring that the public who has (or should have) a substantive interest in the proposed action plays a role in deciding the issues is the most effective way of determining the significance of the issues and also is the most effective way of avoiding conflict.

LINKAGES

Significance is linked to almost all aspects of EA. Initially, the required level of documentation is determined by screening at the initiation stage of EA review. For those actions thought to have potentially significant effects, an EIA is prepared. During scoping, the public has the opportunity to identify significant issues, and these significant issues and concerns help to determine the range of alternatives that are analyzed during assessment. Decisionmaking is based on the significance of the predicted environmental impacts along with other economic and technical considerations and agency statutory missions. Mitigation is designed to reduce potentially significant effects that are unavoidable or to compensate for them. It is usually associated with a monitoring program during and after implementation of the project.

REFERENCES

Bisset, R. 1988. Developments in EIA methods. In: Environmental Impact Assessment, Theory and Practice (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Bonano, E. J., S. C. Hora, R. L. Keeney, and D. von Winterfeldt. 1990. Elicitation and use of expert judgment in performance assessment for high-level radioactive waste repositories. NUREG/CR-5411. Sandia National Laboratory, Albuquerque, New Mexico.

Buffington, J. D., R. K. Sharma, and J. T. McFadden. 1980. Assessment of ecological damage: consensus. In: Biological Evaluation of Environmental Impacts, The Proceedings of a Symposium. Fish and Wildlife Service. FWS/OBS-80/26.

The difficulty in achieving effective public participation was highlighted in work by Ertel (1979). The following are statistics for the attendees of a public meeting:

1. 13·1% of attendees were not educated beyond secondary school level.
2. 37·7% had done college work.
3. 48·1% had college degrees.
4. 35·5% had yearly family incomes in excess of $20 000.

It was further revealed that 44·8% had attended more than five public meetings in the preceding five years and that 36·7% held elective or governmental positions. This result suggests that public meetings do not naturally attract the representative cross-section of society that would provide a balanced input to the EIA process.

It is therefore apparent that special efforts must be made to involve the disadvantaged and less well-educated sections of society. Over half the attendees in the survey were present as a result of receiving a direct postal invitation, far fewer having responded to media advertisements. This suggests that personal invitations to members of target populations may help redress the balance. Another remedy may lie with the use of polling or extensive questionnaire surveys, an effective example of which, the Yosemite National Park Master Plan, is outlined in McAllister (1980).

As applied in Table 1, the methodologies that qualify are those in which public participation is an integral part. In others, such as Stover (1972) and Clark *et al.* (1983) participation is suggested, but left to the discretion of the study-team.

3.4. IS THE LEVEL OF QUANTIFICATION RESTRICTED TO THAT ADEQUATE FOR A DECISION?

From the beginning of an assessment, the aim of the study must be clearly defined, based on an appreciation of the exact nature of the decision to be made. Study resources should then be directed towards a continual clarification of the main issues involved and a refining of the study team's judgement. Quantification of impacts far beyond the point where the difference between alternatives is apparent may be wasteful of resources that would be better used on areas of study where differences are less clear. The methodologies that score on this criterion do not advocate exhaustive attention to detail.

3.5. ARE QUANTITATIVE AND QUALITATIVE DATA PRESENTED TOGETHER?

The attraction of quantitative data lies in their apparent objectivity, whether real or illusory, and with the fact that they facilitate easy comparison between alternatives. Where both quantitative and qualitative data are presented, care should be exercised that the former are not given undue importance. On no account should qualitative data be discarded because they do not fit conveniently into an assessment technique; instead, a way must be found to incorporate them. Certain impacts may be better presented in a quantitative manner whilst others lend themselves to a qualitative treatment. Criteria number five highlights those methodologies where both types of data are likely to be presented. The extent to which they are segregated to allow equal consideration is, however, a presentational matter, the success of which will vary from one case to the next.

3.6. STUDY TEAM DOES NOT EXERT UNDUE INFLUENCE ON THE OUTCOME

The shortcomings inherent in relying solely upon expert opinion when assigning significance to impacts were outlined in 3. This criterion applies to those methodologies where some input of public opinion serves to limit the influence of the study team.

3.7. IS A STRUCTURED GROUP DECISION-MAKING TECHNIQUE SUGGESTED?

Methods used by a study team to achieve consensus on key issues can have an effect on the outcome and are thus worthy of consideration. The effectiveness of various methods was investigated by Delbecq and Van de Ven (1974). Although not applied specifically to EIA, their study is of interest as it shows a way in which consensus decisions might best be achieved. A comparison was conducted between conventional interacting groups, the Delphi technique, and one of their own devising, the Nominal Group Technique. The latter uses a strict procedure for group meetings. The meeting begins with all participants writing down ideas. One idea from each person is taken in turn and written on an agenda board. These ideas are discussed for clarification before independent voting via ranking or rating is used to reach decisions.

The three methods were assessed for their ability to bring new ideas to light, and on the satisfaction with the decision-making process as expressed by those taking part. Results suggested that there exist a number of inhibiting influences that decrease the performance of conventional interacting groups in decision-making. These included too much time being spent on maintaining the social/emotional relationships of group members, and not enough on actual business. An absence of time to think things through individually, a tendency for group norms to emphasize conforming behaviour and for discussions to dwell on areas of agreement at the expense of areas of conflict, were also cited. Furthermore, a problem with higher status/stronger personalities whose views were given a disproportionately large amount of time was also identified.

It was suggested that the Nominal Group and Delphi techniques avoided many of these pitfalls, with the former being the preferred method as it made provision for some structured group interaction. The Delphi technique was favoured when, for logistical reasons, a meeting could not be convened. Work by Baumann *et al.* (1972) suggests that, to the ends of alerting a decision-maker to all the possible options involved and highlighting areas of conflict as well as consensus, the Delphi technique can be particularly useful.

3.8. IS THE DEVELOPMENT OF LOW IMPACT ALTERNATIVES ENCOURAGED?

The value of EIA as a tool for project modification cannot be stressed too strongly. Its success in this function may depend largely on the way in which any given EIA methodology is applied to the project in hand. There are some methodologies, however, which by their design, lend themselves to this function. The prime example of this is McHarg (1969) where the whole purpose of the process is to create the low impact alternative. Other techniques. such as the computer overlay of Krauskopf and Bunde (1972), also have this capability. Sorensen (1971) may also qualify in this respect, although more indirectly, by identifying impact networks and key areas of concern.

3.9. WHEN WEIGHTING IS PERFORMED ARE A NUMBER OF ITERATIONS USED?

Uncertainty as to the reliability of any weighting scheme can be overcome to some extent by using a successive series of weights. These can be derived from any number of reference publics or by the study team itself. Computer-based methodologies are particularly suited to the manipulation of weights. The value of this process lies in the way it reveals the emphasis placed by any particular weighting system by comparison with other systems. Successive treatments may well define key areas of impact, which emerge regardless of the weighting system used. The use of the technique is probably best confined to that of an in-house tool, refining the study-team's insight into the trade-offs involved. The methodology of Krauskopf and Bunde (1972) is computer-based, allowing easy manipulation of weighting schemes. In this respect, it is similar to the method developed and practiced by British Coal (Allett, 1986).

3.10. IS THE METHODOLOGY EASILY ADAPTED FOR USE ON ANY TYPE OF PROJECT?

Whilst it is acknowledged that a technique developed for a particular type of project may be of value, as long as it is used in appropriate circumstances, the flexibility of a methodology is itself an important asset. The ability to shape the assessment technique to fit the unique situation at hand should increase the likelihood of a reliable report being produced. The use of rigid methodologies, with predefined impact categories and weighting schemes, where inappropriate, will distort the assessment and greatly reduce its value.

3.11. IS PROGRESSION THROUGH THE STAGES OF ASSESSMENT EXPLICIT?

The importance of this criterion lies in the need for an assessment to be readily intelligible to lay decision-makers and the public. If it proceeds via a number of clearly defined steps, such as predictions of impact magnitude, followed by conversions to impact significance and explanation of the choice of key trade-offs. then this goal is more likely to be achieved. As applied to the 24 methodologies, this criterion excludes those that were lacking in specific guidelines or those such as Leopold *et al.* (1971) which consist of only one stage.

3.12. ARE RESOURCES TARGETED TOWARDS REACHING A DECISION?

This criterion is essentially a combination of moderate resource needs and a clear presentation of trade-offs. It implies that an on-going clarification of issues will be achieved during the process, without incurring unnecessary costs.

3.13. ARE TRADE-OFFS PRESENTED CLEARLY?

This criterion highlights those methodologies which are likely to provide the decision-maker with a clear series of choices between different areas of impact. It disqualifies both those methodologies that proceed to presentation of a final score and those that progress no further than a disaggregated presentation of data.

3.14. DOES THE METHODOLOGY CONTAIN A TECHNIQUE THAT, IN ITSELF, IS A USEFUL ANALYTICAL TOOL?

It is important that the value of quantitative techniques to the EIA process is not overlooked. Their role should, however, be confined to that of an in-house analytical tool, applied only to the types of impact that lend themselves to a quantitative treatment. Scaling procedures such as the function curves used to define environmental quality in the Battelle methodology (Dee *et al.*, 1973) and WRAM (Solomon *et al.*, 1977) are of value in this respect. Also noteworthy are the transparent impact map overlays to be found in McHarg (1969), and the impact identification networks of Sorenson (1971).

3.15. RESOURCE NEEDS OF THE METHODOLOGY ARE UNLIKELY TO BE EXCESSIVE?

The methodologies that do not qualify in respect of this criterion are those which are likely to incur high costs, either through the need for such high quality data or via expensive public participation programmes.

3.16

Examination of Table 1 allows comparison of the performance of the 24 methodologies against the 15 evaluative criteria. The criteria can all be seen as positive aspects, worthwhile goals for any assessment technique. The qualification of a methodology for a particular criterion is indicated by a "X" in the appropriate cell of the table. It is thus possible to give a broad outline of the attributes held by the methodologies within each of the six groups.

It appears that the methodologies in group 1 consider impact significance explicitly, perform a number of weighting operations where appropriate and progress explicitly towards a fully aggregated "final score" presentation. In most other criteria they fail to score, although aspects of some would be useful components of a methodology for which quantitative presentation of certain impacts was necessary.

Group 2 methodologies appear generally to be an improvement on those in group 1. They incorporate public opinion in some cases, which tempers the influence of the study team, and favour semi-aggregation of impacts and a restricted use of quantification with the emphasis on targeting resources towards the clarification of trade-offs.

PADC methodology (Clark *et al.*, 1983) of group 3, scores highly, except that there is no specific provision for public participation which, it is felt, is a major omission. The methodology of Leopold *et al.* (1971) scores poorly, but was a forerunner of many techniques and as such contributed to development of EIA procedure.

Group 5 and 6 methodologies are at fault in not presenting an explicit indication of significance, relying instead on a composite value that is part impact magnitude and part subjectively assigned importance. In general, they adapt well to many different types of project and have lower resource needs than their counterparts in groups 1–4. Some of group 6 aid the development of low impact alternatives, and McHarg (1969) scores highly by virtue of its presentational qualities.

It would, however, be wrong to sum the number of Xs for each methodology in order to determine a rank order. To do so would effectively place an equal weight on each criterion when such is not the case. Of the 15 evaluative criteria, it is felt that several are absolutely essential to the development of good EIA practice. Significance must be considered discreet from impact magnitude; and there must be some input of public opinion to regulate the influence of the study team. Development of l[redacted]pact

ATTACHMENT 4.F

DEFINITIONS FOR DESCRIBING SIGNIFICANCE OF IMPACTS

- **Impact definitions currently used in the Canadian approach to biophysical environmental impact analysis.** (Source: Conover, S. A. M., K. W. Strong, T. E. Hickey, and F. Sander. 1985. An evolving framework for environmental impact analysis. I. methods. Journal of Environmental Management 21:343-358)

- **Thresholds of potential impacts.** (Source: Haug, P. T., R. W. Burwell, A. Stein, and B. L. Banduski. 1984. Determining the significance of environmental issues under the National Environmental Policy Act. Journal of Environmental Management 18:15-24)

Impact definitions currently used in the Canadian approach to biophysical environmental impact analysis. (Source: Conover, S. A. M., K. W. Strong, T. E. Hickey, and F. Sander. 1985. An evolving framework for environmental impact analysis. I. methods. Journal of Environmental Management 21:343-358)

Impact Definitions

A *Major Impact* is defined as one affecting a whole population or species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent on it, to its former level within several generations. (In some instances, with respect to resource use by humans, an impact that might not satisfy the above conditions might nevertheless result in significant effects on the human user. Thus, a major impact may also be classified as one that affects a subsistence or commercial activity to the detriment of the user.)

A *Moderate Impact* is defined as one affecting a portion of a population which may result in a change in abundance and or distribution over one or more generations of that portion of the population or any population dependent on it, but which does not change the integrity of any population as a whole. It may be localized.

A *Minor Impact* is defined as one affecting a specific group of individuals in a population at a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself.

A *Negligible Impact* is defined as one affecting the population or specific group of individuals at a localized area and/or over a short period in such a way as to be similar in effect to small random changes in the population due to environmental vagaries, but having no measurable effect on the population as a whole.

In many instances, either no interaction occurs, or the interaction does not result in an impact of any sort. Such instances will be identified as *no impact*.

In some cases, a *positive impact* may be registered. These will also be identified, using the same definitions as above with the positive nature of the impact identified.

Thresholds of potential impacts. (Source: Haug, P. T., R. W. Burwell, A. Stein, and B. L. Banduski. 1984. Determining the significance of environmental issues under the National Environmental Policy Act. Journal of Environmental Management 18:15-24)

Thresholds of Potential Impacts

Highest priority - legal thresholds. Thresholds of impacts or resource use established by law or regulation. These may not be exceeded under any circumstances.

Very high priority - functional thresholds. Thresholds established for resource use, or thresholds involving unavoidable adverse impacts on the human environment, and so great that, if these thresholds are exceeded, the impacts will disrupt the functioning of an ecosystem sufficiently to destroy resources important to the nation or biosphere irreversibly and/or irretrievably.

High priority - normative thresholds. Thresholds of impacts or resource use that are clearly established by social norms, usually at the local or regional level, and often tied to social or economic concerns.

Moderate priority - controversial thresholds. Thresholds of impacts or resource use that are highly controversial, or which are sources of conflict between various individuals, advocacy groups, or organizations, *and* which do not warrant higher priority for other reasons.

Low priority - preference thresholds. Thresholds of impacts or resource use that are preferences of individuals, groups, or organizations only, as distinct from society at large, *and* which do not warrant higher priorities for other reasons.

ATTACHMENT 4.G

DETERMINING IMPACT SIGNIFICANCE IN EIA

- Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250.

Journal of Environmental Management (1990) 30, 235–250

Determining Impact Significance in EIA: a Review of 24 Methodologies

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The determination of impact significance from predictions of impact magnitude is a source of much debate among proponents and practitioners of environmental impact assessment (EIA). Of particular concern has been the use of formal quantitative methodologies for comparing project alternatives in order to produce a total impact score for each alternative. It has been suggested that this technique removes the responsibility for the decision from the hands of elected decision-makers. This study concerns a review of 24 EIA methodologies, concentrating on the way in which each addresses the issue of impact significance. The methodologies are each assigned to one of six groups according to their performance against a number of basic criteria. The characteristics of each group are outlined with, by way of illustration, a description of one methodology from each group. A set of 15 evaluative criteria is then presented. These criteria emerged from discussions with a number of EIA practitioners and from reviews of previous general critiques of methodologies. The criteria are then used to re-evaluate the 24 methodologies in order to display the merits and limitations of each, and to highlight attributes essential to any worthwhile methodology. Finally, recommendations for a coherent approach to EIA and warnings against using unsuitable techniques are presented, together with suggestions for future training and research that might benefit EIA practice.

Keywords: environmental impact assessment, significance, methodology

1. Introduction

The recent implementation of the European Directive on Environmental Assessment (85/337/EEC) makes environmental impact assessment (EIA) mandatory for certain types of development project and discretionary for many others. It is likely that the next few years will see an increase in the number of EIAs produced. The directive has the following to say regarding the application of EIA in the planning process:

> ... development consent for public and private projects which are likely to have significant effects on the environment should be granted only after prior assessment of the likely significant environmental effects of these projects has been carried out (Council of the European Communities, 1985).

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This need to determine "significant effects" reinforces the importance of understanding the various methods that can be used to arrive at a list of significant impacts.

2. Classification of EIA methodologies according to treatment of impact significance

In order that EIA may fulfil its function as a decision-making tool, it is necessary that there be a clear distinction between impact magnitude and impact significance. The former is arrived at by prediction based upon empirical measurement, the latter is an expression of the cost of a predicted impact to society. Previous studies have tended to stress the organizational characteristics of EIA methodologies, classifying them as being of an Ad Hoc, Checklist, Matrix, Network or Overlay type. It is felt that a reclassification on the basis of the approaches used to determine significance is more appropriate. Accordingly, a group of 24 methodologies has been examined for the extent to which they fulfil the following criteria:

1. Is the issue of impact significance considered at all, and, if so, is it handled discretely from impact magnitude?
2. Can the methodological guidelines for determining significance be described as:
   (a) precise and explicit?
   (b) non-existent?
   (c) intermediate between (a) and (b)?
3. Are directions given for aggregation of impacts for use in comparing project alternatives?
4. Does the methodology explicitly require an element of public participation?

Whilst it is recognized that the methodologies could arguably be represented as different points on a continuum, it is felt that six discrete groupings can be defined using the above criteria (see Figure 1) from which further assessment can proceed. By way of illustration, an example from each of the six groups is presented.

2.1. GROUP 1

The Water Resources Assessment Methodology (WRAM) (Solomon *et al.*, 1977) makes explicit use of scaling and weighting methods. Environmental, social and economic components are weighted by an interdisciplinary team using a ranked pairwise comparison technique. Scaling is achieved by three alternative approaches; the use of the scaling part of the weighted ranking technique; the use of function curves (see also Dee *et al.*, 1973); and the proportioning of resulting scaled impacts. Full details are included on how this scaling may be carried out. Values obtained for the effects of each alternative on specific environmental components are expressed in terms of "alternative choice coefficients". Weighting and scaling values are multiplied in a matrix to produce a final aggregate score for each alternative. At no stage is there an input of public opinion.

2.2. GROUP 2

The Crawford Methodology (Crawford, 1973) has less explicit guidelines than those exhibited in group 1. It was devised for use in highway route planning and makes

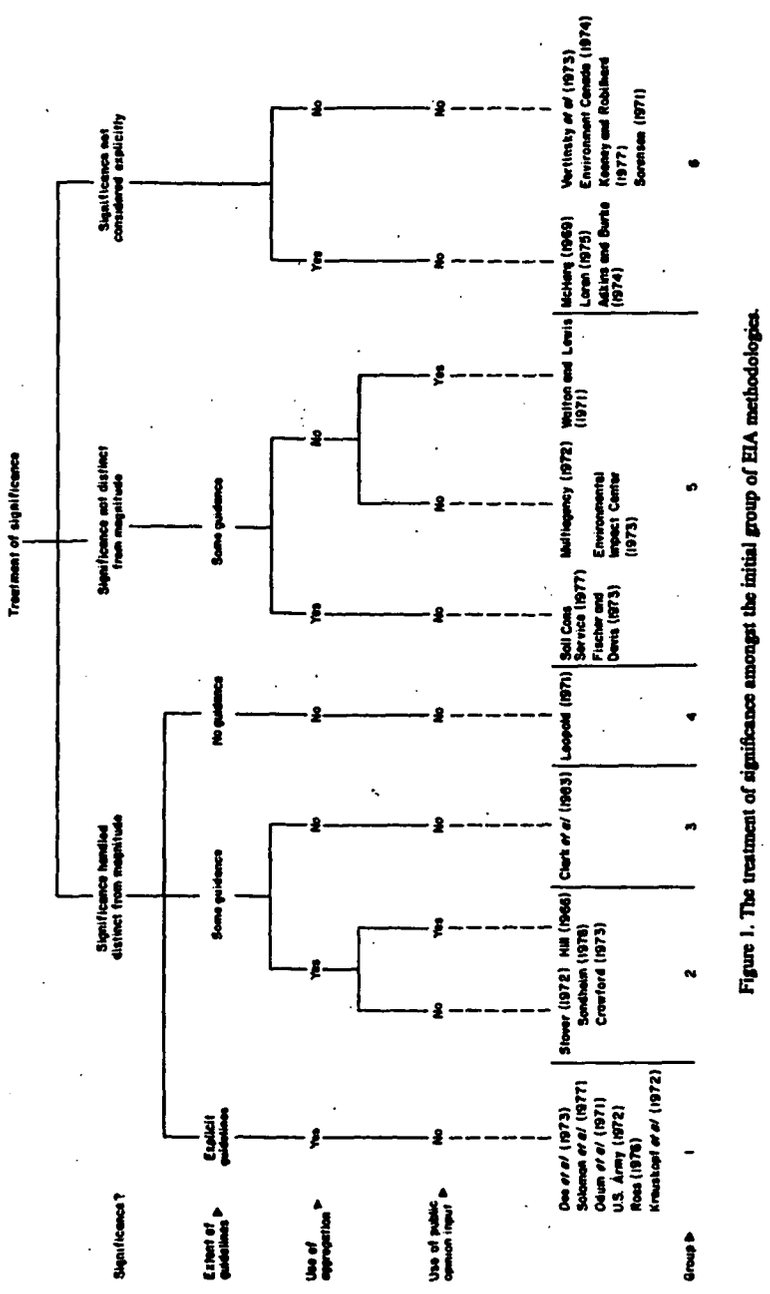

Figure 1. The treatment of significance amongst the initial group of EIA methodologies.

extensive use of public involvement by employing a Delphi technique on three reference publics to gather information for the following:

1. The assigning of relative weights.
2. The prediction of consequences for the alternatives to be evaluated.
3. Estimations of probability for the predicted consequences.
4. Numbers to represent the magnitude of the impact of each consequence on each evaluative criterion.

An interdisciplinary panel of experts is responsible for predicting consequences and estimating probabilities for each highway corridor alternative. Estimates of impact magnitude are developed on a seven point scale, from +3 to −3. The impact of an alternative on each of a set of evaluative criteria is then calculated by multiplying impact size by its probability. Results are then presented showing each highway alternative as a percentage of the maximum possible positive or negative impact. Crawford presents this as a basis for analysing the value trade-offs involved in a decision between project alternatives.

2.3. GROUP 3

The PADC methodology (Clark *et al.*, 1983) favours a dis-aggregated presentation of impacts (i.e. there is no attempt to group impacts under generic headings) and there is no specific mechanism for public involvement. Significance, for each impact, is determined by a choice on each of the following five polarities:

1. Adverse/Beneficial
2. Short-term/Long-term
3. Reversible/Irreversible
4. Direct/Indirect
5. Local/Strategic

Qualitative statements of significance such as this could clearly be aggregated by summing the numbers within each polarity. To do so would, however, implicitly weigh all impacts equally. No indication is given as to how comparisons between alternatives may be made, although the use of "Summary Sheets" as an aid to identification of important impacts is suggested. Ranking and weighting of impacts is also mentioned, but with a warning to guard against creating an "illusion of objectivity".

2.4. GROUP 4

The Leopold matrix (Leopold *et al.*, 1971) contains no guidelines on how significance should be determined. There is no attempt at aggregation of impacts, nor any input of public opinion. The technique influenced the development of many subsequent methodologies, employing matrix cells to relate project activities to environmental parameters. The matrix cells are bisected by a diagonal line, above which is entered a value for impact magnitude whilst below is placed a value for importance. Definitions of magnitude and importance are presented and it is proposed that:

> ... evaluations of the importance of impact, generally will be based on the value-ju[redacted]nt of the evaluator. (Leopold, 1971 p. 2).

A rating scheme from 1 to 10 is suggested as a means of discouraging purely subjective opinion and the method asks that impact statements should contain the reasoning behind the assignment of values for magnitude and importance.

2.5. GROUP 5

The Fischer and Davis methodology (Fischer and Davis, 1973) does not explicitly differentiate between impact magnitude and significance. A complex three-phase process is handled by an interdisciplinary team to develop an implicit indicator of significance. Impacts are assigned a "+" (benefit) or "−" (cost), for which some guidance is given, and the degree of impact from 1 (low) to 5 (high) is assigned subjectively by the team. Additionally an "s" or "l" suffix is used to indicate short-term or long-term impacts. Those achieving plus or minus 4 or 5 scores are transferred from an "environmental compatibility matrix" to a "decision matrix".

The exclusion of "low strength" impacts from the decision matrix can be seen as risking the loss of valuable information, or as focusing the study upon "key issues", depending upon one's viewpoint. The authors claim that the methodology:

> ... recognises that many decisions are based upon judgement and works to sharpen that judgement rather than increase precision at the expense of clarity. (Fischer and Davis, 1973, p. 225.)

2.6. GROUP 6

The Loran methodology (Loran, 1975) does not consider significance explicitly and makes no specific provision for input of public opinion. It uses a matrix of 234 project activities and 27 environmental features. Each element is scaled according to a forecast severity of impact from 0 (none) to 5 (severe) by the interdisciplinary team. The result is recorded using a computer algorithm and a primitive aggregation of impacts is achieved via a "clustering" of highly rated impacts.

It is suggested that the technique serves to identify critical environmental areas. No further evaluation is made and it is not clear how project variant discrimination should proceed. Neither is it clear how isolated high impact values, distant from the "clusters" should be treated.

2.7

The different approaches to handling impact significance, represented by the above examples, exhibit a wide range of techniques from highly quantitative through to qualitative. Whilst it is not suggested that any are ideal, many incorporate ideas or techniques that could be included in any useful EIA methodology. Having outlined the existing range of EIA methodologies, the following section presents a number of attributes which it is felt are either essential or desirable in an EIA methodology. On the basis of these attributes, the 24 methodologies are further evaluated.

3. Evaluation of EIA methodologies

Information gained from three sources namely: the review of 24 methodologies already presented, together with conclusions drawn from discussions with a number of EIA practitioners, and examination of general methodology reviews (see, for example,

Environmental Resources Ltd, 1981) provided the basis for the set of evaluative criteria that follows. It is felt that using the experience gained in the practical application of EIA to evaluate and criticise methodologies should serve to highlight a group of components to be included in any useful methodology. The wide variety of applications to which EIA can be put, however, precludes the possibility of defining a single technique of universal suitability. The following list of criteria should be used as a guide to Table 1 wherein the extent to which the methodologies fulfil the criteria is shown.

3.1. IS IMPACT SIGNIFICANCE CONSIDERED DISCRETE FROM IMPACT MAGNITUDE?

It is of paramount importance to the EIA process that an attempt is made to ascribe significance to any given impact. Not to do so is to leave a project unrelated to the proposed receiving environment. As each site is unique, it will respond in a unique way to any given development. Statements of impact magnitude will, therefore, differ in significance between any two sites. What the decision-maker requires is an expression of this significance. As applied to the 24 methodologies, this criterion differentiates between those that present raw or scaled data with a derived value to indicate significance, and those that simply present one value to indicate importance.

3.2. IS SEMI-AGGREGATION THE END RESULT OF THE PROCESS?

The attraction of an aggregate "final score" for each project alternative at the end of a complex assessment procedure is understandable. An "answer" may be felt to help justify expenditure of effort and resources. The main disadvantage of this approach is that scores mask the strengths and weaknesses within each project alternative. This works against the interests of effective project modification because information needed to perform trade-offs between different areas of impact is obscured.

In contrast, semi-aggregation, where impacts are grouped under any number of suitable headings such as "ecology" and "infrastructure" makes clear which project alternative will produce the best result in relation to any given heading. This allows the decision-maker to draw conclusions based upon a relatively small number of trade-offs and the degree of priority he or she feels is appropriate to different areas of concern. For instance, if "ecology" and "agriculture" are favoured, alternative "A" may be chosen, whilst weighting in favour of "housing" and "employment" might lead alternative "B" to be chosen.

Semi-aggregation should also help to avoid giving the misleading impression of scientific accuracy to which full aggregation of impacts is prone. It has been argued that the latter may be used to avoid scrutiny by members of the lay public. Bisset (1978) remarks that:

> Those who choose the method of assessment are able to make a strategic choice which may give a tactical advantage when pursuing a particular outcome. (Bisset, 1978, p. 56.)

He suggests that opposition views may be weakened by putting them through a method designed to overcome opposition and so remove assessment from public debate. Hobbs (1985) also advises caution on the use of impact amalgamation which, it is argued, should only proceed to a level consistent with maximum clarification of trade-offs. This leaves room for the essential subjective element of the assessment process that is the responsibility of the elected and accountable decision-maker.

3.3. ARE METHODS PROPOSED TO ENSURE PUBLIC PARTICIPATION?

The significance of an impact is essentially an expression of the cost or value of an impact to society. Beanlands and Duinker (1983) state that:

> ... what is really of concern at the decision-making level is the significance to society as determined through social and economic values. Significance ... cannot be confined to what we regard as biologically significant. (Beanlands and Duinker, 1983, p. 45.)

The focus of EIA, therefore, must be a judgement as to whether or not impacts are significant, based upon the value-judgements of society, or groups of people chosen to represent the wishes of society. As stated by Pattison (1976):

> Our benchmarks for clean air, clean water or clean streets have less to do with a definable "degrees above zero" than with what various members of the public consider acceptable or attainable. No matter how accurately the probability and magnitude of certain fish kills are quantified, the "impact" of such kills is essentially subjective. loaded with emotional factors not amenable to cost value analysis. It is the impact of a particular set of findings or predictions upon the minds of men, not the impact of the pollutant on the environment per se that is our key unknown. (Pattison, 1976.)

If this is accepted, then it is clear that an assessment of the way in which significance is handled by EIA methodologies should include consideration of the value-judgements made, whose values they actually represent, and whether or not they can be taken as representative of society as a whole.

Unless a methodology contains specific provision for an element of public opinion, there is a danger that the views of study-team members may exert undue influence upon the result. Few would question the use of experts to define impact magnitude, but leaving them as sole arbiters of significance is open to challenge. O'Riordan (1976) quotes Joseph Sax, a noted American lawyer and EIA advocate:

> ... the special knowledge of the highly trained mind produces its own limitations, and it may be argued that expertise sacrifices the light of common sense to the intensity of experience. It breeds an inability to accept new views from the very depths of its preoccupation with its own conclusions. ... There is also a class spirit about it so experts tend to neglect all evidence that does not come from their own ranks. Above all, where human problems are concerned, the expert fails to see that whatever judgements he makes, which are not purely factual in nature, bring with them a score of values which has no special validity about it. (O'Riordan, 1976, p. 279.)

An example of expert judgement likely to be at odds with public opinion can be found in the Battelle methodology (Dee *et al.*, 1973) where, as observed by Dickert and Domeny (1974) the assignment of over a third of possible weighting points to environmental pollution, whilst only 26 (out of a total 1000) go to housing and employment opportunities, is unlikely to find favour with those from low socio-economic groups.

There is a clear need to achieve a balance between expert opinion and the wishes of society in general. The assignment of weights in favour of long-term considerations such as the continued integrity of ecological systems may be at odds with the more immediate socio-economic needs of large sections of society, but, if the EIA process is to gain the support of the general public, then their immediate needs cannot be overlooked.

TABLE 1. Performance of 24 methodologies against the 15 evaluation criteria

Methodology

Evaluative criteria	Group 1: Dee *et al.* (1973)	Tulsa U.S. Army (1972)	Odum *et al.* (1971)	U.S. Army (1972)	Ross (1976)	Krauskopf and Bunde (1972)	Group 2: Slover (1972)	Hill (1966)	Sondheim (1978)	Crowford (1973)
1 Significance is considered discrete from magnitude										
2 Semi-aggregation is the end result of the process										
3 Methods proposed to ensure public participation										
4 Level of qualification is restricted to be adequate										
5 Quantitative and qualitative data presented together										
6 Study team influence on the outcome not excessive										
7 Structured group decision-making technique suggested										
8 Development of low impact alternatives encouraged										
9 When weighting performed a number of iterations used										
10 Methodology easily adopted for any type of project										
11 Progression through stages of assessment is explicit										
12 Promotes targeting resources to a decision										
13 Trade-offs are presented clearly										
14 Contains a technique that is a useful analytical tool										
15 Resource needs unlikely to be excessive										

Evaluative criteria	Group 6: Tenen (1971)	Beaney and Robilliard (1973)	Environment Canada (1974)	Vertinsky *et al.* (1973)	Adkins and Burke (1974)	Group 4: Loran (1975)	McHarg (1967)	Group 3: Wilton and Lewis (1971)	Env. Impact Center (1973)	Multiagency Task force (1972)	Fisher and Davis (1973)	Soil Cons. Service (1977)	Leopold *et al.* (1971)	Clark *et al.* (1983)
1 Significance is considered discrete from magnitude														
2 Semi-aggregation is the end result of the process														
3 Methods proposed to ensure public participation														
4 Level of qualification is restricted to be adequate														
5 Quantitative and qualitative data presented together														
6 Study team influence on the outcome not excessive														
7 Structured group decision-making technique suggested														
8 Development of low impact alternatives encouraged														
9 When weighting performed a number of iterations used														
10 Methodology easily adopted for any type of project														
11 Progression through stages of assessment is explicit														
12 Promotes targeting resources to a decision														
13 Trade-offs are presented clearly														
14 Contains a technique that is a useful analytical tool														
15 Resource needs unlikely to be excessive														

X = qualifies in criterion

alternatives should be encouraged and resources targeted towards a clear presentation of trade-offs.

A number of other points are worthy of consideration prior to the formulation of an approach to any EIA.

3.17. CLARIFICATION OF ASSESSMENT GOALS

A correct approach to EIA requires thorough forward planning. The aim of the study must be clearly defined, based on an understanding of the exact nature of the decision to be made. Project resources can then be directed towards a continual clarification of the main issues involved and a sharpening of the judgement of the team responsible for the study. Specific assessment techniques should be selected to perform appropriate tasks and not used simply because they are suggested in any set of guidelines.

3.18. PRESENTATION OF DATA

Where both quantitative and qualitative data are presented, care should be taken that the former are not given undue emphasis. The conversion of raw data by scaling, ranking or rating, results in a loss of information that may be both of use and readily comprehensible to the decision-maker. If it is accepted that a semi-aggregated presentation of data under broad impact-type headings is of most use to a decision-maker, then complex data manipulations can be avoided. Qualitative impact descriptions, combined with quantitative data where appropriate, should suffice to indicate which project option is favourable for any given impact type. It is then for the decision-maker to make the necessary value-judgements.

The presentation techniques chosen should serve to highlight trade-offs. The use of checklists, matrices, graphs, summary tables and transparent map overlays may all be of value as long as their use is integral to the assessment, and not merely cosmetic. Such graphic presentation may be very persuasive and should be justified by the importance of the information it represents.

3.19. THE STUDY-TEAM INFLUENCE

All decisions made by the study-team should be adequately documented if possible in the main body of the report and not in appendices or additional volumes. Whilst the attraction of separating details of the techniques employed is understood, it is necessary that the decision-maker and any lay-readers have the reasons for any decision or line of procedure readily to hand. If not, their understanding of the report will be incomplete.

The use of structured group decision-making techniques should be considered by the study-team to ensure that a true consensus of views within the group is reached.

3.20. UNSUITABLE TECHNIQUES

It is recommended that the degree of quantification of impacts should be carefully regulated, particularly in cases where only a few project alternatives exist, and a relatively "coarse" assessment may be adequate to determine the standing of each alternative with respect of any particular impact. Further refinements, which are unnecessary to the decision, may prove costly in time and money and might only serve to complicate the issue.

It is strongly recommended that methodologies which proceed through full aggregation of impacts to a "final score", should not be used as an assessment technique, the results of which are intended for use by the decision-maker. Such an approach would remove the decision from those appointed or elected for that purpose and place it in the hands of the study-team. There is, however, a strong case for using certain component techniques from such methodologies as in-house tools for the clarification of certain impacts.

Arbitrary weighting schemes that are the product of study-team preferences should also be avoided. The impression gained from consultation with EIA practitioners is that weighting of impacts is commonly performed, but most agreed that it is necessary to confine this weighting to an in-house procedure. If a public consultation process is operating, the basis of a weighting scheme not derived solely from expert opinion should be readily to hand.

4. Future training and research

An awareness and understanding of the use of quantitative techniques is essential to the production of good EIAs in the future. Appreciation of their merits, limitations and most appropriate areas of application will hopefully serve to eliminate the use of numbers for their own sake. In its place must come appropriate quantification, i.e. quantification that is both reserved for impacts that lend themselves to such treatment and that results in a clarification and not a clouding of the issues. Accordingly, competence in the performing of impact prediction, scaling, weighting and aggregation is essential for the analyst. This competence should, however, be accompanied by an appreciation that the role of these techniques is best restricted to the in-house level.

A point worthy of strong emphasis, when training future EIA practitioners, is that standard methodologies and techniques are, in every case, of secondary importance to an appreciation of the unique nature of the project and its interaction with the environment. Quantitative techniques should be seen as useful tools to aid the evaluation and expression of this interaction. Otherwise, a pre-occupation with comprehensive assessment methodologies runs the risk of reducing the project's status to that of a source of raw data with which to complete the various "boxes" of a methodology.

Prediction, probability and risk analysis are areas in which improvements in information and understanding would benefit the EIA process, by working towards more reliable statements of impact magnitude.

Study could also usefully be made of current trends and practice in public consultation. Within the field of EIA, this study will determine the current state and highlight areas of deficiency. A study of related fields where information is gathered from populations may provide a number of techniques which could be applied innovatively in EIA.

It is important that the products of any such research are effectively communicated. Alerting the developers responsible for large projects to the benefits of public consultation is worthwhile, one of the main benefits being the avoidance of costly and protracted public inquiries.

The range of methods available to a study team for maximising the objectivity of their output is also worthy of study. Useful options must exist in other fields, which could be applied to the EIA process.

References

Adkins, W. G., and Burke D. Jr. (1974). *Social, Economic and Environmental Factors in Highway Decision-Making*. Research Report 148, Texas A and M University College Station, Texas.

Allett, E. J. (1986). Environmental impact assessment and decision analysis. *Journal of Operational Research Society* 37, 901–910.

Baumann, N., Ervin, O. and Reynolds, G. (1982). The policy Delphi and public involvement programs. *Water Resources Research* 18, 721–729.

Beanlands, G. E. and Duinker, P. N. (1983). *An Ecological Framework of EIA in Canada*. Institute for Resource and Environmental Studies, Dalhousie Uni.

Bissett, R. (1978). Quantification, decision-making and environmental impact assessment in the U.K. *Journal of Environmental Management* 7, 43–58.

Bissett, R. (1980). Methods of environmental impact assessment: recent trends and future prospects. *Journal of Environmental Management* 11, 27–43.

Clark, B. D., Chapman, K., Bisset, R., Wathern, P. and Barrett, M. (1983). *A Manual for the Assessment of Major Development Proposals*. PADC Aberdeen University. London: HMSO.

Council of the European Communities (1985). Council Directive 85/337/EEC. *Official Journal of the European Communities*.

Crawford, A. B. (1973). *Impact Analysis Using Differentially Weighted Evaluation Criteria*, in *Multiple Criteria Decision Making*. Cochrane, J. L., and Zeleny, M. (eds). Columbia, SC: University of South Carolina Press.

Dee, N., Drobny, N., Duke, K., Whimann, I., Fahringer, D. (1973). An evaluation system for water resources planning. Battelle *Laboratory Water Resources Research* 9, 523–535.

Delbecq, A. L. and Van De Ven, A. H. (1974). The effectiveness of nominal, Delphi and interacting group decision-making processes. *Academy of Management Journal* 17.

Dickert, T. G. and Domeny, K. R. (eds). (1974). *Environmental Impact Assessment: Guidelines and Commentary*. Berkeley, California.

Eliott, M. L. (1981). Pulling the pieces together: amalgamation in EIA. *EIA Review* 2, 11–38.

Environmental Impact Centre, Inc. (1973). A Methodology for Assessing the Environmental Impact of Water Resources Development. PB-226 545. U.S. Dept. of the Interior, Bureau of Reclamation, Denver, Colorado.

Environmental Resources Limited. (1981). *Environmental Impact Assessment. Studies on Methodologies, Scoping and Guidelines*. Final Report for the Govt. of the Netherlands. London: ERL.

Environment Canada. (1974). *An Environmental Assessment of Nanaimo Port Alternatives, Ottawa*. Environment Canada.

Ertel, M. O. (1979). A survey research evaluation of citizen participation strategies. *Water Resources Research* 15, 757–763.

Fischer, D. W., and Davis, G. S. (1973). An approach to assessing environmental impacts. *Journal of Environmental Management* 1, 207–227.

Hill, M. (1966). A method for evaluating alternative plans: the goals-achievement matrix applied to transportation plans. Ph.D. Dissertation, University of Pennsylvania, Philadelphia, PA.

Hobbs, B. F. (1985). Choosing how to choose: comparing amalgamation methods for EIA. *EIA Review* 5, 301–319.

Hollick, M. (1981). The role of quantitative decision-making methods in environmental impact assessment. *Journal of Environmental Management* 12, 65–78.

Kane, J., Vertinsky, I. and Thompson, W. (1973). A methodology for interactive resource simulation (KSIM). *Water Resources Research* 9, 65–79.

Keeney, R. L. and Robilliard, G. A. (1977). Assessing and evaluating environmental impact at proposed nuclear power plant sites. *Journal of Environmental Economics and Management* 4, 153–66.

Krauskopf, T. M. and Bunde, D. C. (1972). Evaluation of environmental impact through a computer modelling process. In *Environmental Impact Analysis—Philosophy and Methods*, Ditton, R. and Goodale, T. (eds), pp. 107–125. Madison WI: University of Wisconsin Sea Grant Program, 107–125.

Leopold, L. R., Clark, F. A., Henshaw, B. R. and Balsey, J. R. (1971). *A Procedure for Evaluating Environmental Impact*. U.S. Geological Survey Circular 645.

Loran, B. (1975). Quantitative assessment of environmental impact. *Journal of Environmental Systems* 5, 247–256.

McAllister, D. M. (1980). *Evaluation in Environmental Planning. Assessing Environmental, Social, Economic and Political Tradeoffs*. Cambridge, MA: MIT Press.

Matthew, W. H. (1975). Objective and subjective judgements in environmental impact assessment. *Environmental Conservation* 2, 121–131.

McHarg, I. L. (1969). *A Comprehensive Highway Route Selection Method, in Design with Nature*, pp. 31–41. New York: Doubleday.

Multiagency Task Force. (1972). *Guidelines for Implementing Principles and Standards for Multi-objective Planning of Water Resources, Review Draft*. Washington, D.C.: U.S. Bureau of Reclamation.

Odum E. P. (1971). *Optimum Pathway Matrix Analysis Approach to the Environmental Decision Making Process: Test Case. Relative Impact of Proposed Highway alternatives*. Athens, GA: University of Georgia, Institute of Ecology.

O'Riordan, T. (1976). *Environmentalism*. London: Pion.

Pattison, E. S. (1976). The key ecological unknown. *Technology Review* 3.

Ross, J. M. (1976). *The Numeric Weighting of Environmental Interactions*. Occasional Paper No. 10. Ottawa Lands Directorate, Environment Canada.

Soil Conservation Service (1977). *Guide for Environmental Assessment*. U.S. Dept. of Agriculture.

Solomon, R. C., Colbert, B. K., Hansen, W. J., Richardson, S. E., Canter, L. and Vlachos, E. C. (1977). *Water Resources Assessment Methodology (WRAM) Impact Assessment and Alternative Evaluation*. Technical Report No. Y-77-1 Vicksburg, Mississippi, U.S. Army Corps of Engineers.

Sondheim, M. W. (1978). A comprehensive methodology for assessing environmental impact. *Journal of Environmental Management* 6, 27–42.

Sorensen, J. (1971). *A Framework for Identification and Control of Resource Degradation and Conflict in the Multiple Use of the Coastal Zone*. Berkeley, CA: Dept. of Landscape Architecture, University of California at Berkeley.

Stover, L. V. (1972). *Environmental Impact Assessment. A Procedure*. Miami, FL: Sanders and Thomas.

Thompson, M. A. (1988). The determination of impact significance in environmental impact assessment. MSc. Thesis. University of Manchester.

U.S. Army Corps of Engineers, Tulsa District (1972). *Matrix Analysis of Alternatives for Water Resources Development*, Draft tech. paper. Tulsa, OK.

Walton, L. E. and Lewis, J. E. (1971). *A Manual for Conducting Environmental Impact Studies. VHRC 70-R46*. 39pp. Vehicle Highway Research Council, Charlottesville, VA.

Mitigation

Mitigation measures are actions designed to minimize or to compensate for undesirable impacts of a proposed activity. Furthermore, they are often the focal points for opposition and debate relative to projects. (Canter et. al 1991; Attachment 4.H). Although the U.S. regulations implementing NEPA include avoidance as a mitigation measure, many practioners make a distinction between avoidance as a mitigation measure and other types of mitigation [i.e., reducing or eliminating parts of the proposed activity; repairing, rehabilitating, or restoring the affected environment; instituting management practices over the life of a project to reduce or eliminate the impact; or replacing or providing substitute resources or environments (i.e. compensation) (Table 4.5-1)]. These categories of mitigation are arranged in order of their desirability; compensation is the least desirable approach.

Table 4.5-1. Categories of Mitigation. (Source: Adaptation of Council on Environmental Quality Regulations, 40 CFR 1508.20)

1. Avoidance:	Mitigation by not carrying out the proposed action or the unacceptable parts of the proposed action. For example, if the only area available for a regional airport happens to be an area of extensive wetlands that would be filled in by construction of the airport, avoidance of the action might be the only reasonable way to protect those wetlands.
2. Minimization:	Mitigation by scaling-down the magnitude of a project, reorienting the layout of the project, or employing technology that reduces the factors generating the undesirable environmental impact. For example, the treatment capacity of a wastewater treatment plant discharging to a river might be reduced or it might be required to use advanced water treatment techniques.
3. Rectification:	Mitigation through the restoration of environments affected by the action. For example, areas cleared for the installation of pipelines or power lines can be regraded and then replanted with native vegetation.
4. Reduction:	Mitigation by taking maintenance steps during the course of the action. For example, stormwater management systems can be designed to trap sediments from developed areas.
5. Compensation:	Mitigation through the creation, enhancement or acquisition of environments similar to those affected by an action. This step should only be considered after all steps above have been completed. As a last resort, donation of land or money for a regional program of habitat creation or enhancement could be considered.

Ideally, potential impacts of a proposed activity are identified early during the initiation and scoping stages of a project and all reasonable means to avoid and minimize impacts are incorporated into the alternatives that are being considered. Compensation for the remaining impacts is a final stage of mitigation.

If the acceptability of an alternative depends on fulfillment of certain mitigation measures, then it is important to clearly specify and consider the mitigation measure(s) in the analysis of alternatives and to ensure that any mitigation measures are incorporated into the final decision on the proposed activity. Records of decision in the United States must identify the mitigation measures and the monitoring and enforcement programs that the agency has committed to adopt. These commitments are legally enforceable when they are included in permits, licenses or grants. However, other than monitoring for conditions written into permits, licenses or grants, the EA laws of most countries, (excepting the United States and The Netherlands) do not explicitly require post-EA monitoring for the effectiveness of mitigation measures. Thus, there is generally no motivation to confirm that mitigation measures identified during the planning stages of a proposed activity and/or written into a decision document are actually carried out.

NEEDS

- Effective mitigation planning based on the availability of information for and understanding of the proposed activity, its potential impacts, and the affected environment.

- Identification of realistic mitigation goals and measures. Innovative approaches and attitudes should be encouraged in solving problems and developing mitigation plans. The public may provide acceptable ways of resolving local issues of concern (Attachment 6.A).

- Identification of any local, regional, tribal, national or international laws, regulations, or standards that may affect proposed mitigation measures. For instance, the U.S. Surface Mining Control and Reclamation Act has requirements which must be undertaken to avoid, reduce or compensate for adverse impacts of mining activities.

- Surveillance and legal and regulatory enforcement of mitigation measures. Non-governmental organizations can play an important role in overseeing the effectiveness of mitigation actions.

- Periodic evaluation of mitigation measures and subsequent modification as appropriate (Chapter 6).

TOOLS

- Checklists

  - For many major activities, the environmental issues and potential environmental impacts are well known and there are recognized common mitigation measures. Checklists, either computerized or otherwise are a good way to screen proposed activities for potential impacts and to identify potential mitigation measures. The U.S. Army Construction Engineering Research Laboratory (Champaign, Illinois) operates an Environmental Impact Computer System that indicates, for various project activities, the probability of impact occurrence, why the activity was scored as it was, and ways to lessen or avoid the impacts of the activity. The World Bank has recently published (1991) an Environmental Assessment Sourcebook that reviews the major issues and provides checklists of potential negative impacts and mitigating measures for 32 different development, urban, energy, and industry projects (Attachment 2.B).

- Case Studies

  - Review of EA documents for similar projects is a useful way to identify potential impacts and associated mitigation measures. Canter et al. (1991) summarized the general biological impact mitigation measures for wastewater treatment projects, surface mining operations and highway projects found in 18 environmental impact statements and three project reports (Attachment 4.H). Certain impacts were generic to nearly all major construction activities; operational phase impacts were addressed less frequently. The specifics of the mitigation measures varied in accordance with the location and magnitude of the proposed activity. Table 4.5-2 summarizes the predicted impacts and associated mitigation measures of these 21 studies. It is not meant to be all inclusive but is included here as an indication of some of the approaches to mitigation.

Table 4.5-2. Summary of Impacts and Mitigation Measures for 21 Projects (Eight Wastewater Treatment Facilities, Five Surface Mining Operations, and Eight Highway Construction Projects. Adapted from Canter et. al. 1991).

Impact	Mitigation Measure
Loss or disturbance of vegetation	Limit/zone areas to be cleared; Conserve topsoil; Revegetation program; Management of reclaimed lands; No use of herbicides or defoliants
Disruption or loss of wildlife (including habitat and nesting areas)	Consult wildlife agencies; Minimize habitat disturbances; Avoid sensitive areas; Replacement of affected areas (e.g., nesting area); Creation of aquatic habitat (ponds); Enhancement of habitat; Plan activities around critical periods for wildlife (e.g., migration, spawning); Management program; Bus transportation to work site
Erosion and sedimentation	Schedule activity during dry months; Buffer zones along streams; Limit area disturbed at any one time; Avoid stream crossing by boring beneath or bridging across; Temporary cover crops prior to revegetation; Use of silting basins, traps; Keep excavation materials away from streams; Slope contouring; rip-rap on bridges and approach slopes; Stream reconstruction
Potential introduction of toxic substances into soil or surface water	Control rate of application to acceptable amounts; Dike treatment works, storage tanks, etc.

- Design specifications
  - During initiation, mitigation measures applicable to design, construction, operation, and abandonment should be defined and subsequently incorporated into final design documents (e.g., best engineering practices; practices specified by state and local requirements for construction such as erosion control; American Society for Testing and Materials Standards). Consultation among project managers, engineers, and environmental staff helps bring about clear direction on mitigation through planning, design, project phasing, construction techniques and scheduling. Some measures must be individually adapted to specific project situations, others can be drawn from reliable resource documents with acceptable mitigative

measures (e.g., Forest Service Management Plans). Individual or innovative measures should be field tested to verify their adequacy under a range of conditions prior to wide-spread use.

Once mitigative measures have been incorporated into project planning and design, the remaining potential impacts are evaluated during the analysis of alternatives. The remaining (residual) impacts resulting from the project-environment interactions will consist of those which were reduced but not eliminated by mitigative measures and those for which mitigative measures were not necessary, not possible or not implemented. Residual impact analysis can also identify the persistence and duration of any impacts that may extend beyond the life of the project, including permanent environmental alterations.

- Expert judgment

  - The value of expert judgment in the choice and design of mitigation measures (and to the EA process; Part 4.3) lies in the ability of the professional to: sort through irrelevant information to get to the root issue; reach solutions using incomplete data; make finer categorical distinctions than non-experts; and perceive recurring patterns in a problem and to associate solutions to the patterns. This ability is based on conceptual, analytical and experimental knowledge acquired through training and practice. The principal limitations to expert judgment in EA relate to the quality of expertise and the uncertainty inherent in the judgment and reasoning of the expert. Moreover, there is often a great diversity of opinion among experts on any given environmental question (Nelson 1990). Nevertheless, there are experts on mitigation who should be consulted on practices such as revegetation, wetland reclamation, and erosion control.

ISSUES

- Mitigation strategies may require integrated planning and negotiation to reduce conflicts with local views, needs, and customs and local, state, tribal, and other federal agencies (Attachment 6.A).

- Institutional arrangements for implementing and evaluating mitigation measures must be defined, agreed to, and adequately budgeted for at the time of decisionmaking. Mitigation, to be meaningful, must be able to last over time thus the need for post-project analysis and financial guaranties to ensure that if mitigation does not succeed initially, as proposed, further efforts will be made to achieve the objectives described in the decision document. The selected alternative and its associated mitigation then become the basis for the conditions of permits, contracts, and the detailed design of the project.

- There are many approaches to identifying potential mitigation measures for adverse biological impacts of proposed projects (e.g., checklists, computerized systems, case studies, professional judgment). However, the information provided is mostly generic and must be adapted to site-specific conditions; the methodologies have not been used extensively as a part of the EA process; and data are lacking on the effectiveness of the mitigation measures.

- The reasons given by Lee (1987) for lack of success in mitigation for wetland loss are applicable to other situations as well. These include:

  - inaccurate bounding/delineation of the predicted impact;
  - use of mitigation as a means to access the resource and/or to assuage regulators;
  - inadequately developed or understood technical means to achieve the mitigation objectives;
  - use of spatial and temporal scales for mitigation that are inconsistent with site-specific impacts;
  - lack of project continuity; although goals are set and planning is completed, projects are never begun, finished, or monitored for success.

- Care must always be taken that a mitigation measure does not shift a problem in one medium to another medium (e.g., air pollution to waste disposal)

LINKAGES

Consideration of mitigation measures is linked to each element of the EA process. During the early planning stages of initiation, determination of the need for and development of mitigation measures starts with the proponent and continues during scoping with input from the public and other agencies. During

the assessment stage, mitigation measures are factored into the analysis of alternatives. For decisionmaking, EA documentation should include the options for mitigation of impacts for each of the alternatives if necessary. Throughout implementation of the project (i.e., construction, operation, and abandonment), post-decision analysis should evaluate the impacts and the effectiveness of mitigation measures to allow for modification of the project or development of addition mitigation measures in case of unpredicted impacts. A post-decision analysis of mitigation measures provides feedback on the accuracy of impact predictions and the effectiveness of the mitigation in order to transfer the experience to future activities of the same type.

REFERENCES

Canter, L. W., J. M. Robertson, and R. M. Westcott. 1991. Identification and evaluation of biological impact mitigation measures. Journal of Environmental Management 33:35-50.

Lee, L. C. 1987. Mitigation for wetland loss: how much is appropriate? In: Environmental Impact Assessment, Proceedings of a Conference on the Preparation and Review of Environmental Impact Statements (ed. N. A. Robinson). New York State Bar Association, One Elk Street, Albany, New York 12207.

Nelson, R. W. 1990. Can experts agree on policy directions toward wetlands and agriculture? The Environmental Professional 12:131-143.

World Bank. 1991. Environmental Assessment Sourcebook. Volumes I, II, III. The World Bank, Washington, D.C.

ATTACHMENT 4.H

MITIGATION MEASURES

- Canter, L. W., J. M. Robertson, and R. M. Westcott. 1991. Identification and evaluation of biological impact mitigation measures. Journal of Environmental Management 33:35-50.

Identification and Evaluation of Biological Impact Mitigation Measures

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Identification and Evaluation of Biological Impact Mitigation Measures

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Identification and evaluation of mitigation measures for adverse biological impacts of proposed projects are often the focal points for opposition and debate relative to the projects. This paper delineates several positive approaches for both identifying and evaluating potential mitigation measures. Identification approaches include the review of utilized measures for similar projects, computer-based literature and information searches, and the use of computer-generated checklists of potential measures. Utilized measures for eight wastewater treatment projects, five surface mining operations and eight highway projects are described. Evaluation approaches include post-EIS environmental monitoring, pre-project qualitative evaluation based on case studies, and pre-project quantitative evaluation using structured habitat-based methods. Based upon this review, it has been determined that there are an ample number of approaches which can be used to identify potential mitigation measures for the adverse biological impacts of proposed projects. However, while systematic methodologies are available for evaluating the potential effectiveness of mitigation measures, these methodologies have not been used extensively as a part of the EIS process. Additional attention needs to be given to the incorporation of mitigation evaluation schemes in pre-project environmental impact studies.

Keywords: **environmental impact, monitoring, wastewater, mining, highway projects**

1. Introduction

Planning and implementation of appropriate mitigation measures for adverse biological impacts represent important activities in the environmental impact assessment process. Actual mitigation measures may encompass several techniques. For example, the Council on Environmental Quality (CEQ) in the United States has indicated that impact mitigation should include the sequential consideration of the following (Council on Environmental Quality, 1978): (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating or restoring the affected environment; (4) reducing or eliminating the impact over

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time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

Sequential consideration suggests that the more easily implemented techniques should be selected first, for example, avoiding impacts or minimizing impacts. Compensation would only be considered if other techniques do not completely satisfy the mitigation needs. It should also be noted that the techniques are not mutually exclusive, that is, several might be used in combination in an overall mitigation plan for a given project.

The purpose of this paper is to document several approaches which can be used to identify both potential biological impact mitigation measures and evaluate their potential effectiveness prior to and following implementation. The paper will begin with background information on the institutional requirements for mitigation; this will be followed by the delineation of several approaches for the identification and evaluation of specific mitigation measures.

2. Institutional requirements for mitigation

The generic legislation within the United States which calls for biological impact mitigation is the National Environmental Policy Act (NEPA) of 1969 (PL 91-190). Procedures for implementing the environmental impact statement (EIS) requirements of NEPA have been developed by the CEQ. Agencies within the United States are required to prepare records of decisions (RODs) on projects having EISs. The RODs must state what the decision was and identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives which were considered to be environmentally preferable (Council on Environmental Quality, 1978). In addition, the RODs shall state whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation program.

Several specific environmental quality and natural resources protection laws have been adopted within the United States. These laws typically include policies and implementation requirements for biological impact mitigation measures. Table 1 includes an example listing of some of these laws. Two notable laws in addition to NEPA are the Surface Mining Control and Reclamation Act (SMCRA) which delineates mitigation requirements directed toward restoring habitat disturbed by surface mining operations; and the Endangered Species Act (ESA) which addresses requirements for the protection of habitat for threatened or endangered plant or animal species.

3. Identification of mitigation measures

Systematic approaches can be used to identify potential mitigation measures for the adverse biological impacts of proposed projects. A complete review of all approaches is beyond the scope of this paper; however, three examples will be presented: (1) review of utilized measures for similar projects; (2) use of specific literature-based information on appropriate measures for reducing particular adverse impacts; and (3) use of a computer-generated checklist of potential mitigation measures. The review of EISs and guidance documents can be useful in gaining insight into mitigation requirements and practices. To illustrate this usefulness, examples for United States projects in

TABLE 1. Example listing of United States laws which may directly or indirectly address biological impact mitigation measures

Anadromous Fish Conservation Act
Bald Eagle Protection Act
Clean Air Act
Clean Water Act
Coastal Zone Management Act
Comprehensive Environmental Response, Compensation and Liability Act (Superfund)
Endangered Species Act
Federal Insecticide, Fungicide and Rodenticide Act
Fish and Wildlife Coordination Act
Golden Eagle Protection Act
Marine Mammal Protection Act
Marine Protection, Research and Sanctuaries Act
Migratory Bird Conservation Act
National Environmental Policy Act
Resource Conservation and Recovery Act
Superfund Amendments and Reauthorization Act
Surface Mining Control and Reclamation Act
Toxic Substances Control Act
Wild and Scenic Rivers Act
Wild Horses and Burros Protection Act

categories—wastewater treatment facilities, surface mining operations and highway projects—will be presented.

3.1. UTILIZED MITIGATION MEASURES FOR WASTEWATER TREATMENT PROJECTS

Development and implementation of wastewater treatment systems are presumed to be beneficial to the physical-chemical and biological environments in that the pollutional components of wastewater discharges are minimized. While this is generally true, there may be many adverse impacts associated with wastewater treatment facilities, including those that occur to the biological environment. Table 2 contains a summary of the general biological impact mitigation measures identified in eight EISs. Four major biological impacts were associated with the construction phases of the facilities, including two direct impacts (loss of vegetation and disruption of wildlife) and two indirect impacts (erosion and sedimentation, and destruction of streams and degradation of water quality). The most frequently used mitigation measure was a revegetation program. Operational phase impacts were less frequently addressed and include only two issues: (1) problems from land application of wastewater; and (2) eutrophication from nutrient additions or accidental discharges.

Construction phase erosion represents one of the major impact of concern for wastewater treatment plants. Basic information necessary for estimating erosion in-

TABLE 2. Summary of biological impact mitigation measures for eight wastewater treatment facilities

Impact	Mitigation measure	Wastewater treatment facility† 1	2	3	4	5	6	7	8
Construction phase									
Loss of vegetation	Revegetation programme	+‡	+	+		+	+	+	+
	Reduced destruction by zoning construction areas	+				+		+	
	No use of herbicides or defoliants					+			
Disruption of wildlife	Plan activities around critical periods for wildlife	+	+	+				+	
	Minimize habitat disturbance			+		+		+	
Erosion and sedimentation	Plan activities during dry months	+	+			+			+
	Use temporary cover crops or immediate revegetation	+		+			+	+	+
	Use silt basin and structures to catch silt in runoff					+	+		+
Destruction of streams and degradation of water quality	Accomplish stream crossings by boring beneath or bridging across					+		+	+
	Keep excavation materials away from stream							+	+
Operational phase									
Land application of wastewater to vegetated areas	Control rate of application to acceptable amounts	+	+						
Eutrophication and/or degradation of water quality	Use non-phosphate detergents				+				
	Enclose major treatment works with dikes			+					

† The facilities are in: (1) El Paso, Texas (U.S. Environmental Protection Agency, 1980); (2) Steamboat Springs, Colorado (U.S. Environmental Protection Agency, 1977); (3) Fort Worth, Texas (U.S Environmental Protection Agency, 1983*b*); (4) Benaie County, Michigan (U.S. Environmental Protection Agency, 1979); (5) Norman, Oklahoma (U.S. Environmental Protection Agency, 1982*a*); (6) Tulsa, Oklahoma (U.S. Environmental Protection Agency, 1982*b*); (7) Monterey, California (Monterey Peninsula Water Pollution Control Agency *et al.*, 1977); and (8) Bloomington, Indiana (U.S. Environmental Protection Agency, 1976).

‡ Plus sign denotes mitigation measure mentioned in the EIS for the facility.

cludes selected soil properties such as erosion potential, soil suitability for various land uses and geographical distribution. This information can be procured from several sources, including a computer data base called SOILS; this data base is part of the Environmental Technical Information System of the U.S. Army Construction Engineering Research Laboratory (U.S. Army Construction Engineering Research Laboratory, 1988). The information in soils is from the data collection program of the U.S. Soil Conservation Service.

Commonly used erosion mitigation measures include planning construction during drier months so that there is less potential for the impact, and revegetation involving seeding or replanting the area as soon as possible. Physical measures involve the building of dikes, diversions and stabilizing structures. Table 3 addresses erosion and sedimentation impacts and mitigation measures as related to wastewater treatment facilities; included are some alternative revegetation enhancement methods (FitzPatrick *et al.*, 1977). There are ample mitigation measures which can be used to minimize the detrimental biological impacts which might occur as a result of erosion during the construction phase for wastewater treatment facilities.

3.2. UTILIZED MITIGATION MEASURES FOR SURFACE MINING OPERATIONS

Surface mining activities may cause numerous undesirable impacts on the biological environment. The key law related to mitigation measures for surface mining operations

TABLE 3. Mitigation measures for erosion during wastewater treatment facility construction (FitzPatrick *et al.*, 1977)

Plan development based on drainage patterns, topography and soils of site.
Avoid removal of trees and surface vegetation wherever feasible.
Minimize exposed land area and duration of exposure.
Divert runoff around exposed areas to stabilize outlets.
Provide temporary cover on areas of critical erosion hazards, and establish permanent cover as soon as possible.
Construct impoundments to trap sediment and reduce runoff peaks before flow leaves the construction areas.
Fording streams should be carried out by bridging, sheeting, using conveying equipment, or constructing a stabilized roadbed into and through the stream.
Control soil by revegetation and mulching bare slopes (netting over mulch may increase effectiveness of mulching). Examples of revegetation enhancement methods include:
(a) Grading of spoil areas; if revegetation must be delayed, cover area with tarpaulin, burlap or mulch.
(b) Dikes and ditches to control runoff.
(c) Development of adequate fertility of denuded soil (treated wastewater is good for vegetation growth).
(d) Shallow tillage of area immediately prior to seeding.
(e) Seed mixture containing fast and slow growing species.
(f) Mulching area which has been seeded or planted.
(g) Supplemental controlled irrigation until growth established.

is the SMCRA of 1977. Section 501(b) of SMCRA requires that a permanent regulatory program be implemented, and the regulatory program which has been developed contains requirements which must be undertaken as a part of mining activities. These requirements may be considered as mitigation measures in that they avoid, reduce or

TABLE 4. Summary of biological mitigation measures suggested by the regulatory program as mandated by Section 501(b) in SMCRA (U.S. Department of Interior, 1979)

Biological impact	Possible mitigation measures/requirements of regulatory program
Loss of wildlife and wildlife habitat	A wildlife protection plan is required as part of mining permit application
	Wildlife agencies will be consulted
	Timing, shaping and sizing operations will be conducted to avoid breeding or nesting season and trees, protecting key food, cover and water resources
	Fencing will keep large mammals from direct contact with toxic chemicals in sedimentation ponds and from roadways to reduce number of roadkills
	Revegetation will use species with high nutritional or cover value
	Topsoil handling and replacement prior to revegetation will be conducive to wildlife
	Topsoil storage will be covered with vegetation, thus providing cover for wildlife
	A 30 m buffer zone on each side of streams will be undisturbed
Disturbance of aquatic organisms and aquatic habitats	Implementation of a regulatory program designed for restoration, protection, enhancement and maintenance of aquatic life
	Casing and sealing of surface and underground mine openings to prevent escape of acid and toxic discharge
	Buffer strips be left between mining operations and waterways
	Restoration of all streams to include alternating patterns of riffles, pools and drops
	All diversions will be removed
Erosion and sedimentation	Surface runoff will be collected in sediment ponds
	Disturbed soils will be revegetated
Destruction of vegetation	Affected land must be restored to pre-mining productive capacity
	Topsoil must be removed, segregated, stored and redistributed with minimum loss or contamination
	Topsoil and subsoil may be removed separately and replaced in sequence
	Establish native vegetation or appropriate substitutes after mining
	Agricultural lands must be returned to the same or greater productive capacity as pre-mining conditions

TABLE 5. Summary of biological impact mitigation measures for five surface mining operations

Impact	Mitigation measure	Surface mining operation† 1	2	3	4	5
Destruction of vegetation	Revegetation programme	+‡	+	+	+	+
	Limiting areas to be cleared	+	+	+		
	Management of reclaimed lands	+	+			+
Disturbance of wildlife	Enhancement of habitat	+	+	+	+	+
	Creation of ponds	+	+		+	
	Management program		+			
	Transportation to work site—reduce road kills				+	
Erosion and sedimentation; and destruction of streams and aquatic organisms	30 m buffer zone on each side of stream	+	+			
	Use of sedimentation ponds		+	+		+
	Temporary crops prior to revegetation	+			+	
	Scheduling operations during dry periods or around spawning seasons	+	+	+		
	Stream reconstruction	+		+		+
	Slope contouring	+		+	+	

† The surface mining operations are in: (1) Rusk County, Texas (U.S. Environmental Protection Agency, 1983a); (2) Desoto Parish, Louisiana (U.S. Environmental Protection Agency, 1983c), (3) Mercer County, North Dakota (U.S. Department of Energy, 1980); (4) Campell County, Wyoming (U.S. Department of the Interior, 1980); and (5) Robertson County, Texas (U.S. Environmental Protection Agency, 1982c).
‡ Plus sign denotes mitigation measure mentioned in the EIS for the operation.

compensate for adverse impacts. A summary of some mitigation measures which relate to biological systems or biological impacts is presented in Table 4 (U.S. Department of the Interior, 1979).

In order to determine which impacts are actually being identified, and what mitigation measures are being suggested to offset these impacts in actual practice, five EISs which include mining activities were reviewed. Table 5 contains a summary of the identified impacts and general mitigation measures for implementation. The most commonly used mitigation measures were the development of a revegetation program and enhancing the habitat for wildlife. All five of the EISs examined implemented some measures which fit these categories, though the specifics varied in accordance with the needs created by the mining activities.

3.3. UTILIZED MITIGATION MEASURES FOR HIGHWAY PROJECTS

Many sensitive areas are traversed by highways. These include: wetla[redacted]pine areas; deserts; and areas that are habitats for endangered species. Mitigation procedures for

these sensitive areas may include replacement of habitat size for size, selection of alternate route(s), or complete abandonment of the project (U.S. Department of Transporation, 1975). In order to investigate mitigation measures being addressed in highway projects, five EISs and three project reports were reviewed. Table 6 provides a comparison of the types of impacts versus the mitigation procedure used for the eight projects. Certain impacts are associated with nearly all highway construction activities, including loss of vegetation, erosion and sedimentation, loss of habitat and loss of wildlife.

Proper revegetation and reforestation is essential to alleviate vegetation loss and also the erosion and sedimentation related to vegetation loss. Erosion control devices vary from project-to-project depending on variables such as topography, soil type and rainfall. In most cases, revegetation is best accomplished using native species. Fertilizers may be useful but care should be taken so that excessive amounts are not used; excessive use can cause reduced water quality and stream eutrophication. In some wetland situations, important considerations may involve dredging or filling operations and the possibility of dredging toxic substances. Testing prior to moving the dredged material is a very important aspect which is required by current legislation and regulations. If a dredged material is found to be toxic, it should be placed upland in a secure landfill.

3.4. SPECIFIC LITERATURE-BASED INFORMATION

Usage of computer-based bibliographic retrieval systems can be an effective approach for identifying potential mitigation measures for biological impacts. These systems provide a fast, efficient means of conducting literature searches that produce lists of titles and abstracts of published materials relative to specifically identified topics. There are several commercial companies that provide access to traditional systems such as the National Technical Information Service, Air Pollution Technical Information Center, Water Resources Abstracts, Biosis Previews, Compendex, Pollution Abstracts, Agricola, Smithsonian Scientific Information Exchange and Enviroline.

One example of the usage of a computer-based literature search will be cited. Water resources projects involving the construction of dams and creation of surface water reservoirs may cause certain environmental health impacts via vector-borne diseases. Several mitigation measures are available for controlling vector-borne diseases, and Table 7 provides a summary identified via a literature search (PEEM Secretariat, 1983). Mitigation measures can be considered in terms of environmental modification or manipulation, or modification or manipulation of human habitation or behavior. These measures were identified as a part of developed guidelines for addressing the biological impacts of water resources projects (PEEM Secretariat, 1983).

Some specific data bases have direct applicability for identifying mitigation measures. For example, the U.S. Fish and Wildlife Service has developed an Endangered Species Information System (ESIS) for storage and retrieval of information on nationally listed threatened or endangered plants or animals (U.S. Fish and Wildlife Services, 1988). Records for 435 species were available as of mid-1988, and additional records are still being added. Mitigation-related information in ESIS include reasons for the species' present status, actions recommended for the species' recovery and habitat requirements. Usage of ESIS, and the 66 data items of information for each species record, would enable the systematic identification of potential mitigation measures for threatened or endangered plant or animal species in a project study area.

TABLE 6. Comparison of mitigation measures used in eight highway construction projects

Impact	Mitigation measure	Highway construction project† 1	2	3	4	5	6	7	8
Loss of vegetation	Revegetation programme	+‡	+	+	+	+	+	+	+
Loss of habitat and nesting areas	Replacement of affected areas							+	
	Creation of aquatic habitats	+	+	+	+		+		
	Plant green-tree reservoir	+	+				+	+	
Loss of wetlands	Replacement of affected areas	+			+				
	Excavations designed to produce wetland habitats (proper water depths)	+		+	+				
Effects on endangered species	Planning so route will not affect nesting or other sensitive areas	+	+	+	+	+	+	+	+
	Replacement of nesting areas and other sensitive areas	+			+				
Erosion and sedimentation	Revegetation and reforestation including sodding, sprigging and fertilizing	+	+	+	+	+	+	+	+
	Construction of silting basins and traps	+	+			+		+	
	Rip-rap on bridges and approach slopes				+			+	+
	Limit amount of soil disturbed at any one time					+		+	
Possible introduction of toxic substances of fill materials into surface waters	Test all fill material placed into surface waters for toxic substances	+			+				
	Place toxic material upland or in secure landfill	+							

† The highway construction projects are in: (1) five separate locations (Schuldiner *et al.*, 1979); (2) Monterey County, California and Interstate 10 in Florida (U.S. Department of Transportation, 1975); (3) Tennessee State Route 29, North Dakota I-94, New Mexico I-40, Georgia I-95, Colorado I-10, West Virginia 48, Oregon, numerous projects, (Desjardins, 1979); (4) Oklahoma City, Oklahoma, SH-74 (U.S. Department of Transportation, 1985); (5) Woodward County, Oklahoma, SH-15 (U.S. Department of Transportation, 1988*a*); (6) Virginia-Maryland, District of Columbia, George Washington Memorial Parkway (U.S. National Park Service, 1985); (7) Mays County Oklahoma, SH-33 (U.S. Department of Transportation, 1988*b*); and (8) Tulsa and Osage Counties, Oklahoma, Osage Route (U.S. Department of Transportation, 1980).

TABLE 7. Types of mitigation measures available for control of vector-borne diseases (PEEM Secretariat, 1983)

Vector or intermediate host	Diseases transmitted	Environmental modification										Environmental manipulation										Modification or manipulation of human habitation or behaviour			
		Drainage (all types)	Total earth fills	Deepening and fills	Land grading	Velocity alteration	Impoundment	Clearing and burning of terrestrial vegetation	Shading or exposure to sunlight	Water level fluctuation	Sticking for bushing	Aquatic vegetation	Salinity regulation	Water supply and sewerage	Screening and bednets	Refuse collection and disposal	Land use restriction	Improved housing							
Anopheles mosquitos	Malaria	+	+	+	+	+	–	+	+	+	+	+	+	+	+	+	+	+							
Aquatic snails	Schistosomiasis	+	+	+	+	+	–	+	+	+	+	+	+	+	+	+	+	+							
Culex and Aedes mosquitos	Filariasis: viral and other diseases	+	+	+	+	+	–	+	+	+	+	+	+	+	+	+	+	+							
Blackflies	Onchocerciasis	–	–	–	–	+	+ †	–	–	–	+	–	–	–	–	–	–	–							
Houseflies	Infantile diarrhoea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–							
Tsetse Flies	African trypanosomiasis	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–							
Triatomid bugs	Chagas disease	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	–	+							
Rat fleas	Plague	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–							
Cyclops	Dracontiasis	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–							

– = Little or no directly demonstrated value or not applicable.
+ = Partially effective (some species).
+ + = Primarily effective (most species).
† Small dams = adverse effect: large dams = good effect

3.5. COMPUTER-BASED CHECKLIST

The final example for identifying potential mitigation measures involves the use of a computerized system called the Environmental Impact Computer System (EICS). The U.S. Army Construction Engineering Research Laboratory in Champaign, Illinois, U.S.A., operates EICS (U.S. Army Construction Engineering Research Laboratory, 1981). The EICS includes eight areas of project activities called functional areas, and the "environment" includes 13 categories called technical specialties. The specialties are further disaggregated into basic attributes or indicators. The project activities are then compared to the attributes in each technical specialty, and the system indicates the probability of impact occurrence, rather than the potential magnitude of the impact. Keyed to the activity are ramification and mitigation statements. Ramification remarks explain why the activities were scored as they were. The mitigation statements describe ways to lessen or avoid the impact of that activity (U.S. Army Construction Engineering Research Laboratory, 1981).

An early activity in any environmental impact study could include the use of EICS for a preliminary identification of potential impacts, and the assemblage of pertinent generic information on the ramifications and mitigation measures for those potential impacts. The functional areas include: construction; mission change; operation, maintenance, and repair; training; industrial; procurement; research development, testing, and evaluation; and real estate. The 13 technical specialties include ecology, health and safety, air quality, surface water, ground water, sociology, energy and resources, economics, earth science, land use, noise, transportation, and aesthetics. To serve as an example of the types of mitigation measures which can be identified with EICS, Table 8 summarizes a portion of the key ramifications and mitigations for the impacts from construction on ecology. This information can be used to develop preliminary plans for impact mitigation programs.

4. Evaluation of mitigation measures

An issue which is often not addressed in an environmental impact study is the evaluation of the potential or actual effectiveness of planned or previously implemented mitigation measures. Systematic evaluations of proposed measures are becoming increasingly important due to the costs of such measures, cost-sharing requirements for water resources development projects and the growing usage of the concept of incremental justification of mitigation measures in an overall mitigation program. This section will highlight three examples of evaluation approaches: (1) post-project monitoring; (2) pre-project qualitative evaluation; and (3) pre-project quantitative evaluation.

4.1. POST-EIS MONITORING

The CEQ regulations do not specifically address the evaluation of mitigation measures except in the context of follow-up monitoring to ensure that planned measures are implemented and working (Council on Environmental Quality, 1978). Specifically, paragraph 1505.3 in the regulations states (Council on Environmental Quality, 1978):

> "Agencies may provide for monitoring to assure that their decisions are carried out and should do so in important cases. Mitigation and other conditions established in the EIS or during its review and committed to as part of the decision shall be implemented by the lead agency or other appropriate consenting agency. The lead agency shall: (a) include appropriate conditions in grants, permits or other approvals; (b) condition funding of actions on mitigation; (c) upon

TABLE 8. Summary of a portion† of the ecology impact ramifications from construction and mitigation measures as obtained from the environmental impact computer system (U.S. Army Construction Engineering Research Laboratory, 1981)

EICS code number	Selected ramifications and mitigations
1060	Ramifications Establishment of the support facilities for a major construction project often disturbs vegetation and wildlife for a wide area around the site itself, especially if not regulated.
	Mitigations Limit spread of support facilities by contract provisions and/or temporary fencing, especially if adjacent areas contain trees or other vegetation which is to be retained.
1061	Ramifications Construction of temporary access roads may represent the first major intrusion into a remote building site. Numerous superfluous roads may cause more terrain damage than the project itself.
	Mitigations Plan access roads carefully; improve them if necessary; then restrict development of all other roads and paths.
1064	Ramifications Vehicle fueling and servicing areas, especially temporary ones, may lack precautions against disposal of petroleum wastes on the soil surface or in drainage ways where it then damages aquatic life.
	Mitigations Require that fuel and oil storage be diked and that drain oil be removed from the site in closed containers and disposed of properly, preferably by sale to reclaimers.

† This is an example only; a number of additional EICS code numbers have been omitted.

request, inform cooperating or commenting agencies on progress in carrying out mitigation measures which they have proposed and which were adopted by the agency making the decision; and (d) upon request, make available to the public the results of relevant monitoring."

Planning and implementation of a post-EIS environmental monitoring program for a project typically involves a number of activities. Detailed information on these activities is beyond the scope of this paper; such information is available elsewhere (Canter and Fairchild, 1986). While details will not be provided herein, the use of such monitoring data to evaluate the effectiveness of mitigation measures is obvious.

4.2. PRE-PROJECT QUALITATIVE EVALUATION

Systematic evaluation of potential mitigation measures for biological impacts should be accomplished as a part of the EIS process. This evaluation should enable the selection and implementation of the most cost-effective mitigation program. This pre-project evaluation is not a substitute for post-EIS monitoring; both are needed in a positive program for successfully mitigating adverse environmental impacts.

Pre-project evaluation approaches can be considered in two categories—qualitative and quantitative. A qualitative approach is represented by the evaluation of measures used for similar types of projects. In this context, the earlier section on identification could be considered as an approach to validate qualitatively the effectiveness of identified measures. However, the explicit assumption is that the implemented measure(s) will be successful, and this is not necessarily so. For example, Race (1987) summarized a number of studies of the effectiveness of man-created wetlands used as mitigation measures in the San Francisco Bay area. It was concluded that reports of the success of these man-made wetland projects have been over-stated. Therefore, the key consideration in a pre-project qualitative evaluation should be related to the demonstrated effectiveness of the measures. Case studies which incorporate post-EIS monitoring to verify mitigation program effectiveness would be extremely useful; however, at this time the number of such studies is minimal.

4.3. PRE-PROJECT QUANTITATIVE EVALUATION

Several structured habitat-based methodologies have been developed for evaluating both biological impacts and the potential effectiveness of proposed mitigation measures. Three examples include: (1) the habitat evaluation system (HES); (2) the habitat evaluation procedure (HEP); and (3) the wetland evaluation technique (WET). The first two examples can be used for determining mitigation land requirements for projects impacting fish and wildlife resources (U.S. Army Corps of Engineers, 1980; and U.S. Fish and Wildlife Service, 1980). The latter example can be used systematically to evaluate mitigation measures for projects exhibiting wetland impacts through consideration of wetland functions and values (Adamus *et al.*, 1987). It is beyond the scope of this paper to review thoroughly all three examples; however, the HEP will be briefly described to illustrate its usefulness in a pre-project evaluation of proposed biological impact mitigation measures.

The HEP is a method which can be used to document the quality and quantity of available habitat for both aquatic and terrestrial animal species (U.S. Fish and Wildlife Service, 1980). The HEP is based on the assumption that habitat for selected species can be described by a habitat suitability index (HSI). This index value (from 0·0 to 1·0) which is indicative of quality is multiplied by the area of available habitat (quantity) to obtain habitat units (HUs). The first step of a HEP application consists of: (1) defining the study area; (2) delineating cover types; and (3) selecting three to five evaluation species. Information on species selection is contained elsewhere (U.S. Fish and Wildlife Service, 1980).

A HEP analysis is structured around the calculation of HUs for each evaluation species in the study area. The total area of available habitat for an evaluation species includes all areas that can be expected to provide some support to the species. The total area of available habitat is calculated by summing the areas of all cover types likely to be used by the species. The HSI values are described via HSI models. The HSI models are usually presented in graphic, descriptive and mathematical formats (Schamberger *et al.*, 1982). HSI models have been published for about 150 evaluation species, and more are being developed.

Impact in the HEP is defined as the difference between HUs with the project and HUs without the project. Averaged annual HUs are used in the impact calculations. The final step in the HEP involves the development of mitigation plans, if appropriate. Studies can be used to identify measures that would offset unavoidable HU losses due to a proposed action. Mitiga-

measures to existing habitat to effect a net increase in HUs. The existing habitat may or may not be located in the "impact" study area. In order to obtain mitigation, the HU losses due to the proposed action must be fully offset by the specified acquisition and/or management measures. The three possible mitigation goals are (U.S. Fish and Wildlife Service, 1980):

1. In-kind (no trade-off)—This goal is to offset precisely the HU loss for each evaluation species. Therefore, the list of target species must be identical to the list of negatively impacted species. The ideal compensation plan will provide, for each individual species, an increase in HU's equal in magnitude to the HU losses.
2. Equal replacement (equal trade-off)—This goal is to offset precisely the HU losses through a gain of an equal number of HUs. With this goal, a gain of one HU for any target species can be used to offset the loss of one HU for any evaluation species. The list of target species may or may not be identical to the list of impacted species.
3. Relative replacement (relative trade-off)—With this goal, a gain of one HU for any target species is used to offset the loss of one HU for an evaluation species at a differential rate depending on the species involved. The trade-off rates can be defined by relative value index (RVI) values for each species.

After the goals are set, the mitigation analysis is the same as that used to identify project impacts. The steps in the process are to:

1. Select a candidate mitigation study area. The area can be of any size but must be at least large enough to be a manageable unit for the target species. Develop a cover type map and determine the area of each cover type.
2. Conduct a baseline habitat assessment for each target species. Baseline data for individual species in the "impact" area may be used if the candidate compensation area is similar in terms of HSI values. If this is not the case, additional field work to determine HSIs will be necessary in the study area.
3. Determine the average annual HUs for the study area assuming no future proposed action.
4. Identify a proposed management action that will achieve specified goals. Specify the management measures (e.g. prescribed burning, selective timber cutting and others) that will be used to increase the HUs for the target species in the candidate area.
5. For the mitigation area, contrast the HUs without management to the HUs with proposed management measures and determine the net increase in HUs.

One brief example of a HEP analysis will be mentioned, with this analysis focused on evaluating thermal mitigation alternatives for two nuclear reactors. Specifically, Mackey *et al.* (1987) evaluated the potential effects on wildlife of the implementation of thermal mitigation alternatives for the *C* and *K* reactors at the Savannah River Plant in South Carolina, U.S.A. The HEP approach as modified by the Savannah River Laboratory was used. This approach enabled the relative ranking of project alternatives and/or mitigation strategies with respect to representative wildlife species over the life of the project or for selected time periods in the future. For the *C* and *K* reactors the potential wildlife impacts and/or benefits of once-through and recirculating cooling towers were evaluated for both near-term (30 year) and long-term (100 year) time periods.

Based upon this brief review of the HEP, it can be stated that this method can be used to evaluate the costs and potential effectiveness of differing mitigation strategies for a pro[illegible]. The structured nature of the HEP is conducive to its use as an evaluation t[illegible] for [illegible]gical impact mitigation measures.

5. Summary

Identification and evaluation of mitigation measures for adverse biological impacts of proposed projects has become an important component in the EIS process. The focal point for opposition and debate relative to a proposed project often centers on the type and extent of appropriate mitigation measures. This paper has delineated several approaches for both identifying and evaluating potential mitigation measures. Examples of identification approaches include the review of utilized measures for similar projects, the use of computer-based literature and information searches, and the use of computer-generated checklists of potential measures. Examples of evaluation approaches include: post-EIS environmental monitoring; pre-project qualitative evaluation based on case studies; and pre-project quantitative evaluation using structured habitat-based methods. Based upon this review, the following conclusions can be drawn:

1. **There are an ample number of approaches which can be used to identify potential mitigation measures for the adverse biological impacts of proposed projects.**
2. **While systematic methodologies are available for evaluating the potential effectiveness of mitigation measures, these methodologies have not been extensively used as a part of the EIS process. Perhaps one reason for limited usage is the uncertainty associated with measures such as habitat development and enhancement.**
3. **Post-EIS environmental monitoring can be a definite aid to impact management and determination of the actual effectiveness of implemented mitigation measures.**
4. **Many have the perception that mitigation is simply an unnecessary add-on cost for a project. However, while the implementation of a mitigation program may be costly, it may be much more cost-effective to have a mitigation program from the beginning of a project rather than having to initiate an even more costly environmental clean-up program at some future point in time.**

References

Adamus, P. R., Clairain, E. J., Smith, R. D. and Young, R. E. (1987). *Wetland Evaluation Technique (WET). Volume II—Methodology*. Vicksburg, Mississippi: U.S. Army Engineer Waterways Experiment Station.

Canter, L. W. and Fairchild, D. M. (1986). Post-EIS environmental monitoring, In *Methods and Experiences in Impact Assessment* (H. Becker and A. Porter, eds), pp. 265-285. The Hague, The Netherlands: Reidel Publishing Company.

Council on Environmental Quality (1978). National Environmental Policy Act—Regulations. *Federal Register* 43 (230), 29 November, 55978–56007.

Desjardins, C. R. (1979). Ecological Mitigation: A viable option in the federal-aid highway program. In *The Mitigation Symposium–A National Workshop on Mitigating Losses of Fish and Wildlife Habitats*, pp. 562 565. Washington, D.C.: U.S. Forest Service.

FitzPatrick, M., Willson, J., Ericson, D., Fax, G. and Wood, D. (1977). *Manual for Evaluating Secondary Impacts of Wastewater Treatment Facilities*, pp. 111–112. EPA-600/5-78-003. Washington D.C.: Environmental Protection Agency.

Mackey, H. E. *et al.* (1987). *Habitat Evaluation Procedure (HEP) Assessment for Thermal Mitigation Alternatives for C and K Reactors*. DPST-87-578, Aiken, South Carolina: DuPont de Nemours (E.I.) and Co.

Monterey Peninsula Water Pollution Control Agency. U.S. Environmental Protection Agency and Jones and Stokes Associates Inc. (1977). *Final Environmental Impact Statement and Environmental Impact Report North Monterey Facilities Plan*, pp. XVIII–XXI and 188–198. Monterey, California.

PEEM Secretariat (1983). *Panel of Experts on Environmental Management for Vector Control (PEEM). Report of the Third Meeting, Rome 12–16 September 1983*. VBC/83-4. Geneva, Switzerland: World Health Organization.

Race, M. S. (1987). "San Francisco Bay experience". In *Proceedings of the Conference on [illegible]est Wetlands: What Are They? For Whom? For What?*, pp. 201–209. Seattle, Washington: Institut[illegible]nvironmental Studies, University of Washington.

Schamberger, M., Farmer, A. H. and Terrell, J. W. (1982). *Habitat Suitability Index Models: Introduction*. FWS/OBS-82/10, Fort Collins, Colorado: U.S. Fish and Wildlife Service.

Shuldiner, P. W., Cope, D. F. and Newton, R. B. (1979). *Ecological Effects of Highway Fills on Wetlands: User's Manual*. NCHRP Report 218B, Washington, D.C.: National Cooperative Highway Research Program, Transportation Research Board, National Research Council.

U.S. Army Construction Engineering Research Laboratory (1988). *ETIS Quarterly*. Champaign, Illinois.

U.S. Army Construction Engineering Research Laboratory (1981) *The Environmental Technical Information System: Overview and User Orientation*. Champaign, Illinois.

U.S. Army Corps of Engineers (1980). *A Habitat Evaluation System for Water Resources Planning*. Vicksburg, Mississippi: Lower Mississippi Valley Division.

U.S. Department of Energy (1980). *Final Environmental Impact Statement: Great Plains Gasification Project, Mercer County, North Dakota*, pp. 4-7 to 4-14. DOE EIS-0072F, Vol. I. Washington, D.C.

U.S. Department of the Interior (1979). *Final Environmental Impact Statement: Permanent Regulatory Program Implementing Sec. 501(b) of the Surface Mining Control and Reclamation Act of 1977*, pp. BIII-71 to BIII-81. Washington, D.C.

U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement (1980). *Draft Environmental Statement: Proposed Mining and Reclamation Plan, Rojo Cabellos Mine, Campbell County, Wyoming*, pp. A-9 to A-13. Washington, D.C.

U.S. Department of Transportation (1988a). *Environmental Assessment: Addition of Parallel Lanes to SH 15 from Woodward to Mooreland, Woodward County*, pp. 3-13. Fort Worth, Texas: Federal Highway Administration Region 6.

U.S. Department of Transportation (1988b). *Environmental Assessment of SH 33 Project over the Neosho River East of Chouteau, Mays County, Oklahoma*, pp. 3-11, Appendix A. Fort Worth, Texas: Federal Highway Administration Region 6.

U.S. Department of Transportation (1980). *Final Environmental Impact Statement: Osage Route, Tulsa and Osage Counties, Oklahoma*, pp. F-1 to F-15, and K-1 to K-11. Fort Worth, Texas: Federal Highway Administration Region 6.

U.S. Department of Transportation (1985). *Final Environmental Impact Statement: Proposed SH 74, N.W. 63rd to N.W. 178th, Oklahoma City, Oklahoma*, pp. 30-41, 55-56, A-14 to A-18. Fort Worth, Texas: Federal Highway Administration Region 6.

U.S. Department of Transportation (1975). *Mitigating Adverse Environmental Effects of Highway Construction*, pp. 1-24. Washington, D.C.: Transportation Research Board Annual Meeting.

U.S. Environmental Protection Agency (1979). *Draft Environmental Impact Statement: Alternative Wastewater Treatment Systems for Rural Lake Projects: Case Study No. 1: Crystal Lake Area Sewage Disposal Authority, Benzie County, Michigan*, pp. 151-188. Chicago, Illinois.

U.S. Environmental Protection Agency (1983a). *Draft Environmental Impact Statement: Martin Lake D Area, Lignite Surface Mine, Henderson, Rusk County, Texas*, pp. 6-95 to 6-109. EPA 906/9-83-003. Dallas, Texas.

U.S. Environmental Protection Agency (1982c). *Draft Environmental Impact Statement: Twin Oak Steam Electric Station, Robertson County, Texas*, pp. 6-95 to 6-107. EPA 906/9-82-010. Dallas, Texas.

U.S. Environmental Protection Agency (1982b). *Draft Environmental Impact Statement: Wastewater Treatment Facilities, Tulsa (Northside), Oklahoma*, pp. 5-135. EPA 906/9-82-009. Dallas, Texas.

U.S. Environmental Protection Agency (1980). *Draft Environmental Impact Statement for Wastewater Treatment Facilities, Northeast El Paso, Texas*, pp. 6-42 to 6-56. Dallas, Texas.

U.S. Environmental Protection Agency (1983b). *Environmental Impact Statement: Wastewater Treatment Facilities/City of Fort Worth, Tarrant County, Texas*, pp. 5-158 to 5-161. EPA 906/9-83-008. Dallas, Texas.

U.S. Environmental Protection Agency (1982a). *Environmental Impact Statement: Wastewater Treatment Facilities, City of Norman, Cleveland County, Oklahoma*, pp. 5-25, and 6-51 to 6-53. EPA 906/9-82 008. Dallas, Texas.

U.S. Environmental Protection Agency (1977). *Final Environmental Impact Statement: Steamboat Springs Regional Service Authority, 201 Wastewater Facilities Plan*, pp. 17 and 165-167. Denver, Colorado.

U.S. Environmental Protection Agency (1976). *Final Environmental Impact Statement for Sewage Treatment Facilities for the South Bloomington and Lake Monroe Service Areas, Bloomington, Indiana*, pp. 4-11-1 to 4-11-5. Chicago, Illinois.

U.S. Environmental Protection Agency (1983c). *Supplemental Final Environmental Impact Statement: Dolet Hills Lignite Mine Project, DeSoto Parish, Louisiana (Supplement to the Dolet Hills Power Plant EIS)*, pp. I-11 to I-13, and III-12 to III-40. EPA 906/9-83-007. Dallas, Texas.

U.S. Fish and Wildlife Service (1988). *Endangered Species Information System—Project Brief*. Washington, D.C.

U.S. Fish and Wildlife Service (1980). *Habitat Evaluation Procedures (HEP)*. ESM 102. Washington, D.C.

U.S. National Park Service (1985). *Draft Environmental Impact Statement for Traffic and Recreational Management, George Washington Memorial Parkway, Virginia-Maryland-District of Columbia*, pp. 23-24, and 91 96 Denver, Colorado.

Documentation

The outcome of the EA process is usually a formal document that provides the decisionmaker with environmental information and conclusions about the consequences of a preferred action and reasonable alternatives. In the U.S., there are two types of documents, the environmental assessment (EA) with its associated finding of no significant impact (FNSI) and the environmental impact statement (EIS) with its associated record of decision (ROD). An EA may also be used to determine whether to prepare an EIS. These documents are the primary sources of information for interested and affected individuals and organizations. As such, they must present clearly and objectively the alternatives to be considered in the decisionmaking process (Weiss 1989; Attachment 4.I).

Often, formal documentation is not necessary for actions that an agency has predetermined not to have individual or cumulative significant effects on the human environment (i.e., categorical exclusions; Chapter 2). However, in some cases, agency requirements call for some formal documentation. In the U.S., formal environmental impact assessment documents and, if appropriate, associated determinations are required if the proposed action is 1) one that the agency has pre-determined to require an EIS or 2) it is not known if the potential impacts are significant. When it is known that the potential impacts of a proposed action are significant (Chapters 2.1 and 4.4), an in-depth EIS and the associated determination are required. Table 4.6-1 provides an annotated list of the major elements of an EIS. When as a result of an EA, the potential impacts of a proposed action are determined to be "not significant", a FNSI is issued.

Environmental assessment documentation has a variety of names throughout the world. However, there is a general consensus, with minor variations, on the content of such documents. Recent review of European EA documents showed that for the most part, alternatives to a proposed action were not evaluated, nor were monitoring or follow-up needs discussed. Other aspects frequently not covered were technical and regulatory uncertainties, cumulative impacts, and external policy constraints. Other countries frequently incorporate EA into regional planning documents with the result that the environmental impacts and conclusions related to a project (and alternatives, if any) are neither summarized nor easily accessible.

NEEDS

- A coordinated team approach to the generation, evaluation, and presentation of information. Integrating the various sections of an EIA document is the responsibility of the team leader; however, the findings and specific data and their interpretation should be discussed by the team as a whole prior to drafting the document. Such an effort ensures that everyone has a common understanding of the problem, the existing data, and the data gaps. Moreover, it helps to focus the document on the important issues.

- Use of clear language (Attachment 4.I) that can be understood by lay persons reading the document. Where effects are understood, they should be stated clearly and objectively; where sophisticated analyses are performed, the summaries of the analyses should explain the findings in ordinary phrases. Avoid the use of vague generalities, cliches, or professional jargon.

- Objective presentation of relevant information in terms and formats that are meaningful and useful to interested and affected publics, agencies, and decisionmakers. A glossary of acronyms should be included. All sources of information should be thoroughly documented. Methods for collecting and processing original data should be described and included as appendices.

TOOLS

- A standard organization and format (i.e., the sequence in which information is presented should be the same in all kinds of EA documents so that reviewers and the interested public can easily find relevant information).

- Use of visual displays for descriptions of existing and future conditions, data sets, impact analyses, alternatives comparison, and mitigation measures (Tufte 1983, 1990). Maps and/or photographs should be used to familiarize readers with the affected area. Graphs, bar charts, pie diagrams, summary matrices, and similar information summaries should be used where possible. The visual displays can be briefly explained and discussed in accompanying text. In areas where language barriers or literacy may be a problem, video presentations are an effective way of reaching the affected public.

Table 4.6-1. Format and content of an EIS as required by CEQ regulations

Format	Content
Cover Page	A single page listing the responsible agency and cooperating agencies; the title of the proposed action and its location; the name, address, and telephone number of a contact person; a designation of the EIS as draft or final; a one-paragraph abstract; and the date by which comments must be received.
Summary	A nontechnical summary of the proposed action, preferably less than 15 pages in length, that accurately and adequately describes the content of the EIS. The summary should stress the final conclusions, areas of controversy, and the issues to be resolved.
Table of Contents	A list and page number index of the chapters, sections, and subsections in the EIS, including a list of tables and a list of figures.
Purpose of and need for action	A brief statement of the purpose and need to which the agency is responding in proposing the alternatives, including the proposed action.
Alternatives including proposed action	A presentation of the environmental impacts of the preferred action and all reasonable alternatives in comparative form, exploring each alternative, including the no-action alternative, and the reason(s) why certain alternatives were recommended or eliminated. Include appropriate mitigation measures.
Affected environment	A succinct description of the environment of the areas to be affected by the alternatives under consideration. Data and analyses for any given subject area should be commensurate with the importance of the impact in that subject area, with less important material summarized or referenced.
Environmental consequences	A discussion of the environmental impacts of the various alternatives being considered, identifying any adverse environmental effects that cannot be avoided if the action is implemented; all mitigation measures to be employed to reduce the adverse effects; residual effects of mitigation; the relationship between short-term uses of the environmental and the enhancement of long-term productivity; and any irretrievable or irreversible commitments of resources that would occur if the action were implemented as proposed.
List of preparers	A list of names and summaries of the professional qualifications for persons who were primarily responsible for the preparation of the EIS or significant background materials.
List of agencies, organizations, and persons to whom copies of the report are sent	A list detailing the agencies, organizations, and persons that have been sent copies of the EIS, including the addresses of public repositories (libraries, government offices) where the report is available for review by the public.
Index	A listing of the major components of the EIS by topic or issue, together with page number references.
Appendices	Materials prepared in connection with an EIS that substantiate analyses, that relate to the decision to be made, and that should be circulated with the EIS. Material incorporated by reference is generally not included in these appendices.
	A listing of written comments submitted by governmental agencies, public and private organizations, and interested individuals [illegible] submitted in public hearings on the project. Substantive comments and responses should be attached to the final EIS. The author of the comment [illegible] by name and address. Comments may be paraphrased, and repetitive comments or questions may be listed once and cross-referenced. If the response references material already contained in the EIS, the pertinent page number should be cited.

- Professional technical editing of the draft document for consistency in style and content. Environmental impact assessment documents are generally drafted by interdisciplinary teams and differences in sources of information and writing style often result in contradictory statements or information in various sections of the document.

- In the U.S., federal agencies are responsible for the scope, content, and accuracy of EA documents. Thus, technical review of draft documents by agency staff and independent experts prior to publication is common practice. By virtue of Section 309 of the Clean Air Act, the U.S. EPA has been placed in a special review role. This section of the Clean Air Act requires that the U.S. EPA comment in writing on the environmental impact of newly authorized federal actions or legislation and also upon the adequacy of draft EISs. Attachment 4.J outlines the EPA rating system. In addition, draft EISs are subject to public review for a period of 45 days.

ISSUES

- Generally, effective communication depends on identifying the audience(s) and shaping and styling a publication to meet their specific needs. However, an EIA document must serve multiple functions, being simultaneously a decisionmaking document, a technically rigorous scientific analysis of potential environmental impacts, a record of the EA process and participants, and a source of information for the public. Preparing a report that serves these different uses and audiences requires careful consideration of the ways in which information is presented.

- Legitimate differences of scientific opinion should not be omitted, but should be included in an EIA document to provide the public and the decisionmaker with an unbiased analysis and presentation of the alternative ways of meeting a declared purpose and need.

- Approaches to identifying and assessing the impacts of a proposed action and its alternatives are not always available or universally accepted. This contributes to the fact that in the U.S., the adequacy of EA documents is the second most frequent legal challenge under NEPA (CEQ 1993).

LINKAGES

An EIA document is a record of the EA process and the judgments made by the team. The objective is to communicate information to the decisionmaker and other interested publics and agencies. It reflects the results of early input from initiation and scoping and it describes what is expected after the decision is made (i.e., mitigation and monitoring). Coherent, integrated assessment of reasonable alternatives including the no-action alternative is the linchpin of the EA process. The essential findings of the assessment process must be presented in a concise document.

REFERENCES

Council on Environmental Quality (CEQ). 1993. Environmental Quality. 23rd Annual Report. U.S. Government Printing Office. Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328. ISBN 0-16-041612-4.

Tufte, E. R. 1990. Envisioning Information. Graphics Press, Box 430-Y, Cheshire, Connecticut 06410. 128 pp.

Tufte, E. R. 1983. The Visual Display of Quantitative Information. Graphics Press, Box 430-Y, Cheshire, Connecticut 06410. 197 pp.

Weiss, E. H. 1989. An unreadable EIS is an environmental hazard. The Environmental Professional 11:236-240.

ATTACHMENT 4.I

AN UNREADABLE EIS IS AN ENVIRONMENTAL HAZARD

- Weiss, E. H. 1989. An unreadable EIS is an environmental hazard. The Environmental Professional 11:236-240.

An Unreadable EIS is an Environmental Hazard

Edmond H. Weiss
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Abstract. An Environmental Impact Statement alerts the government and public to the possible hazards of proposed actions. An unreadable EIS is an environmental hazard, potentially as deadly as stack emissions or dioxin in the groundwater.

Many EISs, of course, are written by engineers and researchers, without benefit of professional "wordsmiths." The engineer's notorious aversion to writing (and the unwillingness of most firms to buy writing services) means that EISs are at least as unreadable as most other technical documents prepared by a team of middling writers working to an unforgiving deadline.

But, despite what some consultants may think, the bad writing in an EIS is much more serious than a matter of esthetics; the issue is not "English" or refinements of style. The issue is the quality of the document, its usefulness in support of the goals of environmental legislation, and, by implication, **the quality of the environmental stewardship entrusted to the scientific community.**

PART OF THE PROBLEM OR PART OF THE SOLUTION

An unreadable EIS not only hurts the environmental protection laws and, thus, the environment. It also turns the sincere environmental engineer into a kind of "polluter."

Consider the irony. Environmental engineers, those solitary champions of environmental quality, usually more than ready to do battle with well-financed developers and well-connected waste handlers, are increasingly perceived as paid apologists for the people whose actions may foul the environment. Why? Because most Environmental Impact Statements are so difficult and unpleasant to read that they make people suspicious. Even someone only moderately skeptical might suspect that readers are discouraged from reviewing the report too carefully. And, in a time when bright people worry that environmental laws can be manipulated and undermined by powerful interests, the inaccessible and unreadable EIS has come to be viewed as part of the problem instead of part of the solution.

Some EISs, then, are seen as a deliberate effort to obscure the questions, to inhibit debate and intimidate all the opponents of a proposed project or action.

Of course, this public perception is unfair. Although environmental consultants occasionally err in the favor of the agencies who pay their fees, the typical individual or firm is scrupulously honest in describing and predicting environmental consequences. Whether motivated by the noble ethics of the profession or just by the mundane fear of being discredited in the consulting marketplace, environmental specialists would be the last to defeat the spirit of the environmental protection laws and codes. Quite the contrary. The typical EIS is not obscure by intent. It only seems that way —the consequence of certain bad habits of thought and expression.

There are three broad classes of errors that undermine the clarity and credibility of many EISs:

> **Strategic Errors** are mistakes of planning, failure to understand why the EIS is being written and for whom.
>
> **Structural Errors** are mistakes of organization, failure to arrange the elements in the document in a way that makes them easy to follow, and

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Tactical Errors are mistakes of editing, failure to test and revise the texts for clarity and readability.

STRATEGIC ERRORS

A strategic error is tantamount to writing the wrong document. That is, the engineers and others, for a variety of reasons, produce an EIS that misses the true objective of the project— even while it complies with federal or state "guidelines." Especially when the EIS is composed by several authors working independently, the risk is great that the final product will meet the letter of the law but not the spirit.

More specifically, EISs are often undermined by naive attitudes, the most prevalent being that the document is a dispassionate, objective collection of unambiguous, hard facts about environmental effects. Typically, though an EIS vitally affects hundreds or thousands of people—including a few very rich and powerful ones. In a sense, the principal function of the EIS is to provide facts, projections, and analyses that raise the level of debate among those thousands at interest.

In countless cases the EIS has affected the commercial interests of developers and contractors, even the political aspirations of local officials whose campaigns include promises of projects with environmental implications. No matter what the guidelines say, and no matter what disclaimers appear in the introduction, the findings in an EIS may potentially help or hurt the progress of some project. At the very least, it can uncover adverse effects that add corrective costs to a proposed action. In extreme cases, it can curtail the plans of the very agency or firm that paid for the study.

Moreover, an EIS, like even the best science done in support of public policy and health, contains a substantial number of extrapolations and inferences, many built on simplifying assumptions, debatable theses, and even secondhand data from parties with vested interests. (Given two or three questionable presumptions, environmental assessment becomes only slightly more precise than stock market forecasting.)

In short, an EIS is a work of science, as opposed to an aggregation of hard facts; it is rich with, to use Popper's term, intelligent conjecture. Consultants, often under pressure from sponsors to produce unambiguous conclusions, must remember that the quality of their assessments derives from the quality of the underlying warrants (Stephen Toulmin's term) in their models.

The document should be much more than a compendium of technical details, interesting mainly to readers with the appropriate technical background. But, without meaning to, most EIS authors aim their writing at the wrong audience. They assume not only that the work will be read almost exclusively by environmental engineers and specialists, but also that each specialized component (air, water, archeology, odor. . .) will be read only by persons with that specialty.

Even though many of the readers are such specialists, the most important readers are not. Quite the contrary, the main readers of the EIS are in three motivated groups:

A higher jurisdiction of government, responsible for a series of decisions, often including enforcement, frequently under political pressure to approve or disapprove (in the guise of "neutral" review for compliance)

Supporters of the proposed action, hoping that the EIS will not forecast any unavoidable consequences or more attractive alternatives, impatient to have it approved as quickly as possible

Opponents of the action, alert to any instance in which its adverse effects are minimized or in which those of the alternatives are exaggerated, especially skeptical of all assumptions, inferences, and secondhand or imputed data.

By failing to appreciate that the EIS is a work of scientific conjecture, aimed at motivated and even cynical readers, environmental engineers commit the worst strategic error of all, the one that undermines not only EISs but many other technical documents as well: lack of apparent function or purpose. (That is, there is a tendency among among intellectual writers—scientists, engineers, scholars—to act as though the purpose of the document was to write about the subject. An effective EIS, though, or any effective technical publication, is designed and written to accomplish specific communication objectives in well-defined audiences. Ironically, the more fascinated the author is with the subject, the greater the risk that the document will lack purpose and frustrate its readers.)

An EIS, in addition to presenting its facts and projections, must assure those who deserve to be assured, arouse those whose interests are at risk, satisfy the stewards of environmental laws, and stimulate enlightened discussion among decisionmakers and their constituents.

The assessment of environmental impact is hardly ever simple, objective, or uncontroversial. Rather, it is a problem in scientific advocacy, in which the main issue is whether the investigating team has assembled enough credible evidence and argument to prove a central thesis. Either that:

> The proposed action will have no important adverse effect on the environment, or
>
> The proposed action is better for the environment than "no action," or
>
> The proposed action is clearly better for the environment than the alternatives, or
>
> Although there is an environmentally superior alternative, its greater costs are not justified by its environmental benefits (or are justified). . . .

For an EIS to have an effective thesis (one of those above, or some other more appropriate to the situation), the Project Director must assert responsibility and take intellectual risks. Put simply, he or she must direct the project and see that the EIS has a coherent point of view—that each of the five or ten or twenty specialists at work on each of the "parameters" knows the audience and the thesis. Without such direction, the EIS will look as so many of them do: a patchquilt.

STRUCTURAL ERRORS

If form follows function (as some architects are fond of saying), it is not surprising that many EISs are in a form that reflects their lack of thesis and their indifference toward the audience. Generally, they are huge and inaccessible. Like a patchquilt, they are filled with beginnings and endings, choppy, inconsistent, ragtag.

Most EISs appear to be organized in a way that makes them easier to review or "check off" than to study and question. They are arranged so that even a superficial reviewer will quickly see that everything that is supposed to be in the document is there. And if that were the only mission of the EIS, to satisfy some mindless bureaucratic checklist, such an organization would be appropriate. Furthermore, if that were the only function of the EIS, there would be no reason to write this essay!

But that is not the sole mission or function. EISs are important documents meant to be read by interested readers with vital concerns. (Not just compendiums of fact to be appraised with a checklist.) It is shamelessly cynical for environmental consultants to regard the writing and reviewing of the EIS as nothing more than "going through the motions" of environmental assessment, a tiresome administrative hassle, "red tape" en route to getting the project approved.

For many readers, the typical EIS has an inaccessible organization. Most readers do not want to study each "environmental parameter" in depth. They do not want to reflect on the history of the planet before they find out whether the local groundwater is likely to be fouled. Nor do they want to read several hundred pages to learn if there are any unavoidable consequences of the project.

For the sake of most readers, the EIS should be organized to allow direct and immediate comparison of the proposed action with the "no action" alternative, followed by a similar comparison with alternative sites, technologies, and actions. Moreover, the comparisons should address only what is relevant. If the effect on a certain parameter is inconsequential, it should be reported briefly and dismissed (even though we paid a hefty fee to the subcontractor specialist). If differences between alternatives are too small to matter, they need not be discussed—unless there is reason to believe that part of the audience is especially interested. Nowadays it is hard to escape the impression that the controversial or "soft" parts of the study are being deliberately camouflaged beneath hundreds of pages of unimportant detail.

In a well-made EIS, the average reader—including the lay reader—should be able to find what he or she wants to know in less than five minutes. One minute, if the findings are unusually straightforward.

An effective EIS should be well-endowed with "search tools": introductions, summaries, overviews, reviews, digests, or abstracts. It is even easy to imagine an EIS that is mainly summaries, with much of the technical detail relegated to attachments and appendixes. In contrast, though, what do we usually see?

> The introduction is malnourished; it reads like an afterthought.
>
> The table of contents is incomplete, and the headings (the names of the sections) do not address the questions raised by readers. In effect, one must be an expert to find anything.
>
> There are no chapter introductions or section introductions; no marginal glosses.
>
> There is hardly any typographic emphasis or accent: underscoring, boldfacing, italics, indentation, color, capitalization—none of the simple techniques for making the most pointed and conclusive sentences stand out from the dense background of the page.
>
> (I recently read a 500-page EIS that had not one underscored sentence. When I proposed changes in presentation and typography, I was told directly by the sponsor that he didn't want the EIS to stimulate any more discussion than necessary!)

Because of the way they are written, most EISs are clumsy and disjointed.

They are obviously the work of many authors, with jarringly different styles of writing. Typically, each author doesn't care much about what the others are up to; the project director spends more time reassuring the sponsor than ensuring that all the authors are working on a coherent document.

Often, the several sections are at radically different levels of detail or difficulty—some containing sophisticated models, others high school primers on the measurement of sound. The worst problem is the disjunction of text and exhibits, the needless separation of text from the charts, tables, photos, and figures. Readers are perpetually told to "see Map X"—which is typically several pages away, or in another volume.

My own research in technical communication has led me to conclude that this simple mechanical problem—the separation of the text from the exhibits needed to make it clear—is the single greatest barrier to the reading of EISs and other technical publications. In a well-designed EIS (Note: EISs must be designed, not just assembled!), nearly every time a reader is told to see a chart or table it will be either on the same page or a facing page. The more we ask readers to jump, skip, detour—the more often we ask them to be in two places at once—the greater their suspicion that the writers do not really want the material read.

Of course, most of the people who write the separate parts of an EIS do not even think about so pedestrian a question as the position of the charts and maps. That, after all, is an editor's problem—or, in some places, the typist's problem. Generally, the only writers who care deeply about the physical layout of the document are those who want it to be easy to read.

TACTICAL ERRORS

Tactical errors are failures of editing. They include the mechanical mistakes—misspellings, errors of grammar and punctuation— as well as misused words and phrases. More subtle, and more serious, are failures of style: clumsy syntax or awkward, wordy sentences. When most engineers think about "writing," it is these tactical issues that come to mind. And when most engineers disparage their writing, it is actually their editing that is at fault.

Tactical errors add "friction" to communication. Where there should be a simple transfer of facts and ideas from writer to reader, instead there are distractions, irritations, rubs.

There are two broad kinds of tactical errors: obvious violations and subtle mistakes. The obvious ones are less dangerous because they are more likely to be detected and corrected. Misspelling "supersede," using the word criteria as a singular, using "due to" in place of "because of": these are the bugs that should be caught by the writer, or even such "style-checking" software as RightWriter or Grammatik.

The trouble with the subtler mistakes is that they are rarely textbook errors. And, unless there is a real editor or an especially literate Ph.D in the firm, no one is likely to correct them. These are errors of style, like the "smothered verb" ("perform the computation of" versus "compute"; "conduct an inspection of" versus "inspect"). Or the "vitiated predicate" ("The possibility of damage to the crops from the steam exists" versus "The steam might damage the crops").

There are also scores of wordy, windy, wasteful constructions, like "consensus of opinion" or "ten-year period of time" or "visible to the eye." And ostentatious synonyms, like "utilize" for "use" or "facilitate" for "aid." And misused words, like "fortuitous" (which does not mean lucky) and "enormity" (which does not mean immensity) or "preventative" (which is not the same word as preventive) or "remediate" (which is a solecism on the verge of being a barbarism, no matter how many people use it).

Recently I edited an EIS in which I removed the word "situated" more than 100 times. "X is situated in Y" becomes "X is in Y." "Q is situated west of P" becomes "Q is west of P." In the same document I also changed "presently" to "currently" at least fifty times.

Why are there so many young professionals who cannot distinguish "historical" form "historic"? And why is there no basic agreement on whether the word "impact" itself refers to all effects or only to undesirable ones. (Does "no impact" mean no effect, or no harm? If all "impacts" are bad, why do we write "adverse impact"?) Would it improve our EISs if we wrote them without any form of the word "impact"? Answer: Yes

And these are the easy mistakes, the ones even a green editor would correct in a minute. What about the more difficult problems, though? The unbearably long sentences and paragraphs? The lack of links to connect one sentence to the next? The jarring differences in style from section to section? The oppressive lack of variety in sentence patterns? These problems need a better editor, who, in turn, needs the time and authority to correct them.

Most EISs have never been visited by a real editor. Of those I've read, about one in five shows evidence of anything more than rudimentary editing. Partly, this is because most

of the smaller consulting firms believe that they cannot afford an editor, forgetting that their main product is reports. But mainly it is because of deadlines. Almost universally, project directors on environmental assessments regard editing as an incidental frill, a step that can always be sacrificed for the sake of delivering a draft two or three days earlier.

The worship of deadlines is understandable and, in some cases, forgivable. But it is also wrong.

If, for the sake of meeting a review deadline, the consultants allow an unreadable draft to be distributed (and most first drafts by engineers are unintelligible to anyone but the author and some friends), then the consultants are morally compromised. If the purpose of the EIS is to support a frank discussion of the consequences of the proposed action, then an unreadable document is an impediment, an environmental hazard.

If some of the aggrieved readers of the EIS suspect deception, and if the inaccessibility of the text contributes to that suspicion, then the consultants are part of the perceived conspiracy.

SOLVING THE PROBLEM

For the three groups of errors there are three paths of attack.

Eliminating **strategic errors** calls for genuine project leadership by a project director with intellectual vigor. The various specialists on the assessment team, including subcontractors, must **not** begin to write "their sections" until their respective findings and conclusions have been discussed and evaluated.

As impractical as it may sound, and as far from standard practice in most firms, the individual contributors should not be turned loose on their writing assignments until they have presented **written summaries of their data and interpretations for discussion by the team as a whole.** Specialists must not be encouraged to formulate their judgments while they are writing their first (and last) drafts. Put bluntly: competent scientists and engineers ought to be able to summarize what they are going to write before they begin; too many of the people who work on EISs, though, cannot tell you what they are going to say until they have said it. More than a few engineers have told me that their writing assignment was little more than "covering enough pages."

Only after the overall sense of the findings has been clarified, only after the conflicts and inconsistencies have been resolved, should the project director permit the separate pieces to be written.

In this context, only what is relevant should be featured prominently in the body of the EIS. Incidental information, tutorials and primers on environmental science, and miscellaneous exhibits should be relegated to appendixes. (Note: I did not say that only what is "favorable" to the thesis should be in the body of the document; I said what is "relevant." Surely, unfavorable data are quite relevant.)

Eliminating **structural errors** calls for more professional document design. The documents should be packaged and summarized in a way that lets most readers find what they need to know at once. Most important, the central questions of any EIS must be answered prominently: Are there unavoidable consequences? Are there alternative sites or technologies with less environmental hazard? Etc.

The most useful way to help readers follow complicated discussions is to unify the text with the associated tables, maps, and charts. For more than thirty years, certain industries have been preparing "modular" publications, in which the entire document is conceived of as a set of two-page spreads, with text and exhibit on facing pages. (Currently, the only efficient way to read an EIS is to have two copies, with one open to the referenced chart or table.)

And finally, the only way to eliminate or control **tactical errors** is with a professional editor. At the very least, such a person is needed to clean up after the parade of technical specialists has marched through. Every EIS, like every final report, needs the attentions of someone who knows how to reduce the burden on the reader, to contain the effort and "overhead" needed to read and use the document.

To do that job, however, takes time. Schedules must allow room for the editor to work. And project directors must be less willing to deliver undercooked drafts to eager sponsors.

Quality Assurance specialists are fond of saying that the bitterness of poor quality lingers long after the sweetness of meeting a deadline. I might add that the bitterness of an unreadable EIS can undermine the intellectual authority of the environmental engineer. And even foul the air.

ATTACHMENT 4.J

EPA RATING SYSTEM CRITERIA FOR DRAFT EISs

- **The U.S. Environmental Protection Agency rating system criteria for review of draft environmental impact statements.** (Source: U.S. Environmental Protection Agency. 1984. Policy and Procedures for the Review of Federal Actions Impacting the Environment. EPA Manual 1640)

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SUMMARY OF RATING DEFINITIONS AND FOLLOW-UP ACTION

Environmental Impact of the Action

Lo--Lack of Objections. The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC--Environmental Concerns. The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO--Environmental Objections. The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU-- Environmentally Unsatisfactory. The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1--Adequate. EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2--Insufficient Information. The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3--Inadequate. EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

PART D

SELECTED LAWS AND REGULATIONS

United States Environmental Protection Agency
September 1989

Enforcement & Compliance Monitoring (LE-133)

EPA

Facts About The National Environmental Policy Act

The National Environmental Policy Act (NEPA), [42 U.S.C. 4321 et seq.], was signed into law on January 1, 1970. The Act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the federal agencies. The Act also establishes the Council on Environmental Quality (CEQ).

NEPA Requirements

Title I of NEPA contains a Declaration of National Environmental Policy which requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as environmental impact statements (EISs). Section 102 also requires federal agencies to lend appropriate support to initiatives and programs designed to anticipate and prevent a decline in the quality of mankind's world environment.

Title II of NEPA establishes the Council on Environmental Quality (CEQ) and requires the President to transmit to Congress, with the assistance of CEQ, an annual Environmental Quality Report on the state of the environment.

Oversight Of NEPA

The Council on Environmental Quality, which is headed by a fulltime Chairperson, oversees NEPA. A staff assists the Council. The duties and functions of the Council are listed in Title II, Section 204 of NEPA and include: gathering information on the conditions and trends in environmental quality; evaluating federal programs in light of the goals established in Title I of the Act; developing and promoting national policies to improve environmental quality; and conducting studies, surveys, research, and analyses relating to ecosystems and environmental quality.

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Implementation

In 1978 CEQ promulgated regulations [40 CFR Parts 1500-1508] implementing NEPA which are binding on all federal agencies. The regulations address the procedural provisions of NEPA and the administration of the NEPA process, including preparation of EISs. To date, the only change in the NEPA regulations occurred on May 27, 1986, when CEQ amended Section 1502.22 of its regulations to clarify how agencies are to carry out their environmental evaluations in situations where information is incomplete or unavailable.

CEQ has also issued guidance on various aspects of the regulations including: an information document on *"Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act"*, *Scoping Guidance*, and *Guidance Regarding NEPA Regulations*. Additionally, most federal agencies have promulgated their own NEPA regulations and guidance which generally follow the CEQ procedures but are tailored for the specific mission and activities of the agency.

The NEPA Process

The NEPA process consists of an evaluation of the environmental effects of a federal undertaking including its alternatives. There are three levels of analysis depending on whether or not an undertaking could significantly affect the environment. These three levels include: categorical exclusion determination; preparation of an environmental assessment/finding of no significant impact (EA/FONSI); and preparation of an environmental impact statement (EIS).

At the first level, an undertaking may be categorically excluded from a detailed environmental analysis if it meets certain criteria which a federal agency has previously determined as having no significant environmental impact. A number of agencies have developed lists of actions which are normally categorically excluded from environmental evaluation under their NEPA regulations.

At the second level of analysis, a federal agency prepares a written environmental assessment (EA) to determine whether or not a federal undertaking would significantly affect the environment. If the answer is no, the agency issues a finding of no significant impact (FONSI). The FONSI may address measures which an agency will take to reduce (mitigate) potentially significant impacts.

If the EA determines that the environmental consequences of a proposed federal undertaking may be significant, an EIS is prepared. An EIS is a more detailed evaluation of the proposed action and alternatives. The public, other federal agencies and outside parties may provide input into the preparation of an EIS and then comment on the draft EIS when it is completed.

If a federal agency anticipates that an undertaking may significantly impact the environment, or if a project is environmentally controversial, a federal agency may choose to prepare an EIS without having to first prepare an EA.

After a final EIS is prepared and at the time of its decision, a federal agency will prepare a public record of its decision addressing how the findings of the EIS, including consideration of alternatives, were incorporated into the agency's decision-making process.

During the latter half of the 1980s, approximately 450 draft and final EISs were prepared annually on federal actions. During that same period between 10,000 and 20,000 EAs were prepared annually.

EA And EIS Components

An EA is described in Section 1508.9 of the Council's NEPA regulations. Generally, an EA includes brief discussions of the following: the need for the proposal; alternatives (when there is an unresolved conflict concerning alternative uses of available resources); the environmental impacts of the proposed action and alternatives; and a listing of agencies and persons consulted.

An EIS, which is described in Part 1502 of the regulations, should include discussions of the purpose of and need for the action, alternatives, the affected environment, the environmental consequences of the proposed action, lists of preparers, agencies, organizations and persons to whom the statement is sent, an index, and an appendix (if any).

Federal Agency Roles

The role of a federal agency in the NEPA process depends on the agency's expertise and relationship to the proposed undertaking. The agency carrying out the federal action is responsible for complying with the requirements

of NEPA. In some cases, there may be more than one federal agency involved in an undertaking. In this situation, a lead agency is designated to supervise preparation of the environmental analysis. Federal agencies, together with state or local agencies, may act as joint lead agencies.

A federal agency having special expertise with respect to an environmental issue or jurisdiction by law may be a cooperating agency in the NEPA process. A cooperating agency has the responsibility to assist the lead agency by participating in the NEPA process at the earliest possible time; by participating in the scoping process; in developing information and preparing environmental analyses including portions of the environmental impact statement concerning which the cooperating agency has special expertise; and in making available staff support at the lead agency's request to enhance the lead agency's interdisciplinary capabilities.

Under Section 1504 of CEQ's NEPA regulations, federal agencies may refer to CEQ interagency disagreements concerning proposed federal actions that might cause unsatisfactory environmental effects. CEQ's role, when it accepts a referral, is generally to develop findings and recommendations, consistent with the policy goals of Section 101 of NEPA. The referral process consists of certain steps and is carried out within a specified time frame.

In deciding whether or not to refer an action, an agency must consider the extent of potential adverse environmental impacts including: possible violation of national environmental standards or policies, severity, geographical scope, duration, importance as precedents, and availability of environmentally preferable alternatives. A referring agency must advise the lead agency of its intention to refer the matter to CEQ and notify CEQ. In advising the lead agency, the referring agency will address the reasons for the referral and recommendations for remedying the situation. If the lead agency does not satisfactorily respond to the referral agency, then the matter is forwarded to CEQ. CEQ may take several actions to resolve the situation including:

- Discussing the matter with both agencies.
- Holding public meetings to obtain additional information.
- Determining that the issue is not of national importance and that the agencies should proceed with their decision-making.
- Publishing its findings and recommendations.
- Submitting (when appropriate) the referral and its recommendations to the President for action. Although not binding, CEQ's recommendations carry weight and influence. Agencies generally follow CEQ's guidance.

EPA's Role

The Environmental Protection Agency, like other federal agencies, prepares and reviews NEPA documents. However, EPA has a unique responsibility in the NEPA review process. Under Section 309 of the Clean Air Act, EPA is required to review and publicly comment on the environmental impacts of major federal actions including actions which are the subject of EISs. If EPA determines that the action is environmentally unsatisfactory, it is required by Section 309 to refer the matter to CEQ. In the period between 1974 to 1989, there were 24 referrals to CEQ, of which 14 were submitted by EPA. EPA's 309 review process is described at the end of this pamphlet.

Also, in accordance with a Memorandum of Agreement between EPA and CEQ, EPA carries out the operational duties associated with the administrative aspects of the EIS filing process. The Office of Federal Activities in EPA has been designated the official recipient in EPA of all EISs prepared by federal agencies.

The Public's Role

The public has an important role in the NEPA process, particularly during scoping, in providing input on what issues should be addressed in an EIS and in commenting on the findings in an agency's NEPA documents. The public can participate in the NEPA process by attending NEPA-related hearings or public meetings and by submitting comments directly to the lead agency. The lead agency must take into consideration all comments received from the public and other parties on NEPA documents during the comment period.

NEPA And Other Environmental Laws

The NEPA review takes into consideration the effect that an action may have on various aspects of the environment. Some of these areas, such as impacts on endangered species and cultural resources, are also covered by other environmental laws including the Endangered

Species Act, the National Historic Preservation Act, etc. To reduce paperwork and avoid delays in the decision-making process, federal agencies must, to the fullest extent possible, integrate the NEPA review with the analytic and consultation requirements of these other environmental laws.

The NEPA review also takes into consideration whether a federal undertaking is in compliance with statutes such as the Clean Water Act and the Clean Air Act. In these cases, the lead agency would consult with the agencies overseeing these statutes to ensure compliance with any criteria and standards promulgated under these laws.

Integration Into Federal Decision-Making

The CEQ NEPA regulations require federal agencies to make the environmental review documents and any comments and responses a part of the record in formal rulemaking and adjudicatory proceedings. These documents must also accompany the proposal through the federal agency's review process. In making its decision on a proposal, an agency must consider a full range of alternatives including ones evaluated in the NEPA review.

Most federal agencies have promulgated NEPA regulations which address how the NEPA review will be incorporated into their various programs. Agencies are encouraged to prepare broad EISs covering policy or programmatic actions and to tier subsequent NEPA reviews to individual actions included within the program or policy. For legislative proposals, the NEPA process is integrated with the legislative process of Congress. Federal agencies are required to integrate the NEPA review early in program or project planning. In the preparation of EISs, the scoping process provides for early identification and consideration of environmental issues and alternatives.

The Benefits Of NEPA

NEPA has caused federal agencies to incorporate environmental values in their decision-making. For most agencies, the NEPA review is now an integral part of program planning. To oversee compliance with NEPA, many agencies have organized multi-disciplinary staffs. The primary benefit has been more protection for the environment in federal undertakings. This has come about because of the NEPA review process and resultant changes in projects, such as alterations in project design, location or operation; agency consideration of a greater range of alternatives; implementation of mitigation measures; and enhanced opportunity for public involvement in the decision-making process. An additional benefit has been a reduction of some project costs because of changes made in projects. The NEPA review process has also enabled agencies to address compliance with other environmental laws as part of a single review process rather than separate reviews under each law, thereby reducing the amount of paperwork, staff time, and effort.

State NEPAs

Following the passage of NEPA, which only applies to federal actions, a number of states passed laws which incorporate consideration of environmental effects into state actions. Many of the state NEPAs, or "little NEPAs" as they are commonly called, are modelled after the federal NEPA. Presently, 11 states have passed laws with comprehensive environmental review requirements. Fourteen states have limited environmental review requirements established by executive order or other administrative directives.

EPA's "309" Review Process

Section 309 of the Clean Air Act states:

(a) "The Administrator shall review and comment in writing on the environmental impact of any matter relating to duties and responsibilities granted pursuant to this chapter or other provisions of the authority of the Administrator, contained in any (1) legislation proposed by any federal department or agency, (2) newly authorized federal projects for construction and any major federal agency action (other than a project for construction) to which Section 4332 (2) (C) of this title applies, and (3) proposed regulations published by any department or agency of the federal government. Such written comment shall be made public at the conclusion of any such review.

(b) In the event the Administrator determines that any such legislation, action, or regulation is unsatisfactory from the stand-point of public health or welfare or environmental quality, he shall publish his determination and the matter shall be referred to the Council on Environmental Quality."

This Section was added to the Clean Air Act in 1970, at the time the NEPA was passed and EPA was formed. The rationale was that the EISs that federal agencies would be developing under NEPA should have an independent review and that the newly formed EPA should perform it.

EPA developed implementing procedures in 1971 to carry out this responsibility and, in conjunction with the CEQ, has since refined these procedures. Operating procedures are contained in the manual, *Policies and Procedures for the Review of Federal Actions Impacting the Environment* (revised in 1984).

In accordance with these operating procedures, EPA reviews, comments, and makes the comments available to the public, on all federal draft and final EISs, proposed environmental regulations, and other proposed major actions EPA considers to have significant environmental effects. EPA has reviewed all of the draft and final EISs prepared by federal agencies since the passage of NEPA.

The major elements of the 309 review process include the following:

- EPA reviews and comments on both the adequacy of the analysis and the environmental impacts of the proposed action itself.
- EPA comments on issues related to its "duties and responsibilities", which include all environmental media (i.e., air, water, etc.), methodologies related to media-impact assessment, and areas related to its regulatory responsibilities.
- EPA comments on potential violation of or inconsistency with national environmental standards and determines whether adequate information has been provided to assess potential environmental impacts of the proposed action.
- In general, the degree to which the Agency gets involved in attempting to modify a proposed project depends on the level of environmental impacts, the ability and willingness of the proposng federal agency to mitigate those impacts, and the level of responsibility EPA has over the type of impact at issue.
- If the action is a federal project to be located in or on a specific site, the appropriate EPA regional office has the jurisdiction and delegated responsibility for carrying out the Section 309 CAA review and working with the proposing federal agency to resolve any problems. If the action by the proposing federal department/agency is legislative or regulatory, generally the Section 309 CAA review will be conducted directly in EPA headquarters.
- For federal-project cases, EPA headquarters becomes involved if the region finds that the proposed action in the draft EIS is "environmentally unsatisfactory", or that the draft EIS is "inadequate" to assess the potentially significant environmental impacts of proposed actions. In these cases, headquarters must approve the regional comment letter before it is sent. In addition, EPA headquarters works with regional personnel in informing interested parties about the EPA action and will assist the region, as needed, in meeting with the proposing federal agency to resolve the issues. The CEQ is always notified of a draft EIS which has been rated "unsatisfactory" or "inadequate" by EPA.
- If the region finds that the subsequent final EIS is still "environmentally unsatisfactory", the region recommends to the Administrator that the matter be referred to the CEQ for resolution. At this time, EPA headquarters becomes significantly involved in the factual determination and judgment on the EIS.
- The process is carried out so as to ensure the independence of the EPA review responsibilities and to coordinate in a manner which emphasizes consultation with the lead agency and informing interested parties of EPA actions and concerns.

Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act. (Source: 40 Code of Federal Regulations Parts 1500 - 1508)

FORTY MOST ASKED QUESTIONS CONCERNING CEQ'S NATIONAL ENVIRONMENTAL POLICY ACT REGULATIONS

The Council on Environmental Quality published answers to the "forty most asked questions concerning CEQ's National Environmental Policy Act Regulations" in the March 23, 1981 *Federal Register* (46 FR 18026-18038). The answers to the questions were prepared by the General Counsel of CEQ in consultation with the Office of Federal Activities of EPA. The answers do not impose any additional requirements beyond those of the NEPA regulations but are meant to provide aid in the practical application of the regulations. The subjects covered by the 40 questions are as follows:

1. Range of alternatives
2. Alternatives outside the capability of applicant or jurisdiction of agency
3. No action alternative
4. Preferred alternative of the agency
5. Proposed action vs. preferred alternative
6. Environmentally preferable alternative
7. Difference between sections of EIS on alternatives and environmental consequences
8. Early application of NEPA
9. Applicant who needs other permits
10. Limitations on action during 30-day review period for final EIS
11. Limitations on actions by an applicant during EIS process
12. Effective date and enforceability of the regulations
13. Use of scoping before notice of intent to prepare EIS
14. Rights and responsibilities of lead and cooperating agencies
15. Commenting responsibilities of EPA
16. Third party contracts
17. Disclosure statement to avoid conflict of interest
18. Uncertainties about indirect effects of a proposal
19. Mitigation measures
20. Worst case analysis
21. Combining environmental and planning documents
22. State and federal agencies as joint lead agencies
23. Conflicts of federal proposal with land use plans, on policies and controls
24. Environmental impact statements on policies, plans or programs
25. Appendices and incorporation by reference
26. Index and keyword index in EISs
27. List of preparers
28. Advance or photocopies of EIS
29. Responses to comments
30. Adoption of EISs
31. Application of regulations to independent regulatory agencies
32. Supplements to old EISs
33. Referrals
34. Records of decision
35. Time required for the NEPA process
36. Environmental assessments (EA)
37. Findings of no significant impact (FONSI)
38. Public availability of EAs vs. FONSIs
39. Mitigation measures imposed in EAs and FONSIs
40. Propriety of issuing EA when mitigation reduces impacts

QUESTIONS AND ANSWERS

1a. Q. What is meant by "range of alternatives" as referred to in Section 1505.1(e)?

A. The phrase "range of alternatives" refers to the alternatives discussed in environmental documents. It includes all reasonable alternatives which must be rigorously explored and objectively evaluated, as well as those other alternatives which are eliminated from detailed study with a brief discussion of the reasons for eliminating them (Section 1502.14). A decision maker must not consider alternatives beyond the range of alternatives discussed in the relevant environmental documents. Moreover, a decision maker must, in fact, consider all the alternatives discussed in an EIS (Section 1505. 1(e)).

1b. Q. How many alternatives have to be discussed when there is an infinite number of possible alternatives?

A. For some proposals there may exist a very large or even an infinite number of possible reasonable alternatives. For example, a proposal to designate wilderness areas within a national forest could be said to involve an infinite number of alternatives from 0 to 100% of the forest. When there are potentially a very large number of alternatives, only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS. An appropriate series of alternatives might include dedicating 0, 10, 30, 50, 70, 90, or 100% of the forest to wilderness. What constitutes a reasonable range of alternatives depends on the nature of the proposal and the facts in each case.

2a. Q. If an EIS is prepared in connection with an application for a permit or other federal approval, must the EIS rigorously analyze and discuss alternatives that are outside the capability of the applicant, or can it be limited to reasonable alternatives that can be carried out by the applicant?

A. Section 1502.14 requires the EIS to examine all reasonable alternatives to the proposal. In determining the scope of alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether the proponent or applicant likes it or is itself capable of carrying out a

particular alternative. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint, using common sense, rather than those simply desirable from the standpoint of the applicant.

2b. Q. Must the EIS analyze alternatives outside the jurisdiction or capability of the agency or beyond what Congress has authorized?

A. An alternative that is outside the legal jurisdiction of the lead agency must still be analyzed in the EIS if it is reasonable. A potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered (Section 1506.2(d)). Alternatives that are outside the scope of what Congress has approved or funded must still be evaluated in the EIS if they are reasonable, because the EIS may serve as the basis for modifying the Congressional approval or funding in light of the goals and policies of NEPA (Section 1500.1 (a)) .

3. Q. What does the "no action" alternative include? If an agency is under a court order or legislative command to act, must the EIS address the "no action" alterative?

A. Section 1502.14(d) requires the alternatives analysis in the EIS to "include the alternative of no action." There are two distinct interpretations of "no action" that must be considered depending on the nature of the proposal being evaluated. The first situation might involve an action such as updating a land management plan where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases, "no action" is "no change" from current management direction or level of management intensity. To construct an alternative that is based on no management at all would be a useless academic exercise. Therefore, the "no action" alternative may be thought of in terms of continuing with the present course of action until that action is changed. Consequently, projected impacts of alternative management schemes would be compared in the EIS to those impacts projected for the existing plan. In this case, alternatives would include management plans of both greater and lesser intensity, especially greater and lesser levels of resource development.

The second interpretation of "no action" is illustrated in instances involving federal decisions on proposals for projects. "No action" in such cases would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward.

Where a choice of "no action" by the agency would result in predictable actions by others, this consequence of the "no action" alterative should be included in the analysis. For example, if denial of permission to build a railroad to a facility would lead to construction of a road and increased truck traffic, the EIS should analyze this consequence of the "no action" alternative. In light of the above, it is difficult to think of a situation where it would not be appropriate to address a "no action" alternative. Accordingly, the regulations require the analysis of the "no action" alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the "no action" alternatives. It is also an example of a reasonable alterative outside the jurisdiction of the agency which must be analyzed (Section 2502.14(c); see Question 2 above). Inclusion of such an analysis in the EIS is necessary to inform the Congress, the public, and the president as intended by NEPA (Section 1500.1 (a)) .

4a. Q. What is the "agency's preferred alternative"?

A. The "agency's preferred alternative" is the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors. The concept of the "agency's preferred alternative" is different from the "environmentally preferable alternative", although, in some cases, one alternative may be both (see Question 6 below). It is identified so that agencies and the public can understand the orientation of the lead agency.

4b. Q. Does the "preferred alternative" have to be identified in the draft EIS and the final EIS or just in the final EIS?

A. Section 1502.14(e) requires the section of the EIS on alternatives to "identify the agency's preferred alternative if one or more exists, in the draft statement, and identify such alternative in the final statement . . . " This means that if the agency has a preferred alternative at the draft EIS stage, that alterative must be labeled or identified as such in the draft EIS. If the responsible federal official in fact has no preferred alternative at the draft EIS stage, a preferred alternative need not be identified there. By the time the final EIS is filed, Section 1502.14(e) presumes the existence of a preferred alternative and requires its identification in the final EIS, "unless another law prohibits the expression of such a preference."

4c. Q. Who recommends or determines the "preferred alterative"?

A. The lead agency official with line responsibility for preparing the EIS and assuring its adequacy is responsible for identifying the preferred alternative(s) of the agency. The NEPA regulations do not dictate which official in an agency shall be responsible for preparation of EISs, but

agencies can identify this official in this implementing procedures, pursuant to Section 1507.3.

Even though the preferred alternative of the agency is identified by the EIS preparer in the EIS, the statement must be objectively prepared and not slanted to support the choice of the preferred alternative of the agency over the other reasonable and feasible alternatives.

5a. Q. Is the "proposed action" the same thing as the "preferred alternative"?

A. The "proposed action" may be, but is not necessarily, the "preferred alternative of the agency. The proposed action may be a proposal in its initial form before undergoing analysis in the EIS process. If the proposed action is internally generated, such as preparing a land management plan, the proposed action might end up as the preferred alternative of the agency. On the other hand, the proposed action may be granting an application to a nonfederal entity for a permit. The agency may or may not have a "preferred alternative" at the draft EIS stage (see Question 4 above). In that case, the agency may decide at the final EIS stage, on the basis of the draft EIS and the public and agency comments, that an alternative other than the proposed action is the "preferred alternative" of the agency.

5b. Q. Is the analysis of the "proposed action" in an EIS to be treated differently from the analysis of alternatives?

A. The degree of analysis devoted to each alternative in the EIS is to be substantially similar to that devoted to the "proposed action". Section 1501.3 is titled, "Alternatives included in the proposed action," to reflect such comparable treatment. Section 1502.14(9b) specifically requires "substantial treatment" in the EIS of each alternative, including the proposed action. This regulation does not dictate an amount of information to be provided, but rather prescribes a level of treatment which may, in turn, require varying amounts of information to enable a reviewer to evaluate and compare alternatives.

6a. Q. What is the meaning of the term "environmentally preferable alternative", as used in the regulations with reference to records of decision? How is the term "environment" used in the phrase?

A. Section 1505.2(b) requires that, in cases where an EIS has been prepared, the record of decision (ROD) must identify all alternatives that were considered, " . . . specifying the alternative or alternatives which were considered to be environmentally preferable." The environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA, Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.

The Council recognizes that the identification of the environmentally preferable alternative may involve difficult judgments, particularly when one environmental value must be balanced against another. The public and other agencies reviewing a draft EIS can assist the lead agency to develop and determine environmentally preferable alternatives by providing their views in comments on the draft EIS. Through the identification of the environmentally preferable alternative, the decision maker is clearly faced with a choice between that alternative and others, and must consider whether the decision accords with the Congressionally declared policies of the act.

6b. Q. Who recommends or determines that which is environmentally preferable?

A. The agency EIS staff is encouraged to make recommendations of the environmentally preferable alternative(s) during EIS preparation. In any event, the lead agency official responsible for the EIS is encouraged to identify the environmentally preferable alternative(s) in the EIS. In all cases, comments from other agencies and the public are also encouraged to address this question. The agency must identify the environmentally preferable alternative in the ROD.

7. Q. What is the difference between the sections in the EIS on "alternatives" and "environmental consequences"? How do you avoid duplicating the discussion of alternatives in preparing these two sections?

A. The "alternatives" section is the heart of the EIS. This section rigorously explores and objectively evaluates all reasonable alternatives, including the proposed action (Section 1502.14). It should include relevant comparisons on environmental and other grounds. The "environmental consequences" section of the EIS discusses the specific environmental impacts or effects of each of the alternatives, including the proposed action (Section 1502.16). In order to avoid duplication between these two sections, most of the "alternatives" section should be devoted to describing and comparing the alternatives. Discussion of the environmental impacts of these alternatives should be limited to a concise, descriptive summary of such impacts in a comparative form, including charts or tables, thus sharply defining the issues and providing a clear basis for choice among options (Section 1502.14). The "environmental consequences" section should be devoted largely to a scientific analysis of the direct and indirect environmental effects of the proposed action and of each of the alternatives. It forms the analytic basis for the concise comparison in the "alternatives" section.

8. Q. Section 1501.2(d) of the NEPA regulations requires agencies to provide for the early application of NEPA to cases where actions are planned by private applicants or nonfederal entities and are, at some stage, subject to federal approval of permits, loans, loan guarantees, insurance, or other actions. What must and can agencies do to apply NEPA early in these cases?

A. Section 1501.2(d) requires federal agencies to take steps toward ensuring that private parties and state and local entities initiate environmental studies as soon as federal involvement in these proposals can be foreseen. This section is intended to ensure that environmental factors are considered at an early stage in the planning process and to avoid the situation where the applicant for a federal permit or approval has completed planning and eliminated all alternatives to the proposed action by the time the EIS process commences or before the EIS process has been completed.

Through early consultation, business applicants and approving agencies may gain better appreciation of each other's needs and foster a decision making process which avoids later unexpected confrontations.

Federal agencies are required by Section 1507.3(b) to develop procedures to carry out Section 1501.2(d). The procedures should include an "outreach program", such as a means for prospective applicants to conduct preapplication consultations with the lead and cooperating agencies. Applicants need to find out in advance of project planning what environmental studies or other information will be required and what mitigation requirements are likely in connection with the later federal NEPA process. Agencies should designate staff to advise potential applicants of the NEPA information requirements of the agency and should publicize their preapplication procedures and information requirements in newsletters or other media used by potential applicants.

Complementing Section 1501.2(d), Section 1506.5(a) requires agencies to assist applicants by outlining the types of information required in those cases where the agency requires the applicant to submit environmental data for possible use by the agency in preparing an EIS.

Section 1506.5(b) allows agencies to authorize preparation of environmental assessments by applicants. Thus, the procedures should also include a means for anticipating and utilizing applicants' environmental studies or "early corporate environmental assessments" to fulfill some of the NEPA obligations of the federal agency. However, in such cases, the agency must still evaluate independently the environmental issues and take responsibility for the environmental assessment.

These provisions are intended to encourage and enable private and other nonfederal entities to build environmental considerations into their own planning processes in a way that facilitates the application of NEPA and avoids delay.

9. Q. To what extent must an agency inquire into whether an applicant for a federal permit, funding, or other approval of a proposal will also need approval from another agency for the same proposal or some other related aspect of it?

A. Agencies must integrate the NEPA process into other planning at the earliest possible time to insure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts. Specifically, the agency must "provide for cases where actions are planned by . . . applications," so that designated staff are available to advise potential applicants of studies or other information that will foreseeably be required for the later federal action; the agency shall consult with the applicant if the agency foresees its own involvement in the proposal; and it shall insure that the NEPA process commences at the earliest possible time (Section 1501.2(d); see Question 8).

The regulations emphasize agency cooperation early in the NEPA process (Section 1501.5). Section 1501.7 on "scoping" also provides that all affected federal agencies are to be invited to participate in scoping the environmental issues and to identify the various environmental review and consultation requirements that may apply to the proposed action. Further, Section 1502.25(b) requires that the draft EIS list all the federal permits, licenses, and other entitlements that are needed to implement the proposal.

These provisions create an affirmative obligation on federal agencies to inquire early and, to the maximum degree possible, to ascertain whether an applicant is or will be seeking other federal assistance or approval, or whether the applicant is waiting until a proposal has been substantially developed before requesting federal aid or approval.

Thus, a federal agency receiving a request for approval or assistance should determine whether the applicant has filed separate requests for federal approval or assistance with other federal agencies. Other federal agencies that are likely to become involved should then be contacted, and the NEPA process coordinated to insure an early and comprehensive analysis of the direct and indirect effects of the proposal and any related actions. The agency should inform the applicant the action on its application may be delayed unless it submits all other federal applications (where feasible to do so) so that all the relevant agencies can work together on the scoping process and preparation of the EIS.

10a. Q. What actions by agencies and/or applicants are allowed during EIS preparation and during the 30-day review period after publication of a final EIS?

A. No federal decision on the proposed action shall be made or recorded until at least 30 days after the publication by EPA of notice that the particular EIS has been filed with

EPA (Sections 1505.2 and 1506.10). Section 1505.2 requires this decision to be stated in a public record of decision. Until the agency issues its record of decision, no action by an agency or applicant concerning the proposal shall be taken which would have an adverse environmental impact or limit the choice of reasonable alternatives (Section 1506.1(a)). But this does not preclude preliminary planning or design work which is needed to support an application for permits or assistance (Section 1506.1(d).

When the impact statement in question is a program EIS, no major action concerning the program may be taken which may significantly affect the quality of the human environment, unless the particular action is justified independently of the program, is accompanied by its own adequate environmental impact statement, and will not prejudice the ultimate decision on the program (Section 1506. l(c)).

10b. Q. Do these limitations on action (described in Question 10a) apply to state or local agencies that have statutorily delegated responsibility for preparation of environmental documents required by NEPA, for example, under the HUD Block Grant program?

A. Yes, these limitations do apply, without any variation from their application to federal agencies.

11. Q. What actions must a lead agency taken during the NEPA process when it becomes aware that a nonfederal applicant is about to take an action within the jurisdiction of the agency that would either have an adverse environmental impact or limit the choice of reasonable alternatives (e.g., prematurely commit money or other resources towards the completion of the proposal)?

A. The federal agency must notify the applicant that the agency will take strong affirmative steps to insure that the objectives and procedures of NEPA are fulfilled (Section 1506.1(b). These steps could include seeking injunctive measurements under NEPA, or the use of sanctions available under either the permitting authority of the agency or statutes setting forth the statutory mission of the agency. For example, the agency might advise an applicant that if such action is taken, the agency will not process the application.

12a. Q. What actions are subject to the new regulations of CEQ, and what actions are grandfathered under the old guidelines?

A. The effective date of the CEQ regulations was July 30, 1979 (except for certain HUD programs under the Housing and Community Development Act, 42 U.S.C. 5304(h), and certain state highway programs that qualify under Section 102(2)(D) of NEPA for which the regulations became effective on November 30, 1979). All the provisions of the regulations are binding as of that date, including those covering decision making, public participation, referrals, limitations on actions, EIS supplements, etc. For example, a record of decision would be prepared even for decisions where the draft EIS was filed before July 30, 1979.

But in determining whether or not the new regulations apply to the preparation of a particular environmental document, the relevant factor is the date of filing of the draft of that document. Thus, the new regulations do not require the redrafting of an EIS or supplement if the draft EIS or supplement was filed before July 30, 1979. However, a supplement prepared after the effective date of the regulations for an EIS issued in final before the effective date of the regulations would be controlled by the regulations.

Even though agencies are not required to apply the regulations to an EIS or other document for which the draft was filed prior to July 30, 1979, the regulations encourage agencies to follow the regulations "to the fullest extent practicable," i.e., if it is feasible to do so, in preparing the final document (Section 1506.12(a)).

12b. Q. Are projects authorized by Congress before the effective date of the CEQ regulations grandfathered?

A. No. The date of Congressional authorization for a project is not determinative of whether the CEQ regulations or former guidelines apply to the particular proposal. No incomplete projects or proposals of any kind are grandfathered in whole or in part. Only certain environmental documents, for which the draft was issued before the effective date of the regulations, are grandfathered and subject to the former guidelines of the CEQ.

12c. Q. Can a violation of the regulations give rise to a cause of action?

A. While a trivial violation of the regulations would not give rise to an independent cause of action, such a cause of action would arise from a substantial violation of the regulations (Section 1500.3).

13. Q. Can the scoping process be used in connection with preparation of an environmental assessment, i.e., before both the decision to proceed with an EIS and publication of a notice of intent?

A. Yes. Scoping can be a useful tool for discovering alternatives to a proposal or significant impacts that may have been overlooked. In cases where an environmental assessment is being prepared to help an agency decide whether to prepare an EIS, useful information might result from early participation by other agencies and the public in a scoping process.

The regulations state that the scoping process is to be preceded by a notice of intent (NOI) to prepare an EIS. But that is only the minimum requirement. Scoping may be initiated earlier, as long as there is appropriate public notice and enough information available on the proposal so that the public and relevant agencies can participate effectively.

However, scoping that is done before the assessment, and in aid of its preparation, cannot substitute for the normal scoping process after publication of the NOI, unless the earlier public notice stated clearly that this possibility was under consideration, and the NOI expressly provides that written comments on the scope of alternatives and impacts will still be considered.

14a. Q. What are the respective rights and responsibilities of lead and cooperating agencies? What letters and memoranda must be prepared?

A. After a lead agency has been designated (Section 1501.5), that agency has the responsibility to solicit cooperation from other federal agencies that have jurisdiction by law or special expertise on any environmental issue that should be addressed in the EIS being prepared. Where appropriate, the lead agency should seek the cooperation of state or local agencies of similar qualifications. When the proposal may affect an Indian reservation, the agency should consult with the Indian tribe (Section 1508.5). The request for cooperation should come at the earliest possible time in the NEPA process.

After discussions with the candidate cooperating agencies, the lead agency and the cooperating agencies are to determine by letter or by memorandum which agencies will undertake cooperating responsibilities. To the extent possible at this stage, responsibilities for specific issues should be assigned. The allocation of responsibilities will be completed during scoping (Section 1501.7(a)(4)).

Cooperating agencies must assume responsibility for the development of information and the preparation of environmental analyses at the request of the lead agency (Section 1501.6(b)(3)). Cooperating agencies are not required by Section 1501.6 to devote staff resources that were normally used to critique or comment on the draft EIS after its preparation, much earlier in the NEPA process--primarily at the scoping and draft EIS preparation stages. If a cooperating agency determines that its resource limitations preclude any involvement, or the degree of involvement (amount of work) requested by the lead agency, it must so inform the lead agency in writing and submit a copy of this correspondence to the Council (Section 1501 .6(c)).

In other words, the potential cooperating agency must decide early if it is able to devote any of its resources to a particular proposal. For this reason, the regulation states that an agency may reply to a request for cooperation that "other program commitments preclude any involvement or the degree of involvement requested in the action that is the subject of the environmental impact statement." (Emphasis added.) The regulations refers to the "action", rather than to the EIS, to clarify that the agency is taking itself out of all phases of the federal action, not just draft EIS preparation. This means that the agency has determined that it cannot be involved in the later stages of EIS review and comment, as well as decision making on the proposed action. For this reason, cooperating agencies with jurisdiction by law (those which have permitting or other approval authority) cannot opt out entirely of the duty to cooperate on the EIS (see also Question 15, relating specifically to the responsibility of EPA).

14b. Q. How are disputes resolved between lead and cooperating agencies concerning the scope and level of detail of analysis and the quality of data in impact statements?

A. Such disputes are resolved by the agencies themselves. A lead agency, of course, has the ultimate responsibility for the content of an EIS. But it is supposed to use the environmental analysis and recommendations of cooperating agencies with jurisdiction by law or special expertise to the maximum extent possible, consistent with its own responsibilities as lead agency (Section 1501.6(a)(2)).

If the lead agency leaves out a significant issue or ignores the advice and expertise of the cooperating agency, the EIS may be found later to be inadequate. Similarly, where cooperating agencies have their own decisions to make and they intend to adopt the environmental impact statement and base their decisions on it, one document should include all of the information necessary for the decisions by the cooperating agencies. Otherwise they may be forced to duplicate the EIS process by issuing a new, more complete EIS or supplement EIS, even though the original EIS could have sufficed if it had been properly done at the outset. Thus, both lead and cooperating agencies have a stake in producing a document of good quality. Cooperating agencies also have a duty to participate fully in the scoping process to ensure that the appropriate range of issues is determined early in the EIS process.

Because the EIS is not the record of decision, but instead constitutes the information and analysis on which to base a decision, disagreements about conclusions to be drawn from the EIS need not inhibit agencies from issuing a joint document, or adopting an EIS of another agency, if the analysis is adequate. Thus, if each agency has its own "preferred alternative", both can be identified in the EIS. Similarly, a cooperating agency with jurisdiction by law may determine in its own ROD that Alternative A is the environmentally preferable action, even though the lead agency has decided in its separate ROD that Alternative B is environmentally preferable.

14c. Q. What are the specific responsibilities of federal and state cooperating agencies to review draft EISs?

A. Cooperating agencies (i.e., agencies with jurisdiction by law or special expertise) and agencies that are authorized to develop or enforce environmental standards must comment on environmental impact statements within their jurisdiction, expertise, or authority (Sections 1503.2, 1508.5). If a cooperating agency is satisfied that its views are adequately reflected in the environmental impact statement, it should simply comment accordingly. Conversely, if the cooperating agency determines that a draft EIS is incomplete, inadequate, or inaccurate, or it has other comments, it should promptly make such comments, conforming to the requirements of specificity in Section 1503.3.

14d. Q. How is the lead agency to treat the comments of another agency with jurisdiction by law or special expertise which has failed or refused to cooperate or participate in scoping or EIS preparation?

A. A lead agency has the responsibility to respond to all substantive comments raising significant issues regarding a draft EIS (Section 1500.4). However, cooperating agencies are generally under an obligation to raise issues or otherwise participate in the EIS process during scoping and EIS preparation if they reasonably can do so. In practical terms, if a cooperating agency fails to cooperate at the outset, such as during scoping, it will find that its comments at a later stage will not be as persuasive to the lead agency.

15. Q. Are responsibilities of the EPA to review and comment on the environmental effects of agency proposals under Section 309 of the Clean Air Act independent of its responsibility as a cooperating agency?

A. Yes. EPA has an obligation under Section 309 of the Clean Air Act to review and comment in writing on the environmental impact of any matter relating to the authority of the administrator contained in proposed legislation, federal construction projects, other federal actions requiring EISs, and new regulations (42 U.S.C. Sec. 7609). This obligation is independent of its role as a cooperating agency under the NEPA regulations.

16. Q. What is meant by the term "third party contracts" in connection with the preparation of an EIS? (See Section 1506.5(c).) When can "third party contracts" be used?

A. As used by EPA and other agencies, the term "third party contract" refers to the preparation of EISs by contractors paid by the applicant. In the case of an EIS for a National Pollution Discharge Elimination System (NPDES) permit, the applicant, aware in the early planning stages of the proposed project of the need for an EIS, contracts directly with a consulting firm for its preparation (Section 40 CFR 6.604(g)). The "third party" is EPA which, under Section 1506.5(c) must select the consulting firm, even though the applicant pays for the cost of preparing the EIS. The consulting firm is responsible to EPA for preparing an EIS that meets the requirements of the NEPA regulations and the NEPA procedures of the EPA. It is in the applicant's interest that the EIS can comply with the law so that EPA can take prompt action on the NPDES permit application. The "third party contract" method under the NEPA procedures of the EPA is purely voluntary, though most applicants have found it helpful in expediting compliance with NEPA.

If a federal agency used "third party contracting", the applicant may undertake the necessary paperwork for the solicitation of a field of candidates under the direction of the agency, so long as the agency complies with Section 1506.5(c). Federal procurement requirements do not apply to the agency because it incurs no obligations or costs under the contract, nor does the agency procure anything under the contract.

17a. Q. If an EIS is prepared with the assistance of a consulting firm, the firm must execute a disclosure statement. What criteria must the firm follow in determining whether it has any "financial or other interest in the outcome of the project" which would cause a conflict of interest?

A. Section 1506.5(c), which specifies that a consulting firm preparing an EIS must execute a disclosure statement, does not define "financial or other interest in the outcome of the project." The Council interprets this term broadly to cover any known benefits other than general enhancement of professional reputation. This includes any financial benefit such as a promise of future construction or design work on the project as well as indirect benefits the consultant is aware of (e.g., if the project would aid proposals sponsored by the other clients of the firm). For example, completion of a highway project may encourage construction of a shopping center or industrial park from which the consultant stands to benefit. If a consulting firm is aware that it has such an interest in the decision on the proposal, it should be disqualified from preparing the EIS to preserve the objectivity and integrity of the NEPA process.

When a consulting firm has been involved in developing initial data and plans for the project, but does not have any financial or other interest in the outcome of the decision, it need not be disqualified from preparing the EIS. However, a disclosure statement in the draft EIS should clearly state the scope and extent of the prior involvement of the firm to expose any potential conflicts of interest that may exist.

17b. Q. If the firm in fact has no promise of future work or other interest in the outcome of the proposal, may the firm later bid in competition with others for future work on the project if the proposed action is approved?

A. Yes.

18. Q. How should uncertainties about indirect effects of a proposal be addressed, for example, in cases of disposal of federal lands when the identity or plans of future landowners is unknown?

A. The EIS must identify all the indirect effects that are known, and make a good faith effort to explain the effects that are not known, but are "reasonably foreseeable" (Section 1508.8(b)). In the example, if there is total uncertainty about the identity of future land owners or the nature of future land uses, then of course the agency is not required to engage in speculation or contemplation about their future plans. But, in the ordinary course of business, people do make judgments based upon reasonably foreseeable occurrences. It will often be possible to consider the likely purchasers and the development trends in that area or similar areas in recent years; or the likelihood that the land will be used for an energy project, shopping center, subdivision, farm, or factory. The agency has the responsibility to make an informed judgment and to estimate future impacts on that basis, especially if trends are ascertainable or potential purchasers have made themselves known. The agency cannot ignore these uncertain, but probable, effects of its decisions.

19a. Q. What is the scope of mitigation measures that must be discussed?

A. The mitigation measures discussed in an EIS must cover the range of impacts on the proposal. The measures must include such things as design alternatives that would decrease pollution emissions, construction impacts, aesthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. Mitigation measures must be considered even for impacts that by themselves would not be considered "significant". Once the proposal itself is considered as a whole to have significant effects, all of its specific effects on the environment (whether or not "significant") must be considered, and mitigation measures must be developed where it is feasible to do so (Sections 1502.14(f), 1502.16(h), 1508. 14).

19b. Q. How should an EIS treat the subject of available mitigation measures that are (I) outside the jurisdiction of the lead agency or cooperating agencies or (2) unlikely to be adopted or enforced by the responsible agency?

A. All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency or the cooperating agencies and thus would not be committed as part of the RODs of these agencies (Sections 1502.16(h), 1505.2(c)). This will serve to alert agencies or officials who can implement these extra measures and will encourage them to do so. Because the EIS is the most comprehensive environmental document, it is an ideal vehicle in which to lay out not only the full range of environmental impacts, but also the full spectrum of appropriate mitigation.

However, to ensure that environmental effects of a proposed action are fairly assessed, the probability of the mitigation measures being implemented must also be discussed. Thus, the EIS and the record of decision should indicate the likelihood that such measures will be adopted or enforced by the responsible agencies (Sections 1502.16(h), 1505.2). If there is a history of nonenforcement or opposition to such measures, the EIS and record of decision should acknowledge such opposition or nonenforcement. If the necessary mitigation measures will not be ready for a long period of time, this fact, of course, should also be recognized.

20a. Q. When must a worst case analysis be included in an EIS?

A. If there are gaps in relevant information or scientific uncertainty pertaining to an evaluation of an agency of significant adverse impacts on the human environment, an agency must make clear that such information is lacking or that the uncertainty exists. An agency must include a worst case analysis of the potential impacts of the proposal and an indication of the probability or improbability of their occurrence if (a) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining the information are exorbitant, or (b) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known. NEPA requires that impact statements, at a minimum, contain information to alert the public and Congress to all known possible environmental consequences of agency action. Thus, one of the most important obligations of the federal government is to present to the fullest extent possible the spectrum of consequences that may result from agency decisions and the details of their potential consequences for the human environment.

20b. Q. What is the purpose of a worst case analysis? How is it formulated, and what is the scope of the analysis?

A. The purpose of the analysis is to carry out the mandate of NEPA for full disclosure to the public of the potential consequences of any agency decisions, and to cause agencies to consider those potential consequences when acting on the basis of scientific uncertainties or gaps in

available information. The analysis is formulated on the basis of available information, using reasonable projections of the worst possible consequences of a proposed action.

For example, if there are scientific uncertainties and gaps in the available information concerning the numbers of juvenile fish that would be entrained in a cooling water facility, the responsible agency must disclose and consider the possibility of the loss of the commercial or sport fishery.

In addition to an analysis of a low probability/catastrophic impact event, the worst case analysis should also include a spectrum of events of higher probability, but of less drastic impact.

21. Q. Where an EIS or an EA is combined with another project planning document (sometimes called "piggybacking"), to what degree may the EIS or EA refer to and rely upon information in the project document to satisfy the requirements of NEPA?

A. Section 1502.25 of the regulations requires that draft EISs be prepared concurrently and integrated with environmental analyses and related surveys and studies required by other federal statutes. In addition, Section 1506.4 allows any environmental document prepared in compliance with NEPA to be combined with any other agency document to reduce duplication and paperwork. However, these provisions were not intended to authorize the preparation of a short summary or outline EIS, attached to a detailed project report or land use plan containing the required environmental impact data. In such circumstances, the reader would have to refer constantly to the detailed report to understand the environmental impacts and alternatives which would have been found in the EIS itself.

The EIS must stand on its own as an analytical document which fully informs decision makers and the public of the environmental effects of the proposal and those of the reasonable alternatives (Section 1502.1). But, as long as the EIS is clearly identified and is self-supporting, it can be physically included in or attached to the project report or land use plan and may use attached report material as technical backup.

Forest Service environmental impact statements for forest management plans are handled in this manner. The EIS identifies the preferred alternative of the agency, which is developed in detail as the proposed management plan. The detailed proposed plan accompanies the EIS through the review process, and documents are appropriately cross referenced. The proposed plan is useful for EIS readers as an example to show how one choice of management options translates into effects on natural resources. This procedure permits initiation of the 90-day public review of proposed forest plans which is required by the National Forest Management Act.

All the alternatives are discussed in the EIS which can be read as an independent document. The details of the management plan are not repeated in the EIS, and vice versa. This is a reasonable functional separation of the documents: the EIS contains information relevant to the choice among alternatives; the plan is a detailed description of proposed management activities suitable for use by the land managers. This procedure provides for concurrent compliance with the public review requirements of both NEPA and the National Forest Management Act.

Under some circumstances, a project report or management plan may be totally merged with the EIS, and the one document labeled as both "EIS" and "management plan" or "project report". This may be reasonable where the documents are short or where the EIS format and the regulations for clear, analytical EISs also satisfy the requirements for a project report.

22. Q. May state and federal agencies serve as joint lead agencies? If so, how do they resolve law, policy, and resource conflicts under NEPA and the relevant state environmental policy act? How do they resolve differences in perspective where, for example, national and local needs may differ?

A. Under Section 1501.5(b), federal, state, or local agencies, as long as they include at least one federal agency, may act as joint lead agencies to prepare an EIS. Section 1506.2 also strongly urges state and local agencies and the relevant federal agencies to cooperate fully with each other. This should cover joint research and studies, planning activities, public hearings, environmental assessments, and the preparation of joint EISs under NEPA and the relevant "little NEPA" state laws so that one document will satisfy both laws.

The regulations also recognize that certain inconsistencies may exist between the proposed federal action and any approved state or local plan or law. The joint document should discuss the extent to which the federal agency would reconcile its proposed action with such plan or law (Section 1506.2(d); see Question 23).

Because there may be differences in perspective, as well as conflicts among federal, state, and local goals for resources, management, the Council has advised participating agencies to adopt a flexible, cooperative approach. The final EIS should reflect all of their interests and missions, clearly identified as such. The final document would then indicate how state and local interest have been accommodated, or would identify conflicts in goals (e.g., how a hydroelectric project, which might induce second home development, would require new land use controls). The EIS must contain a complete discussion of scope and purpose of the proposal, alternatives, and impacts so that the discussion is adequate to meet the needs of local, state, and federal decision makers.

23a. Q. How should an agency handle potential conflicts between a proposal and the objectives of federal, state, or

local land use plans, policies, and controls for the area concerned? (See Section 1502. IO(c)).

A. The agency should first inquire of other agencies whether there are any potential conflicts. If there would be immediate conflicts, or if conflicts could arise in the future when the plans are finished (see Question 23b below), the EIS must acknowledge and describe the extent of those conflicts. If there are any possibilities of resolving the conflicts, these should be explained as well. The EIS should also evaluate the seriousness of the impact of the proposal on the land use plans and policies and whether, or how much, the proposal will impair the effectiveness of land use control mechanisms for the area. Comments from officials of the affected area should be solicited early and should be carefully acknowledged and answered in the EIS.

23b. Q. What constitutes a "land use plan or policy" for purposes of this discussion?

A. The term "land use plans", includes all types of formally adopted documents for land use planning, zoning, and related regulatory requirements. Local general plans are included, even though they are subject to future change. Proposed plans should also be addressed if they have been formally proposed by the appropriate government body in a written form and are being actively pursued by officials of the jurisdiction. Staged plans, which must go through phases of development such as the Level A, B, and C planning process of the Water Resources Council, should also be included, even though they are incomplete.

The term "policies" includes formally adopted statements of land use policy as embodied in laws or regulations. It also includes proposals for action such as the initiation of a planning process or a formally adopted policy statement of the local, regional, or state executive branch, even if it has not yet been formally adopted by the local, regional, or state legislative body.

23c. Q. What options are available for the decision maker when conflicts with such plans or policies are identified?

A. After identifying any potential land use conflicts, the decision maker must weigh the significance of the conflicts among all the other environmental and nonenvironmental factors that must be considered in reaching a rational and balanced decision. Unless precluded by other law from causing or contributing to any inconsistency with the land use plans, policies, or controls, the decision maker retains the authority to go forward with the proposal, despite the potential conflict. In the record of decision, the decision maker must explain what the decision was, how it was made, and what mitigation measures are being imposed to lessen adverse environmental impacts of the proposal, among the other requirements of Section 1505.2. This provision would require the decision maker to explain any decision to override land use plans, policies, or controls for the area.

24a. Q. When are EISs required on policies, plans or programs?

A. An EIS must be prepared if an agency proposes to implement a specific policy, to adopt a plan for a group of related actions, or to implement a specific statutory program or executive directive (Section 1508.18). In addition, the adoption of official policy in the form of rules, regulations, and interpretations pursuant to the Administrative Procedure Act, treaties, conventions, or other formal documents establishing governmental or agency policy which will substantially alter agency programs could require an EIS (Section 1508.18). In all cases, the policy, plan, or program must have the potential for significantly affecting the quality of the human environment in order to require an EIS. It should be noted that a proposal "may exist in fact as well as by agency declaration that one exists" (Section 1508.23).

24b. Q. When is an area-wide or overview EIS appropriate?

A. The preparation of an area-wide or overview EIS may be particularly useful when similar actions, viewed with other reasonably foreseeable or proposed agency actions, share common timing or geography. For example, when a variety of energy projects may be located in a single watershed, or when a series of new energy technologies may be developed through federal funding, the overview or area-wide EIS would serve as a valuable and necessary analysis of the affected environment and the potential cumulative impacts of the reasonably foreseeable actions under that program or within that geographical area.

24c. Q. What is the function of tiering in such cases?

A. Tiering is a procedure which allows an agency to avoid duplication of paperwork through the incorporation by reference of the general discussions and relevant specific discussions from an environmental impact statement of broader scope into one of lesser scope or vice versa. In the example given in Question 24b, this would mean that an overview EIS would be prepared for all of the energy activities reasonably foreseeable in a particular geographic area or resulting from a particular development program. This impact statement would be followed by site- or project-specific EISs. The tiering process would make each EIS of greater use and meaning to the public as the plan or program develops, without duplication of the analysis prepared for the previous impact statement.

25a. Q. When is it appropriate to use appendices instead of including information in the body of an EIS?

A. The body of the EIS should be a succinct statement of all the information on environmental impacts and alternatives that the decision maker and the public need in order to make the decision and to ascertain that every significant factor has been examined. The EIS must explain or summarize methodologies of research and modeling and the results of research that may have been conducted to analyze impacts and alternatives.

Lengthy technical discussions of modeling methodology, baseline studies, or other work are best reserved for the appendix. In other words, if only technically trained individuals are likely to understand a particular discussion, then it should go in the appendix, and a plain language summary of the analysis and conclusions of that technical discussion should go in the text of the EIS.

The final statement must also contain the response of the agency to comments on the draft EIS. These responses will be primarily in the form of changes in the document itself, but specific answers to each significant comment should also be included. These specific responses may be placed in an appendix. If the comments are especially voluminous, summaries of the comments and responses will suffice. (See Question 29 regarding the level of detail required for responses to comments.)

25b. Q. How does an appendix differ from incorporation by reference?

A. First, if at all possible, the appendix accompanies the EIS, whereas the material which is incorporated by reference does not accompany the EIS. Thus, the appendix should contain information that reviewers will likely want to examine. The appendix should include material that pertains to preparation of a particular EIS. Research papers directly relevant to the proposals, lists of affected species, discussion of the methodology of models used in the analysis of impacts, extremely detailed responses to comments, or other information would be placed in the appendix.

The appendix must be complete and available at the time the EIS is filed. Five copies of the appendix must be sent to EPA with five copies of the EIS for filing. If the appendix is too bulky to be circulated, it instead must be placed in conveniently accessible locations or furnished directly to commentors upon request. If it is not circulated with EIS, the Notice of Availability published by EPA must so state, giving a telephone number to enable potential commentors to locate or request copies of the appendix promptly.

Material that is not directly related to preparation of the EIS should be incorporated by reference. This would include other EISs, research papers in the general literature, technical background papers, or other material that someone with technical training could use to evaluate the analysis of the proposal. These must be made available, either by citing the literature, furnishing copies to central locations, or sending copies directly to commentors upon request.

Care must be taken in all cases to ensure that material incorporated by reference, and the occasional appendix that does not accompany the EIS, are in fact available for the full minimum public comment period.

26a. Q. How detailed must an EIS index be?

A. The EIS index should have a level of detail sufficient to focus on areas of the EIS of reasonable interest to any reader. It cannot be restricted to the most important topics. On the other hand, it need not identify every conceivable term or phrase in the EIS. If an agency believes that the reader is reasonably likely to be interested in a topic, it should be included.

26b. Q. Is a key word index required?

A. No. A key word index is a relatively short list of descriptive terms that identifies the key concepts or subject areas in a document. For example, it could consist of 20 terms which describe the most significant aspects of an EIS that a future researcher would need: type of proposal, type of impacts, type of environment, geographical area, sampling or modelling methodologies used. This technique permits the compilation of EIS data banks, by facilitating quick and inexpensive access to stored materials. While a key word index is not required by the regulations, it could be a useful addition for several reasons. First, it can be useful as a quick index for reviewers of the EIS, helping to focus on areas of interest. Second, if an agency keeps a listing of the key word indexes of the EISs it produces, the EIS preparers themselves will have quick access to similar research data and methodologies to aid their future EIS work. Third, a key word index will be needed to make an EIS available for future researchers using EIS data banks that are being developed. Preparation of such an index now, when the document is produced, will save a later effort when the data banks become operational.

27a. Q. If a consultant is used in preparing an EIS, must the list of preparers identify members of the consulting firm as well as the agency NEPA staff who were primarily responsible?

A. Section 1502.17 requires identification of the names and qualifications of persons who were primarily responsible for preparing the EIS or significant background papers, including basic components of the statement. This means that members of a consulting firm preparing material that is to become part of the EIS must be identified. The EIS

should identify these individuals even though the consultant's contribution may have been modified by the agency.

27b. Q. Should agency staff involved in reviewing and editing the EIS also be included in the list of preparers?

A. Agency personnel who wrote basic components of the EIS or significant background papers must, of course, be identified. The EIS should also list the technical editors who reviewed or edited the statements.

27c. Q. How much information should be included on each person listed?

A. The list of preparers should normally not exceed two pages. Therefore, agencies must determine which individuals had primary responsibility and need not identify individuals with minor involvement. The list of preparers should include a very brief identification of the individuals involved, their qualifications (expertise, professional disciplines), and the specific portion of the EIS for which they are responsible. This may be done in tabular form to cut down on length. A line or two for each person's qualifications should be sufficient.

28. Q. May an agency file photocopies of an EIS with EPA pending the completion of printing the document?

A. Photocopies of an EIS may be filed with EPA prior to printing only if the photocopies are simultaneously made available to other agencies and the public. Section 1506.9 of the regulations, which governs EIS filing, specifically requires federal agencies to file EISs with EPA no earlier than the EIS is distributed to the public. However, this section does not prohibit photocopying as a form of reproduction and distribution. When an agency chooses photocopying as the reproduction method, the EIS must be clear and legible to permit ease of reading and ultimate microfiching of the EIS. Where color graphs are important to the EIS, they should be reproduced and circulated with the photocopy.

29a. Q. What response must an agency provide to a comment on a draft EIS which states that the EIS methodology is inadequate or inadequately explained? For example, what level of detail must an agency include in its response to a simple post card comment making such an allegation?

A. Appropriate responses to comments are described in Section 1503.4. Normally, the responses should result in changes in the text of the EIS, not simply a separate answer at the back of the document. But, in addition, the agency must state what its response was, and if the agency decides that no substantive response to a comment is necessary, it must briefly explain why.

An agency is not under an obligation to issue a lengthy reiteration of its methodology for any portion of an EIS if the only comment addressing the methodology is a simple complaint that the EIS methodology is inadequate. But agencies must respond to comments, however brief, which are specific in their criticism of agency methodology. For example, if a commentor of an EIS said that the air quality dispersion analysis or methodology of an agency was inadequate, and the agency had included a discussion of that analysis in the EIS, little if anything need be added in response to such a comment. However, if the commentor said that the dispersion analysis was inadequate because of its use of certain computational techniques, or that a dispersion analysis was inadequately explained because computational techniques were not included or referenced, then the agency would have to respond in a substantive and meaningful way to such a comment.

If a number of comments are identical or very similar, agencies may group the comments and prepare a single answer for each group. Comments may be summarized if they are especially voluminous. The comments or summaries must be attached to the EIS, regardless of whether the agency believes they merit individual discussion in the body of the final EIS.

29b. Q. How must an agency respond to a comment on a draft EIS that raises a new alternative not previously considered in the draft EIS?

A. This question might arise in several possible situations. First, a commentor on a draft EIS may indicate that there is a possible alternative which, in the view of the agency, is not a reasonable alternative (Section 1502.14(a)). If that is the case, the agency must explain why the comment does not warrant further agency response, citing authorities or reasons that support the position of the agency and, if appropriate, indicate those circumstances which would trigger agency reappraisal or further response (Section 1503.4(a)). For example, a commentor on a draft EIS on a coal-fired power plant may suggest the alternative of using synthetic fuel. The agency may reject the alternative with a brief discussion (with authorities) of the unavailability of synthetic fuel within the time frame necessary to meet the need and purpose of the proposed facility.

A second possibility is that an agency may receive a comment indicating that a particular alternative, while reasonable, should be modified somewhat, for example, to achieve certain mitigation benefits or for other reasons. If the modification is reasonable, the agency should include a discussion of it in the final EIS. For example, a commentor on a draft EIS on a proposal for a pumped storage power facility might suggest that the applicant's proposed alternative should be enhanced by the addition of

certain reasonable mitigation measures, including the purchase and setting aside of a wildlife preserve to substitute for the tract to be destroyed by the project. The modified alternative including the additional mitigation measures should be discussed by the agency in the final EIS.

A third, slightly different possibility is that a comment on a draft EIS will raise an alternative which is a minor variation of one of the alternatives discussed in the draft EIS, but this variation was not given any consideration by the agency. In such a case, the agency should develop and evaluate the new alternative, if it is reasonable, in the final EIS. If it is qualitatively within the spectrum of alternatives that were discussed in the draft, a supplemental draft will not be needed. For example, a commentor on a draft EIS to designate a wilderness area within a national forest might reasonably identify a specific tract of the forest and urge that it be considered for designation. If the draft EIS considered designation of a range of alternative tracts which encompassed forest area of similar quality and quantity, no supplemental EIS would have to be prepared. The agency could fulfill its obligation by addressing that specific alternative in the final EIS.

As another example, an EIS on an urban housing project may analyze the alternatives of constructing 2000, 4000, or 6000 units. A commentor on the draft EIS might urge the consideration of constructing 5000 units, utilizing a different configuration of buildings. This alternative is within the spectrum of alternatives already considered and, therefore, could be addressed in the final EIS.

A fourth possibility is that a commentor points out an alternative which is not a variation of the proposal or of any alternative discussed in the draft impact statement and is a reasonable alternative that warrants serious agency response. In such a case, the agency must issue a supplement to the draft EIS that discusses this new alternative. For example, a commentor on a draft EIS on a nuclear power plant might suggest that a reasonable alternative for meeting the projected need for power would be through peak load management and energy conservation programs. If the permitting agency has failed to consider that approach in the draft EIS, and the approach cannot be dismissed by the agency as unreasonable, a supplement to the draft EIS which discusses that alternative must be prepared. (If necessary, the same supplement should also discuss substantial changes in the proposed action or significant new circumstances or information, as required by Section 1502.9(c)(1) of the CEQ regulations.

If the new alternative was not raised by the commentor during scoping, but could have been, commentors may find that they are unpersuasive in their efforts to have their suggested alternative analyzed in detail by the agency. However, if the new alternative is discovered or developed later, and it could not reasonably have been raised during the scoping process, then the agency must address it in a supplemental draft EIS. The agency is, in any case, ultimately responsible for preparing an adequate EIS that considers all alternatives.

30. Q. When a cooperating agency with jurisdiction by law intends to adopt the EIS of a lead agency and it is not satisfied with the adequacy of the document, may the cooperating agency adopt only the part of the EIS with which it is satisfied? If so, would a cooperating agency with jurisdiction by law have to prepare a separate EIS or EIS supplement covering the areas of disagreement with the lead agency?

A. Generally, a cooperating agency may adopt the EIS of a lead agency without recirculating it if it concludes that its NEPA requirements and its comments and suggestions have been satisfied (Section 1506.3(a),(c)). If necessary, a cooperating agency may adopt only a portion of the EIS of the lead agency and may reject that part of the EIS with which it disagrees, stating publicly when it did not (Section 1506.3(a)).

A cooperating agency with jurisdiction by law (e. g ., an agency with independent legal responsibilities with respect to the proposal) has an independent legal obligation to comply with NEPA. Therefore, if the cooperating agency determines that the EIS is wrong or inadequate, it must prepare a supplement to the EIS, replacing or adding any needed information, and must circulate the supplement as a draft for public and agency review and comment. A final supplemental EIS would be required before the agency could take action. The adopted portions of the lead agency EIS should be circulated with the supplement (Section 1506.3(b)). A cooperating agency with jurisdiction by law will have to prepare its own record of decision for its action, in which it must explain how it reached its conclusions. Each agency should explain how and why its conclusions differ, if that is the case, from those of other agencies which issued their records of decision earlier.

An agency that did not cooperate in preparation of an EIS may also adopt an EIS or portion thereof. But this would arise only in rare instances, because an agency adopting an EIS for use in its own decision normally would have been a cooperating agency. If the proposed action for which the EIS was prepared is substantially the same as the proposed action of the adopting agency, the EIS may be adopted as long as it is recirculated as a final EIS and the agency announces what it is doing. This would be followed by the 30-day review period and issuance of a record of decision by the adopting agency. If the proposed action by the adopting agency is not substantially the same as that in the EIS (e.g., if an EIS on one action is being adopted for use in a decision on another action), the EIS would be treated as a draft and circulated for the normal public comment period and other procedures (Section 1506.3(b)).

31a. Q. Do the CEQ NEPA regulations apply to independent regulatory agencies like the Federal Energy

Regulatory Commission (FERC) and the Nuclear Regulatory Commission (NRC)?

A. The statutory requirements of NEPA Section 102 apply to "all agencies of the federal government." The NEPA regulations implement the procedural provisions of NEPA as set forth in NEPA Section 102(2) for all agencies of the federal government. The NEPA regulations apply to independent regulatory agencies; however, they do not direct independent regulatory agencies or other agencies to make decisions in any particular way or in a way inconsistent with the statutory charter of an agency (Sections 1500.3, 1500.6, 1507.1, and 1507.3).

31b. Q. Can an executive branch agency, like the Department of Interior, adopt an EIS prepared by an independent regulatory agency such as FERC?

A. If an independent regulatory agency such as FERC has prepared an EIS in connection with its approval of a proposed project, an executive branch agency (e.g., the Bureau of Land Management in the Department of Interior) may, in accordance with Section 1506.3, adopt the EIS or a portion thereof for its use in considering the same proposal. In such a case, the EIS must, to the satisfaction of the adopting agency, meet the standards for an adequate statement under the NEPA regulations (including scope and quality of analysis of alternatives) and must satisfy the comments and suggestions of the adopting agency. If the independent regulatory agency fails to comply with the NEPA regulations, the cooperating or adopting agency may find that it is unable to adopt the EIS, thus forcing the preparation of a new EIS or EIS supplement for the same action. The NEPA regulations were made applicable to all federal agencies in order to avoid this result and to achieve uniform application and efficiency of the NEPA process.

32. Q. Under what circumstances do old EISs have to be supplemented before taking action on a proposal?

A. As a rule of thumb, if the proposal has not yet been implemented, or if the EIS concerns an ongoing program, EISs that are more than 5 years old should be carefully reexamined to determine if the criteria in Section 1502.9 compel preparation of an EIS supplement.

If an agency has made a substantial change in a proposed action that is relevant to environmental concerns, or if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, a supplemental EIS must be prepared for an old EIS so that the agency has the best possible information to make any necessary substantive changes in its decisions regarding the proposal. (Section 1502.9(c)).

33a. Q. When must a referral of an interagency disagreement be made to the Council?

A. The referral procedure of the Council is a predecision referral process for interagency disagreements . Hence, Section 1 504. 3 requires that a referring agency must deliver its referral to the Council not later than 25 days after publication by EPA of notice that the final EIS is available (unless the lead agency grants an extension of time under Section 1504.3(b)).

33b. Q. May a referral be made after this issuance of a record of decision?

A. No, except for cases where agencies provide an internal appeal procedure which permits simultaneous filing of the final EIS and the record of decision (Section 1506.10(b)(2)). Otherwise, as stated above, the process is a predecision referral process. Referrals must be made within 25 days after the notice of availability of the final EIS, whereas the final decision (ROD) may not be made or filed until after 30 days from the notice of availability of the EIS (Sections 1504.3(b), 1506.10(b)). If a lead agency has granted an extension of time for another agency to take action on a referral, the ROD may not be issued until the extension has expired.

34a. Q. Must records of decision be made public? How should they be made available?

A. Under the regulations, agencies must prepare a "concise public record of decision," which contains the elements specified in Section 1505.2. This public record may be integrated into any other decision record prepared by the agency, or it may be separate if decision documents are not normally made public. The record of decision is intended by the Council to be an environmental document (even though it is not explicitly mentioned in the definition of "environmental document" in Section 1508.10). Therefore, it must be made available to the public through appropriate public notice, as required by Section 1506.6(b). However, there is no specific requirements for publication of the ROD itself, either in the *Federal Register* or elsewhere.

34b. Q. May the summary section in the final environmental impact statement substitute for or constitute the record of decision of an agency?

A. No. An environmental impact statement is supposed to inform the decision maker before the decision is made (Section 1502. 1,1505.2). The CEQ regulations provide for a 30-day period after notice is published that the final EIS has been filed with EPA before the agency may take final action. During that period, in addition to the internal final review of the agency, the public and other agencies can comment on the final EIS prior to the final action of the

agency on the proposal. In addition, the CEQ regulations make it clear that the requirements for the summary in an EIS are not the same as the requirements for a ROD (Sections 1502.12 and 1505.2) .

34c. Q. What provisions should records of decision contain pertaining to mitigation and monitoring?

A. Lead agencies "shall include appropriate conditions (including mitigation measures and monitoring and enforcement programs) in grants, permits or other approvals" and shall "condition funding of actions on mitigation" (Section 1505.3). Any such measures that are adopted must be explained and committed in the ROD.

The reasonable alternative mitigation measures and monitoring programs should have been addressed in the draft and final EIS. The discussion of mitigation and monitoring in a record of decision must be more detailed than a general statement that mitigation is being required, but not so detailed as to duplicate discussion of mitigation in the EIS. The record of decision should contain a concise summary identification of the mitigation measures which the agency has committed itself to adopt.

The record of decision must also state whether all practicable mitigation measures have been adopted and, if not, why not (Section 1505.2(c)). The record of decision must identify the mitigation measures and monitoring and enforcement programs that have been selected and plainly indicate that they are adopted as part of the decision of the agency. If the proposed action is the issuance of a permit or other approval, the specific details of the mitigation measures shall then be included as appropriate conditions in whatever grants, permits, funding or other approvals are being made by the federal agency (Section 1505.3(a),(b)). If the proposal is to be carried out by the federal agency itself, the record of decision should delineate the mitigation and monitoring measures in sufficient detail to constitute an enforceable commitment or incorporate by reference the portions of the EIS that do so.

34d. Q. What is the enforceability of a record of decision?

A. Pursuant to generally recognized principles of federal administrative law, agencies will be held accountable for preparing records of decision that conform to the decisions actually made and for carrying out the actions set forth in the records of decision. This is based on the principle that an agency must comply with its own decisions and regulations once they are adopted. Thus, the terms of a record of decision are enforceable by agencies and private parties. A record of decision can be used to compel compliance with or execution of the mitigation measures identified therein.

35. Q. How long should the NEPA process take to complete?

A. When an EIS is required, the process obviously will take longer than when an EA is the only document prepared. But the CEQ NEPA regulations encourage streamlined review, adoption of deadlines, elimination of duplicative work, eliciting suggested alternatives and other comments early through scoping, cooperation among agencies, and consultation with applicants during project planning. The Council has advised agencies that under the new NEPA regulations, even large, complex energy projects would require only about 12 months for the completion of the entire EIS process. For most major actions, this period is well within the planning time that is needed in any event, apart from NEPA.

The time required for the preparation of program EISs may be greater. The Council also recognizes that some projects will entail difficult long-term planning and/or the acquisition of certain data which of necessity will require more time for the preparation of the EIS. Indeed, some proposals should be given more time for the thoughtful preparation of an EIS and development of a decision which fulfills the substantive goals of NEPA.

For cases in which only an environmental assessment will be prepared, the NEPA process should take no more than 3 months, and in many cases, substantially less, as part of the normal analysis and approval process for the action.

36a. Q. How long and detailed must an environmental assessment (EA) be?

A. The environmental assessment is a concise public document which has three defined functions: (1) it briefly provides sufficient evidence and analysis for determining whether to prepare an EIS; (2) it aids the compliance of an agency with NEPA when no EIS is necessary, i.e., it helps to identify better alternatives and mitigation measures; and (3) it facilitates preparation of an EIS when one is necessary (Section 1508.9(a)).

Since the EA is a concise document, it should not contain long descriptions or detailed data which the agency may have gathered. Rather, it should contain a brief discussion of the need for the proposal, alternatives to the proposal, the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted (Section 1508.9(b)).

While the regulations do not contain page limits for EAs, the Council has generally advised agencies to keep the length of EAs to not more than approximately 10 to 15 pages. Some agencies expressly provide page guidelines (e.g., 10 to 15 pages in the case of the Army Corps). To avoid undue length, the EA may incorporate by reference background data to support its concise discussion of the proposal and relevant issues.

36b. Q. Under what circumstances is a lengthy EA appropriate?

A. Agencies should avoid preparing lengthy EAs, except in unusual cases where a proposal is so complex that a concise document cannot meet the goals of Section 1508.9 and where it is extremely difficult to determine whether the proposal could have significant environmental effects. In most cases, however, a lengthy EA indicates that an EIS is needed.

37a. Q. What is the level of detail of information that must be included in a finding of no significant impact (FONSI)?

A. The FONSI is a document in which the agency briefly explains the reasons why an action will not have a significant effect on the human environment and, therefore, why an EIS will not be prepared (Section 1508.13). The finding itself need not be detailed, but must succinctly state the reasons for deciding that the action will have no significant environmental effects, and, if relevant, must show which factors were weighted most heavily in the determination. In addition to this statement, the FONSI must include, summarize, or attach and incorporate by reference the environmental assessment.

37b. Q. What are the criteria for deciding whether a FONSI should be made available for public review for 30 days before the final determination of the agency or whether to prepare an EIS?

A. Public review is necessary, for example, (1) if the proposal is a borderline case, i.e., when there is a reasonable argument for preparation of an EIS; (2) if it is an unusual case, a new kind of action, or a precedent-setting case such as a first intrusion of even a minor development into a pristine area; (3) when there is either scientific or public controversy over the proposal; or (4) when it involves a proposal which is or is closely similar to one which normally requires preparation of an EIS (Sections 1501 .4(c)(2), 1508.27). Agencies also must allow a period of public review of the FONSI if the proposed action would be located in a floodplain or wetland (E.O. 11988, Sec. 2(a)(4); E.O. 11990, Sec. 2(b)).

38. Q. Must EAs and FONSIs be made public? If so, how should this be done?

A. Yes, they must be available to the public. Section 1506.6 requires agencies to involve the public in implementing their NEPA procedures, and this includes public involvement in the preparation of EAs and FONSIs. These are public "environmental documents" under Section 1506.6(b), and, therefore, agencies must give public notice of their availability. A combination of methods may be used to give notice, and the methods should be tailored to the needs of particular cases. Thus, a *Federal Register* notice of availability of the documents, coupled with notices in national publications and mailed to interested national groups might be appropriate for proposals that are national in scope. Local newspaper notices may be more appropriate for regional or site-specific proposals.

The objective, however, is to notify all interested or affected parties. If this is not being achieved, then the methods should be reevaluated and changed. Repeated failure to reach the interested or affected public would be interpreted as a violation of the regulations.

39. Q. Can an EA and FONSI be used to improve enforceable mitigation measures, monitoring programs, or other requirements, even though there is no requirement in the regulations in such cases for a formal record of decision?

A. Yes. In cases where an environmental assessment is the appropriate environmental document, there still may be mitigation measures or alternatives that would be desirable to consider and adopt, even though the impacts of the proposal will not be "significant". In such cases, the EA should include a discussion of these measures or alternatives to "assist agency planning and decision making" and to "aid an agency's compliance with (NEPA) when no environmental impact statement is necessary" (Section 1501.3(b), 1508.9(2)). The appropriate mitigation measures can be imposed as enforceable permit conditions, or adopted as part of the final decision of the agency in the same manner mitigation measures are adopted in the formal record of decision that is required in EIS cases.

40. Q. If an environmental assessment indicates that the environmental effects of a proposal are significant, but that, with mitigation, those effects may be reduced to less-than-significant levels, may the agency make a finding of no significant impact rather than prepare an EIS. Is that a legitimate function of an EA and scoping?

A. Mitigation measures may be relied upon to make a finding of no significant impact only if they are imposed by statute or regulation or submitted by an applicant or agency as part of the original proposal. As a general rule, the regulations contemplate that agencies should use a broad approach in defining significance, and should not rely on the possibility of mitigation as an excuse to avoid the EIS requirement (Sections 1508.8, 1508.27).

If a proposal appears to have adverse effects which would be significant, and certain mitigation measures are then developed during the scoping or EA stages, the existence of such possible mitigation does not obviate the need for an EIS. Therefore, if scoping or the EA identifies certain mitigation possibilities without altering the nature of the overall proposal itself, the agency should continue the EIS process and submit the proposal and the potential mitigation for public and agency reviews and comment. This is essential to ensure that the final decision is based on all the relevant factors, and that the full NEPA process will

result in enforceable mitigation measures through the record of decision.

In some instances where the proposal itself so integrates mitigation from the beginning that it is impossible to define the proposal without including the mitigation, the agency may then rely on the mitigation measures in determining that the overall effects would not be significant (e.g., where an application for a permit for a small hydroelectric dam is based on a binding commitment to build fish ladders, to permit adequate down stream flow, and to replace any lost wetlands, wildlife habitat, and recreational potential). In those instances, agencies should make the FONSI and EA available for 30 days of public comment before taking action (Section 1501.4(e)(2)).

Similarly, scoping may result in a redefinition of the entire project as a result of mitigation proposals. In that case, the agency may alter its previous decision to do an EIS, as long as the agency or applicant resubmits the entire proposal and the EA and FONSI are available for 30 days of review and comment. One example of this would be where the size and location of a proposed industrial park are changed to avoid affecting a nearby wetland area.

Summaries of Related U.S. Environmental Laws. (Source: EPA, Cross-cutting Environmental Laws, 21E 4001, January 1991.)

Endangered Species Act, 16 U.S.C. 1531 et seq.

The purpose of the Endangered Species Act (ESA) is to ensure that federal agencies and departments use their authorities to protect and conserve endangered and threatened species. Section 7 of the Act requires that federal agencies prevent or modify any projects authorized, funded, or carried out by the agencies that are "likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of critical habitat of such species." Implementing regulations are found at 50 CFR Parts 402, 450, 451, 452, and 453.

National Historic Presentation Act, 16 U.S.C. 470

The National Historic Preservation Act (NHPA), as amended, directs federal agencies to integrate historic preservation into all activities which either directly or indirectly involve land use decisions. This is to ensure federal leadership in the preservation of prehistoric and historic resources of the United States. Implementing regulations are found at 36 CFR Parts 60, 61, 63, 65, 68, 79 and 800. Guidelines are found at 48 FR 190, Part IV and 53 FR 4727-46.

Archeological and Historic Preservation Act, as amended, 16 U.S.C. 469-469c

The Archeological and Historic Preservation Act (AHPA), as amended, furthers the policies of the Historic Sites Act of 1935 by providing for the preservation of cultural resources that may be damaged by federal or federally authorized construction activities. The statute contains the Reservoir Salvage Act of 1960 and amendments made to it in 1974 (P.L.93-291, known as the Moss-Bennett Act) and 1978 (P.L.95-625). The portions of AHPA that may apply to federal agency projects are Section 4(a) and Section 7(a). Section 4(a) requires that the Secretary of the Interior be notified when unanticipated archeological materials are discovered during construction of a federal undertaking. Section 7(a) limits the amount of funds expended for archeological data recovery as part of a federal undertaking to one percent of project expenses. However, Section 208 of the 1980 amendments to the national Historic Preservation Act (P.L.96-515) established a procedure for agencies to request the Secretary of the Interior to waive the one percent limitation. Implementing regulations are found at 36 CFR Part 800. "Standards and Guidelines for Archeology and Historic Preservation" are found at 48 FR 44716.

The Wild and Scenic Rivers Act, 16 U.S.C. 271 et seq.

The purpose of the Wild and Scenic Rivers Act (WSRA) is to preserve the free-flowing state of rivers that are listed in the National Wild and Scenic Rivers System (System) or under study for inclusion in the System because of their outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Rivers in the System are classified as either wild river areas, scenic river areas, or recreational river areas. The WSRA establishes requirements applicable to water resource projects and protects both the river, or river segments, and the land immediately surrounding them. Implementing regulations are found at 36 CFR Part 297 Subpart A. Guidelines entitled "National Wild and Scenic Rivers System, Final Revised Guidelines for Eligibility, Classification and Management of River Areas" were published in the Federal Register on September 7, 1982.

The Fish and Wildlife Coordination Act, 16 U.S.C. 661 et seq.

The Fish and Wildlife Coordination Act (FWCA), as amended in 1964, was enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. The statute requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; take action to prevent loss or damage to these resources; and provide for the development and improvement of these resources. There are no implementing regulations.

Coastal Zone Management Act, 16 U.S.C. Section 1451 et seq.

The Coastal Zone Management Act (CZMA) encourages the management of coastal zone areas and provides grants to be used in maintaining coastal zone areas. It requires that federal agencies be consistent with the enforceable policies of state coastal zone management programs when conducting or supporting activities which affect a coastal zone. It is intended to ensure that federal activities are consistent with state programs for the protection and, where possible, enhancement of the nation's coastal zones. As defined in the Act, the coastal zone includes coastal waters extending to the outer limit of state submerged land title and ownership, adjacent shorelines and land extending inward to the extent necessary to control shorelines. The coastal zone includes islands, beaches, transitional and intertidal areas, salt marshes, etc. Implementing regulations are found at 15 CFR 930 Subpart D and Part 923.

Coastal Barrier Resources Act, 16 U.S.C. 3501 et seq.

The purpose of the Coastal Barrier Resources Act (CBRA) is to protect ecologically sensitive coastal barriers along the coasts of the U.S. The Act establishes the Coastal Barrier Resources System (CBRS) and, with certain exceptions, prohibits new federal expenditures and financial assistance for development within the System. Section 5(a) of the Act lists expenditures and assistance specifically prohibited, while Section 6 outlines the specific exceptions to the general prohibition. The U.S. DOI Coastal Barrier Act Advisory Guidelines were issued by the Fish and Wildlife Service on October 6, 1983.

The Wilderness Act, 16 U.S.C. 1131 et seq.

The Wilderness Act (WA) established a system of National Wilderness areas and a policy for protecting and managing this system. With certain exceptions, the Act prohibits motorized equipment, structures, installations, roads, commercial enterprises, aircraft landings, and mechanical transport. The Act permits mining on valid claims, access to private lands, fire control, insect and disease control, grazing, water-resource structures (upon the approval of the President), and visitor use. Implementing regulations are found at 50 CFR Part 35; 43 CFR Parts 19 and 8560; and 36 CFR Parts 293, 261 and 219.

Farmland Protection Policy Act, 7 U.S.C. 4201 et seq., and EPA Policy to Protect Environmentally Significant Agricultural Lands, September 1978.

The purpose of the Farmland Protection Policy Act (FPPA) is to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses, and to assure that federal programs are administered in a manner that, to the extent practicable, will be compatible with state, local, and private programs and policies to protect farmland. Additionally, EPA's policy is to protect the Nation's significant/important agricultural lands from conversions that are irreversible and result in the loss of an essential food or environmental resource. Implementing procedures are found at 7 CFR Part 658 and the USDA Final Rule, Farmland Protection Policy of July 5, 1984 (proposed revisions published on January 8, 1987).

Executive Order 11990-Protection of Wetlands (May 24, 1977, 42 FR 26961).

The purpose of Executive Order 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the Order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The Order applies to:

- acquisition, management, and disposition of federal lands and facilities;
- construction and improvement projects which are undertaken, financed or assisted by federal agencies;
- federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

EPA's implementing procedures "Statement of Procedures on Floodplain Management and Wetlands Protection" were issued on January 5, 1979 (see

Appendix A of EPA's NEPA regulations at 40 CFR Part 6).

Executive Order 11988-Floodplain Management, May 24, 1977.

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities" for the following actions:

- acquiring, managing, and disposing of federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements;
- conducting federal activities and programs attending land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

EPA's implementing procedures were issued on January 5, 1979 (see Protection of Wetlands above). On February 10, 1978, the Water Resources Council published "Floodplain Management Guidelines" at 40 FR 6030. In 1987, the Federal Emergency Management Agency issued "Further Advice on EO 11988 Floodplain Management".

States with Environmental Policy Acts. (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

Sixteen states, the District of Columbia, and Puerto Rico have environmental policy acts or "little NEPAs."

State	Citation
Arkansas	Ark. Stat. Ann. §8-1-101 (1987)
California	Cal. Pub. Res. Code §§21000 et seq. (West 1982)
Connecticut	Conn. Gen. Stat. Ann. §§22a-14 to 22a-20 (West Supp. 1974-75)
District of Columbia	D. C. Code Ann. 1981 §6-981 et seq.
Florida	Fla. Stat. §§380.92 et seq.
Hawaii	Hawaii Rev. Stat. §§343-1 to 343-8 (1985)
Indiana	Ind. Code Ann. §§13-1-10-1 to 13-1-10-8 (West 1987)
Maryland	Md. Nat. Res. Code Ann. §§1-301 to 1-305 (1983 and Supp. 1987)
Massachusetts	Mass. Gen. Laws Ann. ch. 30, §§61-62H
Minnesota	Minn. Stat. Ann. §§116D.01 et seq. (West 1977 and Supp. 1981)
Montana	Mont. Code Ann. §§75-1-101 to -105; §75-1-201 (1981)
New York	N.Y. Envtl. Conserv. Law §§8-0101 to 8-0117 (McKinney 1984)
North Carolina	N.C. Gen. Stat. §§113A-1 to 10 (1978)
Puerto Rico	P.R. Laws Ann. tit. 12, §§1121-1127
South Dakota	S.D. Codified Laws Ann. §§34A-9-1 to 34A-9-12
Virginia	Va. Code §§10.1-1200 through 10.1-1212 (Subject to redefinition by the Virginia General Assembly in 1992)
Washington	Wash. Rev. Code §§43.21C.010-43.21C.910 (1974); Wash. Admin. Code R. 197-11
Wisconsin	Wis. Stat. §1.11 et seq.; Department of Natural Resources WEPA rules are found in Wis. Admin. Code NR 150.01-40

States with Limited Environmental Review Requirements Established by Statute, Executive Order, or Other Administrative Directives. (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

Eighteen states and the District of Columbia have limited environmental review requirements established by statute, executive order, or other administrative directives.

State	Requirement
Arizona	An Executive Order mandates that the Governor's Commission on Arizona Environment evaluate environmental problems, make recommendations to the Governor, and establish a clearinghouse for the exchange of information relating to environmental problems and their solutions.
Arkansas	In addition to a "little NEPA," Ark. Code Ann. §15-41-108 provides that the Arkansas Game and Fish Commission must prepare an EIS for cutting timber on Commission land.
California	In addition to a "little NEPA," the following California Codes require environmental impact reports: Cal. Food & Agric. Code §33487 (new construction or repairs of dairy farms) Cal. Gov. Code §7075 (establishment of enterprise zones) Cal. Gov. Code §7087.5 (initial study and notice of preparation under Employment and Economic Incentive Act) Cal. Gov. Code §51119 (timberland production zones; exemption) Cal. Gov. Code §65950.1 (extension of time for EIR for planning and zoning of development projects) Cal. Health & Safety Code §33333.3 (preparation and adoption of community redevelopment plans) Cal. Health & Safety Code §56040 (implementation and administration for large scale urban development) Cal. Pub. Res. Code §6873.2 (oil and gas leases on tide and submerged lands and beds of navigable rivers and lakes) Cal. Pub. Res. Code §25540.4 (power facility and site certification) Cal. Pub. Res. Code §30718 (implementation of port development under California Coastal Act) Cal. Str. & H. Code §199.9 (mass transit guideway system) Cal. Water Code §13389 (applicability of EISs to Clean Water Act)
Delaware	In the Del. Code Ann. tit. 7, Chapter 66 concerns wetlands permits, and Chapter 20, coastal zone permits.
District of Columbia	In addition to a "little NEPA," D.C. Code Ann. §43-1903 involves public utility environmental impact statements.
Georgia	The Code of Georgia provides that on certain types of actions on a case by case basis, the state may require that an environmental assessment be prepared; EAs would be reviewed by the state Department of Natural Resources, Environmental Protection Division.
Louisiana	La. Rev. Stat. Ann. §30:2021 (West 1991) covers interstate compacts on environmental control, for which the Louisiana Department of Environmental Quality serves as a clearinghouse for all statements of environmental impact to be prepared or reviewed by state agencies (other than Department of Transportation and Development), in accordance with NEPA. The Department of Wildlife and Fisheries is responsible for review and comment on any EIS regarding fish and wildlife resources or their habitat, as well as the discharge of dredge and fill material into state waters. The Department of Health and Human Resources is responsible for EISs regarding public health.
Massachusetts	In addition to a "little NEPA," Mass. Gen. Laws Ann. ch. 111H, §30 concern low-level radioactive waste facility licensing.
Michigan	Executive Order 1974-4 requires each state agency to prepare a formal environmental assessment for all major activities of the agency having a possible significant impact on the environment or human life. Mich. Comp. Laws Ann. §281.655 et seq. covers EISs for sand dune mining and model zoning plans under the Lakes and Rivers Sand Dune Protection and Management Act.

New Jersey	Executive Order No. 53 (1973) requires all state agencies and departments to submit to the Department of Environmental Protection a description of the environmental impact of all major construction projects. N.J. Rev. Stat. §13:19-7 provides for EISs for such projects as coastal protection, N.J. Rev. Stat. §27:23-23.5 covers EISs for the New Jersey Turnpike authority (highways and turnpikes). N.J. Rev. Stat. 52:13F-4 refers to environmental impact statements on specific legislative bills.
North Carolina	In addition to a "little NEPA," N.C. Gen. Stat. §104G-11 concerns low-level radioactive waste management technology licensing.
North Dakota	N.D. Century Code §§54-01-05.4 provides that the Governor may require EISs of a limited nature prior to the transfer of any interest in state-owned land to federal agencies.
Oregon	Although Oregon Rev. Stat. ch. 46 does not require EISs for major actions having a significant impact on the environment, permit applications for siting of major energy generating facilities must include a background report addressing various anticipated environmental impacts.
Pennsylvania	Executive Order requires Environmental Assessments for all transportation projects. Various state regulations require EAs for other state actions.
Rhode Island	R.I. Gen. Laws §23-63-3 provides that a facility which plans to export tires for burning must submit an EIS conforming to the EPA standards.
South Dakota	In addition to a "little NEPA," S.D. Codified laws Ann. §49-41B-21 et seq. concern energy conversion and transmission facilities.
Utah	State of Utah Exec. Order (Aug. 27, 1974).
Washington	In addition to a "little NEPA," Wash. Rev. Code Ann. §78.52.125 (oil and gas conservation drilling that affects surface waters) Wash Rev. Code Ann. 70.95.700 (solid waste incineration or energy recovery facility).
Wisconsin	In addition to a "little NEPA," Wis. Stat. Ann. §144.68 (solid waste, hazardous waste, and refuse).

CHAPTER 5

DECISIONMAKING

CHAPTER 5

DECISIONMAKING

For the purpose of this sourcebook, decisionmaking is the authorizing decision for a proposed project. It does not refer to the incremental technical decisionmaking that occurs throughout the EA process (e.g., choice of impact analysis techniques) or decisions made early on during initiation and scoping (e.g., choice of alternatives) or decisions made during screening that proposed actions do not require the complete EA process. However, the real value of the EA process may be in the avoidance of, or reduction in, adverse environmental impacts as a result of incremental decisionmaking before a proposed action reaches final decisionmaking.

Integration of EA into the decisionmaking process varies among countries. In the U.S., EA is designed to assist agency planning and decisionmaking and not to justify decisions that have already been made. An agency decision to adopt a particular alternative is based on the EA document and formalized by a record of decision that is available to the public. In the United Kingdom, the EA report is seen as a supporting document to the submission of a project for authorization. However, such projects have met a number of other statutory requirements during their development.

In the U.S., decisionmaking can be seen as a two-stage process. Before a draft EA document is ready for public and other agency review and comment, the proponent must endorse the draft subject to additional information and comment during public hearings and review. After the draft document is revised to reflect public and other agency comment, the document is finalized, an agency decision is made, and a formal record of decision is published.

NEEDS

Effective decisionmaking depends on 1) coordination and continuing communication between the EA team leader and the decisionmaker(s), 2) a well-organized executive summary of the final EA document that provides the decisionmaker with concise and objective information relevant to the important issues, and 3) a public decision document that summarizes the basis for the final decision including the uncertainties and mitigation and/or monitoring requirements.

- Decisionmaking requires compromise among many elements (e.g., technical, environmental, economic, political and administrative factors). Thus, it is important that the decisionmaker is an integral part of the EA process so that his/her decision is based on understanding the choice of issues analyzed in the EA document and the limitations of the analysis. Progress reports and periodic briefings serve to eliminate surprises.

- Decisions are often made by persons who are not closely involved with the EA. Thus, an executive summary, based on the table of contents of the EA document, must provide the decisionmaker with clear and concise information to facilitate comparison of alternatives and to support the choice of the environmentally preferred alternative. The executive summary should include brief discussion of the:

  - proposed action with a schedule for implementation;
  - viable alternatives that reflect the purpose of and need for the proposed action;
  - potential impacts of implementation (e.g., construction, operation, accidents);
  - relative importance of the environmental issues;
  - basis for balancing the environmental impacts with other impacts/benefits (e.g., economic, social, technical);
  - recommendations and their implications;
  - uncertainties and risks of proceeding and how the uncertainties will be managed;
  - concerns/views of the publics and technical specialists (e.g., biologists, engineers); and
  - mitigation in response to unavoidable impacts or outstanding concerns and follow-up requirements.

  As a general guide, an executive summary should be about 10 percent of the length of the report, up to a maximum of 10 pages. It is often useful to print the executive summary on paper of a different color (South Africa Department of Environment Affairs 1992)

- The decisionmaking process culminates in the preparation of a concise public record of the decision. It should include:

  - a statement of the decision;
  - discussion of the alternatives considered in reaching a decision, including identification of the environmentally

preferable alternative or alternatives and any other relevant factors that entered into the decision (e.g., economic and technical considerations including, if appropriate, trade-offs made in not selecting one of the preferred alternatives, as well as agency statutory missions and national policy);

- a statement that all practical means to avoid or minimize environmental harm from the selected alternative have been adopted, and if not, why not; and
- a summary of the monitoring and enforcement program for any mitigation measures.

TOOLS

- Westman (1985) reviews the methods and limitations associated with economic approaches to evaluating resources [e.g., cost-benefit analysis, hypothetical valuation (willingness-to-pay surveys)]. He notes that although monetary units have a familiar meaning to decisionmakers and the public, they are almost impossible to apply in a universally acceptable way to resources that are not typically marketed (e.g., human life, bacteria, wind). Nevertheless, the need for evaluation is inescapable and in the absence of explicit evaluations, implicit evaluations are performed by decisionmakers. Thus, it is important to remind decision-makers of the assumptions and limitations of the evaluation methods being used (Westman 1985). The use of sensitivity analysis (see below), and of several different evaluation methods simultaneously, can help to reveal the assumptions and limitations of an analysis (Westman 1985).

  - Cost-benefit analysis (CBA) among alternatives of projects is widely used in decisionmaking to determine if the economic benefits of development exceed the costs. The costs and benefits considered include not only the expenditures and revenues of public sector entities but also benefits and costs experienced by private businesses and individuals. It may go beyond consideration of direct economic issues and also assess indirect effects and "intangibles" (e.g., aesthetics) but is seldom addresses "externalities" (e.g., media that act as pollutant sinks such as atmosphere or watercourses). Thus, although CBA may be important in decisionmaking it excludes most environmental costs.

- Cost-effectiveness analysis focuses on the cost of providing selected services, or more broadly, of achieving selected objectives. This technique emphasizes determining the least cost approach to achieving a given objective and typically considers a range of alternative actions within the constraint of a fixed level of resources (Leistritz and Murdock 1981).

- Results of public opinion polls show that individuals are deeply concerned about the environment and that people in both rich and poor nations give priority to environmental protection over economic growth (Dunlap et al. 1992). At present, however, scientific dispute and incomplete knowledge limit our ability to balance scientific, social and economic factors in decisionmaking. Nevertheless, there is increasing interest in developing environmental indicators that translate environmental data into a form that can be readily understood and used by decisionmakers and the public (Environment Canada 1991). Efforts have been made to weight individual (expert-selected) environmental indicators into composite environmental indices using expert opinions (Inhaber 1976). More recently, an effort has been made to use public opinion polls to weight environmental aggregate indices (Alberti and Parker 1991). To date, monitoring the status of environmental resources has increased the volume of environmental data but has failed to provide decisionmakers and the public with specific answers to critical questions concerning actual conditions, trends, and the causes of environmental damage (Alberti and Parker 1991).

- Trade-off analysis typically involves comparison of a set of alternatives relative to a series of decision factors (Table 5-1).

Table 5-1. Trade-off Matrix. (Source: Canter, L. W., S. F. Atkinson, and F. L. Leistritz. 1985. Impact of Growth. Lewis Publishers, Inc., Chelsea, Michigan.)

	Alternatives				
Decision Factors	1	2	3	4	5
Degree to Meeting Needs and Objectives					
Economic Efficiency					
Social Concerns (public preference)					
Environmental Impacts					
–Biophysical					
–Cultural					
–Socio-economic (include health)					

The following approaches can be used to complete the trade-off matrix (Canter et al. 1985):

- qualitative approach in which descriptive information on each alternative relative to each decision factor is presented in the matrix;
- quantitative approach in which quantitative information on each alternative relative to each decision factor is displayed in the matrix;
- ranking, rating, or scaling approach in which the qualitative or quantitative information on each alternative is summarized via the assignment of a rank, or rating, or scale value relative to each decision factor (the rank, or rating, or scale value is presented in the matrix);
- weighing approach in which the importance weight of each decision factor relative to each other decision factor is considered, with the resultant discussion of the information on each alternative (qualitative; quantitative; or ranking, rating or scaling) being presented in view of the relative importance of the decision factors; and
- weighing-ranking/rating/scaling approach in which the importance weight for each decision factor is multiplied by

the ranking/rating/scale of each alternative, then the resulting products for each alternative are summed to develop an overall composite index or score for each alternative.

Importance weighing and ranking techniques are described by Canter et al. (1985). Description and references for the weighing-scaling/rating/ranking approach are found in Canter (1979). The problems associated with the development and use of environmental indicators are discussed by Alberti and Parker (1991; see Attachment 5.A).

- Scaling-weighing or ranking-weighing checklist methodologies (Canter et al. 1985; Chapter 4.3) involve the assignment of importance weights to environmental factors and the scaling or ranking of the impacts for each alternative on each factor. Comparisons of alternatives can be made through the development of a product matrix which consists of multiplying importance weights by the scale or rank for each alternative. Canter et al. (1985) note that information for these approaches can be based on impact prediction. They list some structured importance weighing or ranking techniques as well as suggesting that less-formal approaches such as scoping can be used as the basis for importance weighing.

- Sensitivity analysis is a technique that identifies the parameter or variable of a model that is most sensitive to change. It also provides a measure of the sensitivity of the important variables to changes in the parameters. For instance, if the endpoint of the analysis is to predict the effects of herbicide application on insects, then varying the kind or amounts of herbicides should be reflected in the response(s) of the insect(s) of interest. Because there is so much uncertainty associated with prediction in EA (e.g., assumptions underlying models, correctness of input data, significance of results), examination of the sensitivity of a result to differing assumptions on ranking and weighing within a methodology helps modelers and decisionmakers understand how changes to the input of an analysis affect the predicted impacts of a proposed action (Jørgensen 1991).

ISSUES

- In the U.S., there is a minimum 30-day period between publication of a final EA document and publication of the agency decision on

the proposed action. Thus, the public has an additional opportunity to review the final EA document to make their views known and to take appeals on the forthcoming decision. However, because the public has had ample opportunity to influence decisionmaking during scoping, review of the draft document, and any associated public hearings, the courts do not look favorably on appeals at this point in the EA process.

- Even after the most thorough EA, the decisionmaker is still faced with uncertainties about the future, about stochastic events, and about uncertainties underlying the EA methods. All prediction techniques, by their nature, involve some degree of uncertainty. So along with each attempt to quantify an impact, the EA team should also quantify the uncertainty of the prediction in terms of probabilities or "margins of error". Factors contributing to uncertainty are:

  - limits on resources for planning and analysis,
  - lack of evidence that a system is sensitive/insensitive to uncertain input,
  - inadequate training/understanding of probability and statistics,
  - concern about public acknowledgment of uncertainty, and
  - lack of understanding of the importance/consequences of uncertainty in decisionmaking.

- Decisions are not made solely on the basis of environmental consequences. There are interagency agreements, regulatory constraints, and political realities that must be considered when selecting a course of action. Moreover, the decisionmaker must take into account not only the facts, but also people's perceptions. Once a decision is reached, perhaps with mitigation measures, there are usually additional responsibilities. These may include preparation and oversight of plans to reduce conflict (e.g., public participation in planning, public education, compensation for affected groups) and to provide for mitigation and monitoring (Attachment 6.A).

- The scope of decisionmaking often is constrained by the nature of the proposal. For instance, there are proposals with:

  - no analysis of alternatives (e.g., legislatively directed decisions in the "how-to-do" context),

- limited analysis of alternatives (e.g., the mandated closure of military bases under the Defense Base Closure and Realignment Act of 1990), and
- analysis of multiple alternatives where the decisionmaker is faced with sophisticated EA methods.

LINKAGES

Effective decisionmaking depends on integration of all of the elements of EA. During initiation and scoping, issues are raised, alternatives are generated, and valued resources are identified; public perception of the proposed action and the potential for controversy are usually detected during these early stages. The assessment process, beginning with description of the affected environment and culminating with documentation, provides the decisionmaker with answers to the following questions:

- what will happen as a result of the project?
- what will be the extent of the changes?
- do the changes matter?
- what can be done about them?

Mitigation is designed to address the last question and although most agencies do not have requirements for follow-up studies, there is a growing interest in post-decision analysis.

REFERENCES

Alberti, M., and J. D. Parker. 1991. Indices of environmental quality: the search for credible measures. Environmental Impact Assessment Review 11:95-101.

Canter, L. W., S. F. Atkinson, and F. L. Leistritz. 1985. Impact of Growth. Lewis Publishers Inc., Chelsea, Michigan.

Canter, L. W. 1979. Water Resources Assessment - Methodology and Technology Sourcebook. Ann Arbor Science, Ann Arbor, Michigan.

Dunlap, R. E., G. H. Ballup, Jr., and A. M. Gallup. 1992. The Health of the Planet Survey. The George H. Gallup International Institute, Princeton, New Jersey.

Environment Canada. 1991. A Report on Canada's Progress Towards a National Set of Environmental Indicators. SOE Report Number 91-1. Environment Canada, Ottawa.

Inhaber, H. 1976. Environmental Indices. Wiley Interscience, New York.

Jørgensen, S. E. 1991. Environmental management modeling. In: Introduction to Environmental Management (eds. P. E. Hansen and S. E. Jørgensen). Elsevier, New York. 403 pp.

Leistritz, F. L., and S. H. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Westview Press, Boulder, Colorado. 286 pp.

South Africa Department of Environment Affairs. 1992. Guidelines for Report Requirements. Department of Environment Affairs, Private Bag X447, Pretoria 001, Republic of South Africa. (One of six documents in The Integrated Environmental Management Guideline Series that are available on request).

ATTACHMENT 5.A

INDICES OF ENVIRONMENTAL QUALITY

- Alberti, M, and J. D. Parker. 1991. Indices of environmental quality, the search for credible measures. Environmental Impact Assessment Review 11:95-101.

VIEWPOINT

INDICES OF ENVIRONMENTAL QUALITY
THE SEARCH FOR CREDIBLE MEASURES

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Informed choices about environmental policy require increasing our capacity to monitor changes in the status of environmental quality. For example, monitoring concentrations of toxic substances in the atmosphere, water, soil, and food chain is crucial in order to prevent adverse health effects. Monitoring alterations in the productivity and biodiversity of various ecosystems is essential to the anticipation of problems before they reach critical proportions. Moreover, measuring changes in environmental quality over time gives policymakers a basis for assessing the effectiveness of environmental policies.

However, monitoring environmental change is much more difficult than most people think. Environmental changes are difficult to interpret without a clear understanding of how environmental systems work. There are sharp disagreements among scientists and policymakers concerning the best measures and methods for measuring changes in environmental quality. In this Viewpoint article, we argue that the measures and methods used to monitor the status of the environment play an important role in framing environmental problems and in shaping the way we think about possible solutions. We suggest that the success

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of environmental monitoring activities and their impact on policy-making depend above all on our ability to handle disagreement among experts.

The Need for Environmental Indicators

Attempts to monitor the status of environmental resources have increased the volume of environmental information available. However, they have failed to provide decision makers and the public with specific answers to critical questions concerning actual conditions, trends, and the causes of environmental damage. First, environmental monitoring systems are designed to meet specific regulatory purposes. They reflect the often fragmented approach of the regulations themselves. Secondly, monitoring data gathered by different agencies in different periods using different methods are not comparable over time. Moreover, raw data are often too complex to relate to poor or good conditions. Likewise, fluctuations in physical, biological, and chemical variables are very difficult to correlate to environmental trends.

To enhance their ability to monitor environmental change, national and international organizations have recently specified sets of indicators. At the 1989 economic summit in Paris, the Group of Seven requested that the Organization for Economic Cooperation and Development (OECD), within the context of its work on integrating environment and economic decision making, examine how selected environmental indicators could be developed (OECD 1989).

Several OECD countries have allocated substantial economic resources to set up environmental monitoring systems and to produce national environmental statistics. Currently, the Office of Research and Development of the U.S. Environmental Protection Agency (EPA) is developing a monitoring system to assess and document the changing condition of national ecological resources (US EPA 1990a). The Canadian federal government is currently developing a computerized environmental information system for specifying national and large-scale regional environmental indicators. Several European countries, such as France, the Netherlands, the Federal Republic of Germany, Denmark, and the United Kingdom, who already produce regular reports on the state of the environment, have recently tried to upgrade existing environmental statistics. As part of Scandinavian environmental cooperation among Denmark, Finland, Iceland, Norway, and Sweden the Integrated Monitoring Programme was begun in Finland in 1985.

Currently, the OECD is developing environmental indicators in three specific areas: 1) indicators for reporting on environmental conditions and trends, 2) indicators for integrating environmental considerations into sectoral decision-making, and 3) indicators for incorporating natural resources into overall economic accounts. These indicators will be used to monitor the state of the environment and its evolution over time; evaluate the performance of projects, programs and plans; and communicate with the public and among decision makers (OECD 1991a, 1991b).

Measuring Environmental Quality

The status of environmental resources can best be described through using physical, chemical, or biological variables. These variables in turn are used to construct indicators of environmental change of various kinds. Indicators of air quality, for example, are measures of the concentrations of air pollutants. Indicators of surface water quality consolidate changes in several variables such as pH, dissolved oxygen, suspended solids, etc. The process of designing indices of environmental quality implies simplification and the use of subjective judgment.

Detecting variations in these indicators at local, regional, and national levels is relatively simple. However, the choice of variables, the construction of indicators, and the selection of measurement methods are critical. While some environmental phenomena are relatively well understood, others are still unclear. Incomplete and inadequate choice concerning indicators and measurement methods can lead to wrong interpretations.

The definition of environmental "indicators" and "indices" was taken up in a exchange of views between Wayne Ott and Herbert Inhaber (Ott and Inhaber 1979) in the 1970s. Inhaber states, "Environmental indicators provide information about the state of the environment, not obtainable in other ways" (Inhaber 1976). In his view the development of an environmental index is aimed at reducing a large amount of unrelated data to a single measure. He defines an index as "the comparison of a quantity to a scientific or arbitrary standards" (Inhaber 1976). Ott prefers to define an indicator as a mathematical function based on one pollutant variable (for example, the sulfur dioxide concentration) and an index as a mathematical function based on two or more pollutant variables (Ott 1978).

The EPA Environmental Monitoring and Assessment Program (EMAP) (see US EPA 1990a) defines an environmental indicator as "a characteristic of the environment that, when measured, quantifies the magnitude of stress, habitat characteristics, degree of exposure to the stressor, or degree of ecological response to the exposure" (US EPA 1990b). The EPA defines an environmental index as a mathematical aggregation of indicators or metrics. One example is the Index of Biotic Integrity (IBI), which combines several metrics describing fish community structure, incidence of pathology, population sizes, and other characteristics" (US EPA 1990b), proposed by the EPA to assess the quality of streams.

Scientific Controversies

Environmental indicators and indices are essential to the development of environmental statistics. Yet, the task is not straightforward. Disagreement persists among experts concerning appropriate definitions. Controversies exist within and across different disciplines. Ecologists express the conditions of environmental

resources in terms of ecological integrity and assess them on the basis of observed changes in ecological attributes. Experts disagree on the definition of ecological integrity and on the characterization of critical conditions.

The basic controversy between advocates and opponents of environmental indices concerns the distortion that can occur in the simplification process implied by aggregating environmental variables into one single value. Advocates of environmental indices maintain that, while imperfect, measures of environmental quality are useful tools and that some distortion is acceptable. The opponents reject these possible distortions and warn about misleading the users of these measures.

The EPA Environmental Monitoring and Assessment Program

The environmental indicators used in the EMAP are being developed for six ecological resources categories: near-coastal waters, inland surface waters, wetlands, forests, arid lands, and agroecosystems. The EMAP strategy identifies three main categories of indicators: 1) response indicators, 2) exposure or habitat indicators, and 3) stressor indicators (US EPA 1990a).

Response indicators are characteristics of the environment measured to provide evidence of the overall biological conditions of resources. They quantify the response of ecosystems to anthropogenic stress by measuring organisms, populations, communities, and ecosystems processes. For example, one response indicator for arid land is soil erosion; for inland surface water an important indicator is the Fish Index of Biotic Integrity.

Exposure or habitat indicators may be used to diagnose and measure ecosystem exposure to pollutants and habitat degradation. Exposure indicators are measures of the occurrence or magnitude of ecosystems exposure to physical, chemical, and biological stress (i.e., ambient pollutant concentration). Habitat indicators are physical attributes that characterize conditions necessary to support an organism, population, or community (i.e., abundance and density of key physical features).

Stressor indicators measure socioeconomic, demographic, and natural processes which cause changes in exposure and habitat conditions and are indicative of environmental stress. They include hazard indicators (e.g., emissions of air pollutants), management indicators (e.g., incidence of dredging and filling activities), and natural process indicators (e.g., natural climatic fluctuations).

EMAP indicators are designed to answer critical questions such as: 1) What is the current status, extent, and geographic distribution of our ecological resources? 2) What proportions of these resources are degrading or improving, where, and at what rate? 3) What are the likely causes of adverse effects? and 4) Are adversely affected ecosystems responding as expected to control and mitigation programs (US EPA 1990b)?

The EPA strategy of selecting indicators that will help to answer these specific questions does not address the problem of subjective judgment. The review process for selecting indicators includes several steps by which a large number of experts will evaluate expected and actual performance of proposed indicators and will specify those that match selected desirable criteria. How controversies will be solved is not clear.

The EPA's Office of Research and Development claims that EMAP scientists "will answer these questions by defining and implementing over the next five years integrated monitoring networks ..." (US EPA 1990b). The EPA insists also that "EMAP networks will use a statistically based sampling design to provide unbiased estimates with quantifiable confidence limits over regional and national scales for periods of years and decades" (US EPA 1990b).

Although the EPA approach is extremely well structured and responds to accepted statistical principles, it does not address the critical question of how best to resolve the scientific and political controversies involved in the choice of indicators. We argue that there is no universal method for determining changes in environmental quality, likely causes of adverse effects, or satisfactory responses. Environmental quality is a mixture of both tangibles (such as the concentration levels of chemical substances in the atmosphere) and intangibles (such as an acceptable level of air quality for the exposed population and the environment). Conflicts will continue to exist.

The Search for Credible Measures

The intended purposes of measuring environmental changes is to inform policymaking. Therefore, a measure of its success is the impact of monitoring activities on designing and adjusting environmental policies at the national, regional, and local levels to meet new environmental emergencies and priorities.

Compared with economic and social indicators, environmental indicators have little direct impact on environmental policy and even less impact on sectoral or economic policies. Economic statistics are well developed worldwide. While the development of economic indicators has been characterized by enormous controversies, several economic indices such as Gross National Product (GNP) and the price indices are recognized worldwide as measures of economic wealth. These two economic indices are generally used as the basis for economic policymaking.

Some important insights into the present debate on environmental indicators may be gained by examining the controversial history of social indicators. While social indicators now significantly influence social and economic policies, the development of these indices was characterized by great controversies concerning cause-and-effect relationships. A similar pattern of controversy can be observed in the attempts to define indicators of environmental quality, particularly quality-of-life indices (Carley 1981). Beesley and Russwurm contend that "social in-

dicators are embedded within a political and value judgment reality which may pose problems in their design and use" (Beesley and Russwurm 1990). Also, it is not always possible to establish relationships between the objective social indicators and the social concepts that they are supposed to measure. This has provoked considerable interest in searching for subjective social indicators which might be particularly useful in highlighting social concerns and problems (Beesley and Russwurm 1990). However, these attempts lack the "official" seal of approval that objective indicators carry (Carley 1981).

Similar concerns emerge regarding the attempts to incorporate subjective judgment in the development of aggregate environmental indices. Efforts have been made to weight individual (expert-selected) environmental indicators into composite environmental indices using expert opinions. These include the work of Inhaber for Canada (Inhaber 1976) and those applying the Delphi technique. Some current work uses public opinion polls to weight environmental indicators in forming aggregate indices such as Hope, Parker, and Peake have done for the United Kingdom (Hope and Parker 1990; Hope, Parker, and Peake 1990). These approaches underscore the important role of social considerations in developing such measures.

Conclusions

Indicators of environmental quality will not influence the policy-making process unless there is agreement on the choice and the design of such measures. As Judith Innes has suggested for social indicators, "the intended purpose of developing measurements to be used in the policy-making process has to play a role in the process of designing them" (Innes 1975). In her analysis of social indicators and public policy she maintains that the things we measure and the way we measure them contribute to the formation of norms and goals.

We suggest that measurement is an integral part of the process of identifying problems as well as of searching for solutions. Our increased capacity to collect, analyze, and manage information will not have an impact on policy-making unless we are more careful about the information we select. Scientific disputes and incomplete knowledge have serious implications for policy decisions. Furthermore, the serious social implications of irreversible environmental changes underscore the responsibility of the scientific community to take part in the policy-making process. Designing appropriate measures to monitor environmental problems requires the ability to balance scientific, social, and political considerations in the process of designing and applying these measures. This process will inevitably reflect tradeoffs between political and social actors. Effective and comprehensive policy making requires increased sophistication in assessing conflicts between scientific experts.

References

Alberti, M. 1990. Environmental indices. *Ambiente Italia*. Milán: Mondadori.

Beesley, K.B., and Russwurm, L.H. 1990. Social indicators and quality of life research: Toward synthesis. *Environments* 20(1): 22–39.

Carley, M. 1981. *Social Measurements and Social Indicators*. London: Allen & Unwin.

Commission of the European Communities (CEC). 1990. Council Directive, 7 June 1990 on the freedom of access to information on the environment. *Official Journal of the European Communities* No. L 158/56-58, 23-6-1990.

Innes J. 1975. *Social Indicators and Public Policy*. New York: Elsevier.

Hope, C.W., Parker, J.D.E. 1990. Environmental information for all-the need for a Monthly Index. *Energy Policy* 18(4):312–319 (May 1990).

Hope, C.W., Parker, J.D.E., and Peake, S. 1990. A pilot index for the United Kingdom. Management Studies Research Paper, University of Cambridge, 10/90.

Inhaber, H. 1976. *Environmental Indices*. New York: Wiley Interscience.

Organization for Economic Cooperation and Development (OECD). 1989. Summary Conclusions of the OECD Workshop on Environmental Indicators. Dec 4–5. Paris: OECD.

Organization for Economic Cooperation and Development (OECD). 1991a. *The State of the Environment*. Paris.

Organization for Economic Cooperation and Development (OECD). 1991b. *Environmental Indicators—a preliminary set*. Paris.

Ott, W. 1979. *Environmental Indices: Theory and Practice*. Ann Arbor, MI: Ann Arbor Science Publishers.

Ott, W., Inhaber, H. 1979. Discussion on Canadian Air Quality. *Atmospheric Environment* 2:428–429.

U.S. Environmental Protection Agency (US EPA) 1990a. *Environmental Monitoring and Assessment Program*. Office of Modeling, Monitoring Systems and Quality Assurance. Washington DC: EPA.

U.S. Environmental Protection Agency (US EPA) 1990. *Ecological Indicators for the Environmental Monitoring and Assessment Program*. Atmospheric Research and Exposure Assessment Laboratory. Research Triangle Park, NC: EPA.

U.S. Environmental Protection Agency (US EPA) 1990c. *International Symposium on Ecological Indicators*. Conference Proceedings, 15–19 October 1990. Fort Lauderdale, FL.

CHAPTER 6

POST DECISION ANALYSIS

CHAPTER 6

POST-DECISION ANALYSIS

Post-decision analyses (PDA) are environmental studies (i.e., data collection and evaluation) undertaken during and following the implementation phases of an activity after the decision to proceed has been made. They are also known as follow-up studies and sometimes as environmental monitoring or audits. There is no universally accepted set of principles defining an approach to PDA (Davies and Sadler 1990). The analyses may be undertaken prior to construction, during construction or operation, and at the time of abandonment to determine if the project was carried out as planned in the EA documentation, to determine the adequacy of impact prediction methods, to ensure accordance with regulatory requirements and/or with terms imposed by EA documentation for mitigation or monitoring, to modify mitigation measures if needed, to learn from the particular activity, and to prevent irreversible environmental damage (United Nations 1990). It is particularly important for activities that involve new technologies.

For purposes of this sourcebook, PDA is a generic term for a wide-range of activities that can occur after a decision is made. The focus can be on scientific, social and technical issues and also those dealing with procedural and administrative matters. Related terms such as monitoring (Canter 1993) and auditing (Culhane 1993) are narrower in concept. For instance, compliance monitoring is designed to ensure that regulatory requirements are observed and standards are met. Audits are independent and objective examinations of compliance with legal requirements, internal policies and/or accepted practices. However, the needs and tools discussed in this section are generally applicable to any of these activities. Components within a broad definition of PDA include as appropriate:

- planning the collection of data to meet specific objectives and environmental information needs;
- designing monitoring systems and studies;
- selecting sampling sites;
- collecting and handling samples;
- laboratory analysis;
- reporting and storing the data;
- assuring the quality of the data; and
- analyzing, interpreting, and making the data available for subsequent decisionmaking.

- The purpose of PDA must be carefully defined and the planning for PDA must be an integral part of the EA process. The focus of PDA is usually on: issues of concern and valued resources for which there is insufficient information; monitoring compliance with regulatory requirements and agreed upon conditions; and evaluating proper and cost-effective management. A decision on a PDA plan should be made at the time that a decision is made regarding the project.

- There must be a commitment to the PDA program at all levels of management, including adequate financial support. Roles and responsibilities must be defined for the proponent, other government agencies, scientific and technical advisors, and the public early in the EA planning process. Furthermore, provisions must be made for:

  - management responses to PDA findings, including how to handle environmental surprises (i.e., unanticipated impacts);
  - revision of mitigation or monitoring if it is found to be inadequate or unnecessary;
  - ending the program if and when it is no longer needed.

- Independent design and implementation of the PDA program is encouraged, particularly for those areas of the program that are sensitive and for which work done by the proponent may not be regarded as credible by the public.

- Monitoring programs are expensive to plan and implement; thus every effort should be made to coordinate with and utilize routinely collected data from ongoing monitoring programs as appropriate. Various government agencies and the private sector collect data which once identified can be aggregated and interpreted relative to the particular area of interest (Attachment 4.A). There probably never is enough information collected to thoroughly test PDA hypotheses. Therefore, it is usually necessary for professionals to extrapolate from monitoring data to arrive at an "educated best-guess".

- Periodic evaluation of PDA data and preparation of an annual report for distribution to interested and affected publics.

- A review of 11 case studies (United Nations 1990) showed four important needs for PDA. These include:

  - development during EA planning of verifiable hypotheses for testing during PDA;
  - collection of relevant baseline data for interpretation of subsequent monitoring data and testing of impact prediction hypotheses;
  - careful documentation throughout projects to lessen effects of personnel turnover; and
  - use of appropriate statistical methods to test hypotheses so that effects of projects can be satisfactorily isolated from other environmental effects.

TOOLS

- Monitoring (i.e., the systematic collection of data through a series of repetitive measures) is usually an essential component of PDA. The detailed means of monitoring and the issues monitored will vary greatly depending on the proposed activity (ORNL 1978; U.S. EPA 1989; ASTM 1992; ANSI 1982; Canter 1993). In general, methods for assessing adverse effects in freshwater systems are well developed while methods for assessing adverse effects in terrestrial systems are less well developed. Most PDA incorporates one or more of the following categories of monitoring:

  - **Compliance Monitoring.** Periodic sampling and/or continuous measurement of levels of waste discharge, emissions or introductions to determine that regulatory conditions and/or standards of good practice are met.

  - **Effects Monitoring.** Measurement of environmental parameters during construction and/or operation to detect changes in the parameters which can be attributed to the project or to test predictions of an EA and/or the effectiveness of mitigation measures.

  - **Internal Audits.** A methodological examination (sometimes involving analyses and tests) and confirmation of local procedures and practices leading to verification of compliance with legal requirements, internal policies, and/or accepted practices.

  - **Inspection and Surveillance.** Depending upon the purpose of PDA or where data are absent or inadequate, the analysis can be

based on less quantitative methods such as inspection and surveillance to determine adherence to environmental operating conditions (e.g., road or pipeline construction).

- Negotiation is currently seen as a promising tool in the design of monitoring programs, particularly for resource development activities. It creates a forum where affected interests can deal directly with disagreements over what should be monitored and how those things should be assessed and dealt with. Rolf (Attachment 6.A) notes three particularly important factors with respect to negotiating a monitoring program: symmetry of power and resources, a multiple issue agenda, and a mechanism for resolving disputes. She argues that a negotiated monitoring program leads to better decisions, fairness, and better implementation.

ISSUES

- Space and time coordination of data collection is necessary to eliminate variation in analytical results associated with differences in geographical regions and changes in biota and pollutants over time.

- Although in the U.S., CEQ regulations require federal agencies to monitor the effects of proposed mitigation measures in "important cases" and to report on the progress of such mitigation measures to other agencies and the public on request, in practice, this provision has not been enforced. Currently, except for The Netherlands, there is a lack of formal PDA in most countries. As a result, there is little opportunity to learn from and apply the experience to subsequent activity. Sadler (1988) notes that the lack of PDA stems from jurisdictional fragmentation (in Canada), ambiguous mandates, and insufficient resources.

  In cases where PDAs were done, Bisset and Tomlinson (1988) note that only 12 percent of all predictions could be audited; of the predictions tested about half were inaccurate. There was a tendency for the inaccurate predictions to indicate impacts which subsequently did not occur. They found that the nature of EA documents makes it difficult to audit the predicted impacts of a development for these reasons:

  - predictions are expressed in vague, imprecise language;

- impact predictions are not phased in a way that allows auditing (e.g., design changes can eliminate the predicted impact); and
- monitoring programs often do not provide the data needed to allow predictions to be tested in a scientifically acceptable way.

- Bisset and Tomlinson (1988) suggest that decisionmakers do not like to have their decisions questioned by subsequent investigations. Thus, it is important that PDA is an integral part of EA documentation with the stated goal of not questioning the rationale of the decisionmaker but rather, of determining the quality of the information in the EA document. Decisionmakers need to be convinced that PDA will result in better information for decisionmaking (i.e., less uncertainty), better EA at less cost, and greater public confidence in the project.

- The PDA should focus on important issues and impacts for which there are insufficient information. Identification of these issues and impacts and their priorities occurs during the EA process and a PDA plan, commensurate with their complexity and uncertainty, should be prepared as an integral part of the EA process.

- PDA developed in response to public concerns must be credible, and the proponent must be willing to respond even to unacceptable results.

- Questions to consider in relation to EA and PDA might include:

  - were the important project-related impacts and mitigation responses identified accurately in the EA?
  - did the EA process provide sound, relevant, and focused information concerning project effects and their implications?
  - were there clear levels of confidence and significance placed on the predictions?
  - were the cumulative and secondary impacts traced properly?

LINKAGES

For PDA to provide useful feedback for decisionmaking, it must be based on issues identified during initiation and scoping. The assessment process must result in testable hypotheses based on important issues. Mitigation and

monitoring programs must be designed to ensure that requisite data are available for testing the hypothesis. Collection, evaluation, and publication of the results of PDAs can contribute to reducing uncertainty in decisionmaking and enhancement of agency credibility.

REFERENCES

American National Standards Institute (ANSI). 1992. American National Standard for Surveys of Terrestrial Ecology Needed to License Thermal Power Plants. ANSI/ANS-18.5-1982. Published by the American Nuclear Society, 555 North Kensington Avenue, LaGrange Park, Illinois 60525. 26 pp.

American Society for Testing and Materials (ASTM). 1992. Annual Book of ASTM Standards, Section II, Water and Environmental Technology. Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187. 1426 pp.

Bisset, R., and P. Tomlinson. 1988. Monitoring and auditing of impacts. In: Environmental Impact Assessment (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Bisset, R. 1980. Problems and issues in the implementation of EA audits. Environmental Impact Assessment Review 1:379-395.

Canter, L. W. 1993. The role of environmental monitoring in responsible project management. The Environmental Professional 15:76-87.

Culhane, F. J. 1993. Post-EIS environmental auditing: a first step to making rational environmental assessment a reality. The Environmental Professional 15:66-75.

Davies, M., and B. Sadler. 1990. Post-project Analysis and the Improvement of Guidelines for Environmental Monitoring and Audit. Report EPS 6/FA/1. Environment Canada, Ottawa, Ontario K1A 0H3.

Graves, B. M., and P. L. Dittberner. 1986. Variables for Monitoring Aquatic and Terrestrial Environments. U.S. Fish and Wildlife Service Biological Report 86 (5). 55 pp.

Marcus, L. G. 1979. A Methodology for Post-EIS (Environmental Impact Statement) Monitoring. U.S. Department of the Interior, Geological Survey Circular 782.

Oak Ridge National Laboratory. 1978. Environmental Monitoring Handbook for Coal Conversion Facilities. ORNL-5319 Special. Available from the National Technical Information Service. U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

Rolf, C. A. Negotiating a monitoring program. 1986. Impact Assessment Bulletin 4:99-109.

Sadler, B. 1988. The evaluation of assessment: post-EIS research and process development. In: Environmental Impact Assessment (ed. P. Wathern). Unwin Hyman, Boston. 332 pp.

Sigal, L. L., and G. W. Suter II. 1987. Evaluation of methods for determining adverse impacts of air pollution on terrestrial ecosystems. Environmental Management 11:675-694.

United Nations Economic Commission for Europe. 1990. Post-Project Analysis in Environmental Impact Assessment, ECE/ENVWA/11. 54 pp. Available from the United Nations, Sales Section, New York.

U.S. Environmental Protection Agency. 1989. Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference. EPA/600/3-89/013.

ATTACHMENT 6.A

NEGOTIATING A MONITORING PROGRAM

- Rolf, C. A. Negotiating a monitoring program. 1986. Impact Assessment Bulletin 4:99-109.

[40] Ucko, P.J., "Australian Academic Archaeology: Aboriginal Transformation of Its Aims and Practices." *Australian Archaeology*, 1983, 16:11-38.

[41] Wells, Katie, John Tallow, Esther Tailfeathers and Gerald Conaty, "Archaeological Research on the Blood Reserve. *Alberta Archaeological Review* No. 9:3-16, 1984.

[42] Wildesen, Leslie E., "The Study of Impacts on Archaeological Sites." In *Advances in Method and Archaeological Theory*, volume 5. Michael B. Schiffer (ed), pp. 59-96. Academic Press, New York, 1982.

[43] Winter, Joseph C., "Indian Heritage Preservation and Archaeologists." *Am. Ant.* 45:121-131, 1980.

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NEGOTIATING A MONITORING PROGRAM

Carol Anne Rolf*

INTRODUCTION

In February 1981, Western Fuels-Utah Inc. filed an application to develop a 1.4 million tons per year coal mine in Rio Blanco County, Colorado in order to supply a 400 megawatt power plant 33 miles away in Bonansa, Utah.[1] Rio Blanco County was primarily an agriculture-based economy with oil shale potential and a fairly sparse population of about 3,200 people who would experience the most direct impacts of mine construction and operation.

As is true with many instances of large scale resource projects, residents and local government officials recognised the potential benefits of development, but they were concerned that negative impacts would impose unacceptable burdens and disruptions upon both the existing and project-related population. There was particular concern that locating the power plant across the state line denied Rio Blanco County access to tax revenues which would offset the increased costs of providing hard and soft public services.[2]

In June 1981, Western Fuels-Utah and nine special districts in Rio Blanco County signed a comprehensive socioeconomic impact mitigation agreement worth $15 million in front end payments. Unlike many other mitigation and compensation agreements, it included provisions to de-

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[1]This case as well as other cases of American experience is analysed in Rolf, C.A. *Mandatory Negotiation: A Means to Determine Mitigation and Compensation in the Context of Energy Development.* University of California, Berkeley: unpublished master's thesis.

[2]Interview: Mark Bubriski, County Impact Coordinator, Rio Blanco County, Colorado.

velop and implement a monitoring program. The details of this program were subsequently renegotiated over an 11 month period in 1983.[3]

This paper is about negotiating monitoring programs, which aspects of the Colorado experience might be transferable to places such as the Beaufort Region in the NWT, and the kinds of issues which must be considered if a negotiation policy were adopted.

REASONS FOR NEGOTIATION

The value of impact monitoring is not in dispute. At the conceptual level at least, there is considerable consensus as to why monitoring is generally a good idea. Unfortunately, if not unexpectedly, monitoring practices to date appear to fall rather short of their theoretical promise. Whatever factors may contribute to this shortfall, it is clear from experience that no one monitoring model exists which can be universally applied to resource development.[4] In other words each monitoring program must be tailor-made to suit its particular requirements and circumstances. In this light, the problem of designing and implementing a monitoring model may be recast as a problem of process: how should we go about the designing and implementing? One answer to this question is to use negotiation.

Negotiation is a particularly apt tailoring process if the problem is represented as a game. More specifically, it is not the kind of game where winners are possible only when others lose: a zero-sum game. It is, instead, a game where there are common interests as well as value conflict.[5]

[3]Interview: Reid Haughey, County Impact Coordinator, Rio Blanco County, Colorado.

[4]See for example, Bankes, N. & Thompson, A.R. *Monitoring for Impact Assessment and Management: An Analysis of the Legal and Administrative Framework*, University of British Columbia: Westwater Research Centre, 1980; Carley, M. *Cumulative Socioeconomic Monitoring: Issues and Indicators for Canada's Beaufort Region*. Prepared for Energy, Mines and Resources Secretariat, G.N.W.T. and The Northern Economic Planning Branch, Department of Indian Affairs and Northern Development, March 1984; Veit, S. Presentation to Workshop on Cumulative Socioeconomic Monitoring for the Beaufort Region. Sponsored by Energy Mines and Resources Secretariat, G.N.W.T., June 11-12, 1984.

[5]Thomas Schelling calls this co-existence of value conflict with common interests a "mixed-motive game" and suggested that what would be rational strategic behavior on the part of those involved in a zero-sum game would be irrational in the mixed-motive. See *The Strategy of Conflict*, Cambridge, Mass: Harvard University Press, 1960.

In this kind of game, winning means" ...gaining relative to one's own value system..." [6] and bargaining or negotiation is one of the ways of doing so. The argument here is that a negotiated monitoring program leads to higher quality decisions, is fair, and will get implemented.

1. **Better Decisions:** In a related vein, impact monitoring may be thought of as a decision-making process. Because of the number of decisions which cannot be or are not made at the time a project is approved, monitoring and impact management has, in fact, been referred to as a process of postponed decision-making.[7] Whatever the timing, these decisions must be made under a considerable degree of uncertainty, when information is often inadequate, unavailable or unobtainable and when there may be conflict over both values and facts.

One illustration of the need to resolve ostensibly factual controversy in an environmental context comes from Wisconsin where there has been an effort to implement a new pollution control policy for the Fox River.[8] Participants (from state and regional governments, industry and municipalities, and academia) in the design of the new policy found that a major step was to agree on the variables and quantitative measures comprising a model of Fox River pollution, and they further recommend the establishment of institutional arrangements to deal with future advances in modelling which might affect the new policy.

Negotiation is argued to be suited especially to such decision situations because incentives to make good use of information, to detect and correct error and the ability to resolve conflict are inherent in this joint decision making or problem solving process.[9] It allows the confrontation of "value-bound components of scientific analysis" and the opportunity

[6]Ibid, p. 5.

[7]Thompson, A.R., Bankes, N. & Souto-Major, J. *Energy Project Approval in British Columbia*. University of British Columbia: Westwater Research Centre, 1981, p.11.

[8]David, M.H. & Joeres, E. is a viable implementation of TDPs transferable? in Joeres & David (eds) *Buying a Better Environment*. Madison, Wis: University of Wisconsin Press, 1983, 233-248.

[9]See for example, Boschken, H. *Land Use Conflicts: Organizational Design and Resource Management*, Urbana: University of Illinois Press, 1982; Pruitt, D. *Negotiation Behavior*, New York: Academic Press, 1981; Schelling, supra note 5; Zaltman, I.W. Negotiation as a joint decision-making process, *Journal of Conflict Resolution*, 197 .1(4), 619-638.

to fold distributional concerns into the analytic process.[10]

Perhaps even more noteworthy, negotiation fosters the capacity to adapt to changing conditions. In Colorado, for example, the company and the county initially negotiated the development of a monitoring program and were then able to re-negotiate the terms of that program as changes became necessary.[11]

This advantage may be attributed to the fact that negotiation involves an agreement between parties not to reach a solution in terms of rules but to create the rules by which they can organise their relationship to one another. [12] In other words, a monitoring program can be conceived as a kind of relational contract where the parties create a structure through which to address problems and make decisions over time.[13] Not only does this adaptability make sense in the real and uncertain world of resource development, but the actual negotiation structure for making decisions is considered to be economically efficient.[14]

2. **Fairness**: Negotiating the design of a monitoring program may enhance the equity of resource development. One reason is that helps redress some of the powerlessness of affected communities (who do not usually participate directly in the decision to develop the local resources) by allowing direct participation in some of the decisions about the project.

A common form of public participation in resource development policy is some version of the public hearing, and information gathered through this essentially adversarial process may form the basis for designing a monitoring program. Though this kind of input may have alleviated some of the poverty of power at the local level, the participation role is not decision-making but one of information provision. The public hearing process is generally absent in criteria for weighting different sources of information and the built-in incentives are to persuade the deciders. As a result, the information which is provided may represent those issues most easily or powerfully argued, or most easily measured. These may not, and are unlikely to be synonymous with what is of greatest concern in affected communities.

Negotiation creates a forum where affected interests can deal directly with disagreements over what should be monitored and how those things should be assessed and dealt with. Although it comes with no guarantees of authenticity or integrity, negotiation does provide an alternative avenue of participation which may increase the level of representation in making of decisions. In Wyoming, for example, where there is some experience with community negotiated mitigation and compensation agreements, the first stage in the negotiation is reported to be reaching a consensus on projected impacts and their importance to various constituencies in the community.[15] This is particularly true with respect to impacts based on population and demographic projections.

3. **Better Implementation**: Monitoring programs, like most policies, have suffered from intentional and unintentional implementation problems.[16] Negotiating the program may discourage intentional violation because participating in the design tends to increase the commitment of those responsible for implementation. That this is equally valuable for energy companies and for communities is evidenced by the Western Fuels case where the company was initially worried that the county might charge them for "cadillac servicing."[17]

The flexibility and adaptive capacity created through negotiation contributes to avoiding as well as detecting and correcting unintentional error.

The theory and so far relatively limited practice with negotiation in this context suggest that negotiation promises to be an effective tool in the design of monitoring programs. The degree to which it fulfills this promise depends a great deal on how the negotiation process is structured. To this

[10] Osawa, C. & Susskind, L. *Mediating Science-intensive Public Policy Disputes*. Presented to the Association for Public Policy Analysis and Management, New Orleans, October, 1984.

[11] Supra note 3.

[12] Gulliver (1973) cited in Nader, L. & Todd, H.F. Jr., *The Disputing Process — Law in Ten Societies*, New York: Columbia University Press, 1978, p. 10.

[13] Williamson, O.E. Transaction-cost economics: the governance of contractual relations. *The Journal of Law and Economics*, 1979, 22, 233-261.

[14] Ibid. Among other reasons, Williamson notes that negotiation creates relationships that circumvent opportunism and also establish what he refers to as "communication economics."

[15] Supra note 1. Interviews with company and town negotiators.

[16] See for example Bankes & Thompson and Thompson, Bankes & Souto-Major Supra note 4.

[17] Supra note 3.

end, several issues and elements should be factored into the design of a policy to negotiate an impact monitoring program.

DESIGN ELEMENTS

1. Negotiator Selection and Accountability: It is the interests which need to be represented in the negotiation rather than particular constituencies.[18] Nevertheless, there must be some way to get the right people to the table and to make sure they are accountable to their constituents. "The right people" means that the negotiators are able to commit their constituencies to supporting and implementing the monitoring program, and that some mechanism for accountability exists which may help assuage the problems of imperfect representation.

From the community point of view, the most appropriate way of choosing negotiators and achieving accountability seems to be one that is compatible with the local political culture, and there are many variations. In the Western Fuels case, for example, three country commissioners and the general manager negotiated on behalf of nine special districts and the agreement was approved by those districts. And in Montana, when the Northern Cheyenne successfully negotiated with the Montana Power Company, the Tribal Council selected two negotiators (one a member of the Council's Mineral Committee and one outside expert on energy resources) and then ratified the final agreement.[19]

In Massachusetts and Connecticut, where hazardous waste siting legislation provides statutory support for this kind of negotiation, a Local Assessment Committee and a Local Project Review Committee respectively are appointed to negotiate with project proponents.[20] Town Councils do not have ratification power under these Acts but to ensure wider accountability, the respective State Siting Councils must approve the final agreement.[21] In Wyoming where the negotiation process is less formally structured, the final agreements are usually approved by the Town Council.[22]

[18]Susskind, L.E., Richardson, R.R. & Hildebrand, K.J. Resolving Environmental Disputes, MIT: Environmental Impact Assessment Project, 1978, p.26.

[19]Sullivan, T.J. The difficulties of mandatory negotiation (the Colstrip Power Plant case) in L. Susskind, L. Bacow, & M. Wheeler (eds.) *Resolving Environmental Regulatory Disputes*, Cambridge, Mass: Schenkman Publishing Company, 1983, 56-85. See also Supra note 1.

[20]*Connecticut Hazardous Waste Facility Siting Act*, Public Act 81-369, Ch. 448 (see in particular S. 16) and Massachusetts Hazardous Waste Facility Siting Act, Ch. 502, Mass. Acts 673, 111, 21c. (see in particular S. 6, 8, 13).

It should be noted, however, that peer pressure and the politics of personality often found in small communities may threaten this kind of accountability. In one case in Wyoming one leader of a group of disaffected citizens received threats to his life and business, and no local attorney would agree to represent this group at public hearings.[23] The absence of dissent cannot be unambiguously equated with the legitimacy of agreements, but presumably the more open the negotiation process, the more accountable the results.

2. Negotiation Procedures: Of the multiple factors affecting the success of the actual negotiation process and the chances of reaching a settlement,[24] three seem particularly important with respect to negotiating a monitoring program: symmetry of power and resources, a multiple issue agenda, and a mechanism for resolving disputes.

(a.) Power and Resource Symmetry: Symmetry is necessary to ensure that negotiation is the "product of necessity"[25] or in other words that the alternative to negotiation, whatever that may be, is not a more attractive option to one of the parties than negotiation. Problems of asymmetry in this kind of negotiation are likely to lie in information, funding and technical expertise, all of which may be in favour of senior governments and the energy companies unless deliberately designed otherwise. The Northern Cheyenne in Montana have a Research Centre staffed by planners and environmental scientists who conducted a study of coal de-

[21]For one discussion of some of the issues of wider accountability in the context of environmental mediation (a related process) see Susskind, L. & Ozawa, C. Mediated Negotiation in the Public Sector: Mediator Accountability and the Public Interest Problem. *American Behavioral Scientist*, 1983, 27(2), 255-279.

[22]Supra note 1.

[23]Interview: Powder River Basin Resource Council, Douglas, Wyoming.

[24]See for example Cormick, G.W. The "theory" and practice of environmental mediation, *The Environmental Professional*, 1980, 2, 24-33; Sullivan, T.J. *Resolving Development Disputes through Negotiation*, New York: Plenum Press, 1983; and Supra note 1.

[25]Ibid, see Cormick.

velopment impacts.[26] In Colorado, the county received a $200,000 loan from the Governor's Office with which to hire legal assistance and two university-based economists who reviewed Western Fuel's Environmental Impact Study.[27] The Massachusetts and Connecticut legislation provides for Technical Assistance Grants of up to $15,000 but there is not yet enough experience under these Acts to assess how well this method works.[28]

(b.) Multiple Issue Agenda: A narrow agenda may easily transform the process into a sero-sum game because there is little opportunity for reciprocal concessions, thus threatening the negotiation. Parties are unable to trade concessions in one issue for gains in another. A multiple issue agenda makes bargaining more likely to be successful.[29]

After years of acrimony and an aborted attempt at negotiation, the final success of the Northern Cheyenne and Montana Power negotiations is attributed partially to a broader agenda.[30] And one of the strengths of the Western Fuels Agreement is its "package program" nature instead of a series of individual agreements between the company and various local government entitites. In addition to broadening the agenda, this promotes monitoring that is more likely to be comprehensive than fragmented.

(c.) Dispute Resolution Mechanism: This mechanism actually serves dual purposes. One is to cope with the inevitable spectre of stalemate and the other is to help to create some sense of urgency, or pressures for decisiveness in the negotiations. Without this sense, negotiating the monitoring program may be just another way of avoiding or delaying its implementation. In the Western Fuels case, there were only five months between the filing of applications and the expected construction start, and the coal market had not softened yet. Rather than relying on idiosyncratic circumstances or the world market, action-forcing deadlines may create the same sense of urgency. In Massachusetts, for example, negotiation is statutorily required to be completed within 60 days (although up to two 30 day extensions may be granted).

[26]Supra note 24 Sullivan.

[27]Supra note 2.

[28]Note in Connecticut, more money may be available if total project costs are over $500,000.

[29]Supra note 24 Sullivan.

[30]Supra note 22 Sullivan.

Another method would be for the parties to actually negotiate those deadlines, an exercise which would also educate the negotiators by providing an opportunity to learn that agreement is possible.[31] To parties who have been locked in long-standing disputes, or where there is a history of mistrust, this can come as a surprising revelation. If the parties were unsuccessful, one default option would be to resort to the dispute resolution mechanism. This safeguards against such deadlines subverting the process and forcing an illegitimate settlement.

The key variable to an effective dispute resolution mechanism is that it not be more attractive than negotiation. A common provision is some form of arbitration which transfers the decision-making power to a third party who has more or less authority to bind the parties to some decision. Under the Massachusetts legislation, for example, stalemated parties have the option of a three person arbitration panel (one person chosen from each side and the third jointly selected) or one arbitrator jointly selected. In the event that this too is stalemated, the State Siting Council will select an arbitration panel. Veterans of this kind of negotiation report a reluctance to transfer their authority and power; negotiating decisions, no matter how difficult, is generally preferred to their external imposition.[32]

3. **Enforcement Mechanism:** In case of disputes or of intentional violations during implementation, there must be some way of enforcing the agreement. Some enforcement strength stems from the contract nature of a negotiated agreement. Standard civil law remedies, or variations thereof, might then be called upon.[33]

Substantial enforcement strength stems, however, from the ongoing nature of monitoring and the possibility for re-negotiation. This ability to deal with both intentional and unintentional problems with implementation contributes to the flexibility and legitimacy of the agreement and to the continued evolution of the norms and rules governing the relationships among the parties involved.

[31]Supra note 1.

[32]Supra note 1.

[33]For a discussion of possible remedies and some of the issues which might be involved see Bankes & Thompson Supra note 4 and Barton, B.J., Franson, R.T., & Thompson, A.R. *A Contract Model for Pollution Control*. University of British Columbia: Westwater Research Centre, 1984.

In effect, this advantage requires a monitoring of monitoring and some way to resolve disputes, and the Western Fuels Agreement again provides an example. There, an Advisory Committee comprised of representatives from each of the districts involved in the agreement and the coal and power companies reviews the monitoring program and implementation of the agreement. In an amendment to the initial agreement, the parties agreed to bargain over disputes arising during implementation.[34] Should bargaining fail, and if the dispute originates with a local government entity other than the County, the County resolves the issue with a final, binding decision. (An aggrieved party may file a notice invoking arbitration within 10 days). If the County is involved in the dispute, the problem goes directly to arbitration.

As mentioned earlier, the Advisory Committee and this dispute resolution mechanism have been tested. After problems arose with applying fiscal formulae to calculate mitigation payments, the terms of the monitoring agreement were re-negotiated. Although the re-negotiation went on for nearly a year, neither side opted for arbitration; among other things, a testimony to the alleged superiority of negotiation in making decisions about monitoring.

CONCLUSION

Designing a monitoring program which is both meaningful to the people affected by resource development and which will work is always going to be a challenge. Negotiation, however provides one way to try and meet that challenge which suits the nature of the game that is resource development. Although it is a conflict solving process common to most cultures, we know less about it works than we do about other procedures which involve third parties or the transfer of participant power.[35]. We know even less about how it works in the making of policy decisions such as the design of a monitoring program.

From what we do know about negotiation, from what we know about how it works in other contexts, and particularly from what we know about how it works in the resource development context, it is possible to identify some of the issues which needs be considered if one were to recommend the negotiation of a monitoring program. We know enough to fabricate

[34]Western Fuels Agreement, Article XII.

[35]N[redacted]L. & Todd, H.F. Jr. Supra note 12

at least a framework for this rather blunt policy instrument, the dynamic nature of which may preclude precision even in the future. Nevertheless, more and more experience will allow more and more refinement and growth.

As a maker of monitoring programs, negotiation may be imperfect. It may be more craft than art or science. But given its superior ability to weave decisions from uncertainty, complexity and conflict, and to weave them with community power, it seems a worthwhile craft.

PART C

CASE STUDIES

PART C

CASE STUDIES

CASE STUDY OUTLINE

Case studies based on practical experience can provide useful lessons on the institutional, procedural, and methodological elements of EA for proponents of projects, preparers of EA documents, decisionmakers, and others involved in the EA process. Users of the sourcebook (and others) are invited to submit case studies that illustrate their experience with EA for inclusion in the sourcebook particularly for policy and program level and regional and sub-regional EA.

To the degree possible, case studies should conform to the following outline and be no longer than three pages. The area of interest should be emphasized; other areas should be accounted for in very few words. Case studies need not fit the outline in all respects in order to be useful. Please submit case studies to Sourcebook for the EA Process, U.S. EPA Office of Federal Activities (A-104), Washington, D.C. 20460.

Outline for Case Studies

The main elements of the study are summarized as follows:

Title:
Type of action:
Action characteristics:
Proponent:
Competent authority:
Main environmental impacts involved:
Decision/results

I. General Information on the Action
II. Planning Process (regulations, responsibility, screening, etc.)
III. Initiation of the EA Process (history of the process)
IV. Responsibility for Preparation of the EIA
V. Content of the EIA (may be table of contents)
VI. Description of the Proposed Action and Alternatives
VII. Selection Process for Alternatives
VIII. Description of the Existing Environment (what aspects were addressed?)
IX. Scoping
X. Description of the Environmental Impacts of the Proposed Action, Alternatives, and Assessment (comparison)
    (a) Impact identification
    (b) Methods used for predicting impacts
    (c) Methods used for comparing the environmental effects of the various alternatives
XI. Review and Public Participation
XII. Decisionmaking
XIII. Monitoring
XIV. Time/Costs

LISTING OF CASE STUDIES

- **Case Study on the Application of EIA Methodologies to the Phoenix Pulp Mill Project in Thailand.** (Source: Lohani, B.N., and N. Halum. 1987. Recommended methodologies for rapid environmental impact assessment in developing countries: experiences derived from case studies in Thailand. In: Environmental Impact Assessment for Developing Countries (eds. A.K. Biswas and Q. Geping). Tycooly International, London. 232 pp.)

CONCLUSION

The EIA is not only intended to identify impacts which will result from implementation of a project, but is also an effective planning tool in environmental management. The purpose of EIA is by no means to inhibit economic development. In fact its aim is to enhance economic development. The EIA identifies potential negatives which may on a long-term basis require substantial economic expenditure for solutions. Environmental management plans should include impact studies for prevention, minimization or mitigation of negative impacts, and enhancement of positive impacts.

It may be understandable that developing countries may not have enough data, manpower and budget to undertake elaborate impact studies. However, some of the rapid identification techniques like the use of checklists and matrices in conjunction with a set of established guidelines should be encouraged for wider cases, as they could be of significance as a first step in identifying major impacts which have detrimental impacts on the environment. Developing countries should also try to draw up checklists and matrices as guidelines for examining development projects, some countries such as Thailand having already accomplished such guidelines.

References

Canter, L. W., (1977). *Environmental Impact Assessment*. New York: McGraw-Hill

Dee, N., *et al.*, (1979). *Environmental Evaluation System for Water Resources Planning*. Columbus, Ohio: Battelle Columbus Laboratories

Evans, J. W., (1979). *Environmental Impact Assessment in Thailand: An Environmental Planning Tool*. UNAPDI Regional Workshop on Area Development Planning and Environment, Bangkok, August

Evans, J. W., (ed.), (1980). *Proceedings and Report on In-House Workshop on Environmental Impact Evaluation*. Bangkok: National Environment Board

Evans, J. W., (1982). *Rapid Techniques for Environmental Impact Assessment and their Application in South-East Asian Countries*. Inter-Country Workshop on Rapid Assessment Techniques for Environmental Assessment in Developing Countries, sponsored by WHO/SEARO in collaboration with the NEB and AIT, Bangkok

A Feasibility Study: 70,000MT/YR. Pulp Mill for Phoenix Pulp and Paper Company Limited (1975). Bangkok

Holling, C. A., (ed.), (1978). *Adaptive Environmental Assessment and Management*. Chichester, UK: John Wiley

Hufschmidt, M., and Carpenter, R. A., (1980). *Natural System Assessment and Benefit-Cost Analysis for Economic Development*. Hawaii: East-West Centre

Leopold, L. B., *et al.*, (1971). *A Procedure for Evaluating Environmental Impact*. US Geological Survey Circular 645. Washington, DC

Lohani, B. N., (1980). Environmental Impacts of Rural Transformation Activities and their Assessment, in Singh, R. L. and Singh, P. B. (ed.), *Rural Habitat Transformation in World Frontiers*. NGSI publication no. 30, ICRHS pub. 4

Lohani, B. N., and Arceivala, S. J., (1982). *Checklists and Matrices for Rapid Assessment of Environmental Impacts*. Inter-Country Workshop on Rapid Techniques for Enviromental Assessment, AIT, Bangkok, January

Lohani, B. N., and Kan, S. A., (1982). *Environmental Evaluation System for Water Resources Projects in Thailand: Water Supply and Management*. Oxford, UK: Pergamon Press

Lohani, B. N., and Thanh, N. C., (1980). Impacts of Rural Development and their Assessment in Southeastern Asia. *Environmental Conservation*, 7 (3), Winter

Ludwig, H. F., (1982). Environmental Aspects of Multipurpose Reservoir Projects in Developing Countries. *Water Science Technology*, 14, pp. 269–88

McHarg, I., (1968). *A Comprehensive Highway Route-Selection Method. Highway Research Record*. 246. Washington, DC: Highway Research Board, pp. 1–15

Mekong Committee, (1982). *Nam Pong Environmental Management Research Project. Final Report for Phase II*. Bangkok, April

NEB, (1979). *Manual of NEB Guidelines for Preparation of Environmental Impact Evaluation*. Bangkok

Phillip and DeFillipi, J. A., (1976). A Matrix Approach for determining Wastewater Management Impacts. *WPCF* 48 (7)

Rau, J. G., and Wooten, D. G., (1980). *Environmental Impact Analysis Handbook*. New York: McGraw-Hill

Seatec *et al.*, (1978). *Environmental and Ecological Investigation of Pattani Multipurpose Project*. Vols. I–III, October

UNEP, (1982). *The Use of Environmental Impact Assessment for Development Project Planning in ASEAN Countries*. Bangkok: Regional Office for Asia and the Pacific

UNEP and UNAPDI, (1980). *Environmental Impact Statements: A Test Model Presentation. Bangkok*

Warner, M. L., and Preston, E. H., (1974). *Review of Environmental Impact Assessment Methodologies*. Washington, DC: US Environmental Protection Agency

Welch, H. W., and Lewis, G. D., (1979). An Approach to Assessment. *Journal of Environmental Management* 2

ANNEX

Case Study on the Application of EIA Methodologies to the Phoenix Pulp Mill Project in Thailand

THE PHOENIX PULP MILL PROJECT

The proposed project is a pulp mill which will use kenaf as the basic raw material to produce 70,000 t/year (tonnes per year) of bleached and unbleached pulp. The project requires a land area of 1,065 rai (625 Rai = 1 km^2). The annual requirement of kenaf for the proposed mill would be 200,000 t.

The basic raw material include the cellulosic raw material kenaf and process chemicals (sodium sulphate, caustic soda, chlorine, chlorine dioxide, lime, sulphur, alum and water). The raw water supply is from the Nam Pong River. The water requirement will not exceed 0.7 m^3/sec. It will be treated to meet the water quality standards for industrial use, with a fraction treated to meet domestic use water quality standards.

Figures 2.8 and 2.9 show the location of the Phoenix Pulp Mill and the proposed resettlement area.

Figure 2.8. Plant site location

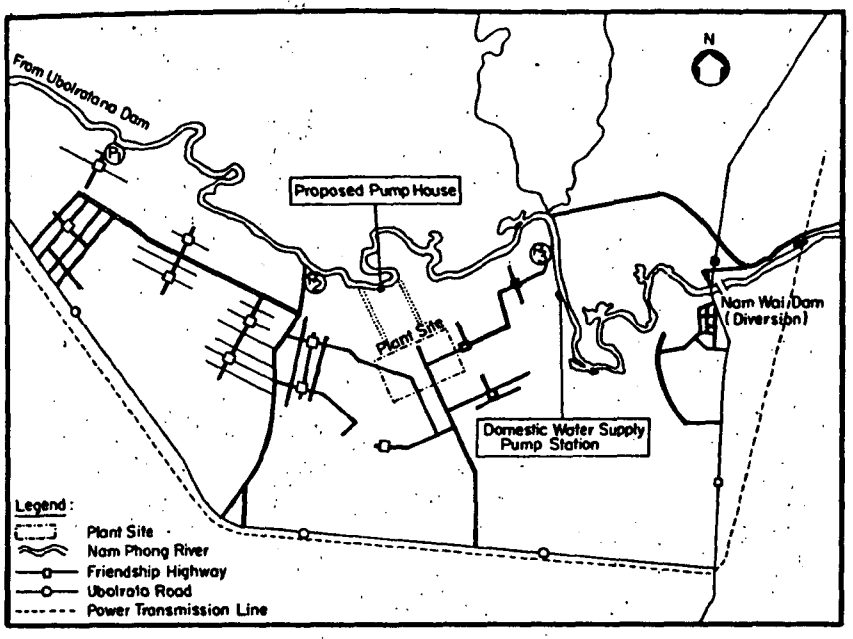
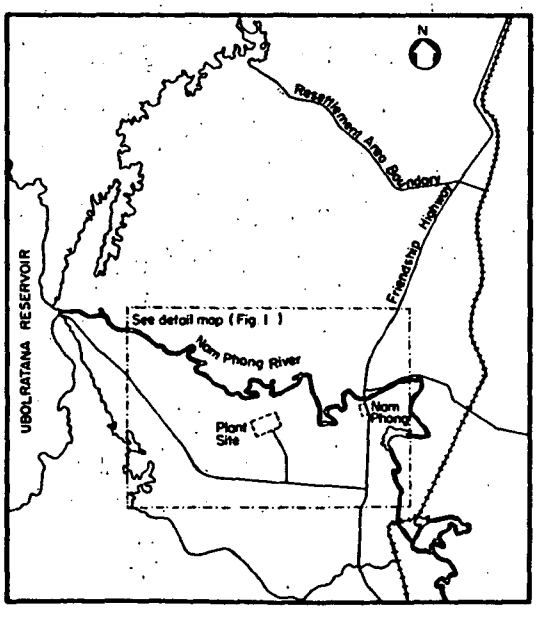


Figure 2.9. Plant site and general Ubolratana resettlement area



EXISTING ENVIRONMENTAL CONDITIONS

Physical resources. Most of the tributaries in the project area are intermittent streams, including the Huai Chot; which is the drainage course for the plant site. The Huai Chot is dry during drought seasons, and water quality in some parts is not suitable for domestic use.

Both the air quality and land quality (pollution) of the area are good. There are no mineral resources in the immediate project area.

Ecological resources. Fisheries and aquatic ecosystems are not significant in the Nam Pong river in the project area. Terrestrial wildlife populations are low or absent in the project area.

Human use values. The land use in the project area is mainly agricultural. Known water uses are domestic water supply, agricultural water supply (including a large irrigation district), fisheries, and industrial water supply.

Quality-of-life values. In the project area the average annual income is 6,169 Baht (CUS$1=22.7 Baht).

APPLICATION OF MATRICES

Different types of environmental impact matrices have been tried and they are briefly described here.

Discussion on the Simple Environmental Impact Matrix

Table 2.14 is a simple environmental impact matrix for the Phoenix Pulp Mill. Activities such as wastewater discharge will have impacts on several environmental components, such as surface water quality, fisheries, aquatic ecology, water supply and health. The use of pesticide and fertilizer will affect the surface water quality, fisheries, aquatic ecology and water supply. Other project activities such as solid waste disposal, plant construction, etc. will have impacts on few environmental parameters.

It may be noted that the technique does not provide information on the magnitude and importance of impact, the nature of impact, and whether adverse or beneficial, etc.

Discussion on Graded Matrix

Table 2.15 shows the graded matrix for the proposed Phoenix Pulp Mill Project.

Effect of effluent discharge on surface water quality. The project proponent has already included the wastewater treatment facilities that are expected to give effluent

Table 2.14. Simple environmental impact matrix for the Phoenix pulp mill project

Environmental components \ Project activities	Plant construction	Farming of kenaf	Use of pesticide fertilizer	Transportation of raw materials	Water intake	Solid waste	Effluent discharge	Emission	Employment
Surface water quality			X			X	X		X
Surface water hydrology					X				
Air quality				X				X	
Fisheries			X				X		
Terrestrial wildlife habitat	X								
Terrestrial wildlife	X								
Land-use pattern		X							
Highways/railways				X					
Water supply			X				X		
Agriculture		X							
Housing									X
Health						X	X	X	
Socio-economic conditions									X

Table 2.15. Graded environmental impact matrix for the Phoenix pulp mill project

Effects on \ Project activities	Plant construction	Farming of kenaf	Use of pesticide fertilizer	Transportation of raw materials	Water intake	Solid waste	Effluent discharge	Emission	Employment	Total
Surface water quality			6 7			4 4	2 8		5 5	17 24
Surface water hydrology					1 7					1 7
Air quality	3 6			2 6				4 5		9 17
Fisheries			2 5				2 7			4 12
Aquatic ecology			2 6				2 5			4 11
Terrestrial wildlife habitat	3 4									3 4
Terrestrial wildlife	2 5									2 5
Land-use pattern	5 6	8 7								13 13
Highways/railways				6 5						6 5
Water supply			3 6				2 7			5 13
Agriculture		7 7								7 7
Housing									7 6	7 6
Health						3 5	2 8	2 6		7 19
Socio-economic conditions		10 8							8 8	18 16
	13 21	25 22	13 24	8 11	1 7	7 9	10 35	6 11	20 19	

with pollutant concentration as follows: BOD,8 ppm; SS,10 ppm; DS,10 ppm; pH,7–8; temperature, 37°C. These are well within the allowable limits in the effluent standard. Thus a negligible impact of magnitude 2 is considered in the matrix.

Effect of farming on surface water quality. Increased kenaf production may result in increased use of pesticides and fertilizer, which if not properly used will lower the surface water quality. An impact of magnitude 6 with importance of 7 is thus assigned.

Effect of emission on air quality. Since control measures are incorporated in all the equipment, the impact on air quality can be regarded as insignificant and of magnitude 4.

Effect of effluent discharge on fisheries and aquatic ecology. With the proposed wastewater treatment facilities, the effluent will have only minor effects on both fisheries and aquatic ecology and may be denoted by an impact magnitude of 2.

Effect of kenaf farming on agriculture. The agricultural industries will benefit from the proposed project because there will be a steady demand for kenaf. This is considered a major positive impact and is rated here as of magnitude 7.

Discussion on Modified Matrix

Table 2.16 shows the environmental baseline evaluation. Among the physical resources, surface water quality, air quality, soil erosion and sedimentation have an importance of 5, with also very good present conditions as denoted by scale 5. In the human interest category, socio-economic and health factors have an importance of 5, and the present condition is of scale 3.

Table 2.17 shows the environmental compatibility matrix. Four of the human interest parameters (land-use pattern, agriculture, socio-economic, highways) are positively significantly impacted by the project.

Table 2.18 shows the decision matrix, denoting that most of the significant impacts of the project on environmental parameters are positive. The negative impacts are contributed mainly to ecological and physical resources. The human interest parameters are positively and significantly impacted, and the present condition for most of them is unfavourable; this can be easily explained by the lack of development of the region. Hence the project could be approved on environmental grounds.

CHECKLIST APPLICATION

A checklist which provides a qualitative assessment of the project as beneficial or adverse, reversible or irreversible, short-term of long-term, and of local or wide impact has been developed and is presented in Table 2.19.

The ecology of the area is unlikely to be disturbed. Since there is no evidence of rare and endangered species, such an impact will be minor. Siltation is a long-term effect resulting mainly from erosion of kenaf farmland. Air pollution abatement

Table 2.16. Environmental baseline evaluation of the Phoenix pump mill project

	Environmental parameters	Scale of importance					Scale of present condition					Scale of management				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Ecological	Terrestrial wildlife habitat			■				■						■		
	Terrestrial wildlife			■				■						■		
	Rare & endangered species (terrestrial)		■				■							■		
	Fisheries				■			■								■
	Rare & endangered species (aquatic)		■				■							■		
Physical resources	Surface water hydrology				■						■					■
	Surface water quality					■				■						■
	Groundwater quality			■						■					■	
	Air quality					■					■					■
	Soil erosion					■					■					■
	Sedimentation					■					■					■
Human interest	Land-use pattern				■					■						■
	Highways/railways			■					■						■	
	Navigation															
	Water supply				■					■						■
	Power supply			■				■							■	
	Ariculture				■				■							■
	Housing															
	Health					■			■							■
	Socio-economic conditions					■			■							■

Table 2.17. Environmental compitability matrix for the Phoenix pulp mill project

Environmental parameters \ Project activities	Construction					Plant operation					Related activities		
	Site clearing	Highway/ access road	Transportation	Drilling & blasting	Plant construction	Wastewater discharge	Air emissions	Water intake	Power supply	Solid waste disposal	Housing	Employment	Kenaf farming
Ecological													
Terrestrial wildlife habitat	-2L	-2L			-3L					-1L			
Terrestrial wildlife	-2L	-2L			-3L								
Rare & endangered species (terrestrial)													
Fisheries	-3S					-3L							-4L
Rare & endangered species (aquatic)													
Physical resources													
Surface water hydrology								-2L					
Surface water quality	-4S				-4S	-3L						-2L	-3L
Groundwater quality										-2L			
Air quality	-4S		-3L	-4S			-3L						
Soil erosion	-4S												-5L
Soil fertility													
Sedimentation	-4S												-4L
Human interest													
Land-use pattern													-5L
Highways/railways		+5L											
Navigation													
Water supply						-3L							
Agriculture													+5L
Housing													
Health	-4S			-4S		-3L	-2L			-2L	+3L		
Socio-economic conditions									+2L		+3L	+5L	+5L
Power supply													

Table 2.18. Decision matrix for the Phoenix pulp mill project

Environmental parameter	Project alternative: No project	With the project
Terrestrial wildlife habitat	2	–3L
Terrestrial wildlife	2	–3L
Rare & endangered species (terrestrial)	1	–
Fisheries	2	–4L
Rare & endangered species (aquatic)	1	–
Surface water hydrology	5	–2L
Surface water quality	4	–3L
Groundwater quality	4	–2L
Air quality	5	–3L
Soil erosion	5	–5L
Sedimentation	5	–
Land-use pattern	4	+5L
Highways/railways	3	+5L
Navigation	–	–
Water supply	4	–3L
Power supply	2	–
Agriculture	3	+5L
Housing	–	+3L
Health	3	+3L
Socio-economic conditions	3	+5L

measures will be adequately provided in the mill operation. Thus pollution due to gaseous emission will be well within the standard value. The wastewater discharge will be adequately treated to meet the effluent water quality standards, and the impact can be considered negligible.

The project will provide a stable source of income for 20,000 farmers and employ directly 700 workers, leading significant beneficial impact on the socio-economic sector.

ASSESSMENT USING THE UNEP TEST MODEL

In presenting this section, the format recommended by the UNEP document is followed.

Introduction

The proposed Phoenix Pulp Mill will use kenaf as the basic raw material to produce 70,000 t/year of bleached and unbleached pulp. The project requires a land area of 1,000 rai. The water requirement will not exceed 0.7 m^3/sec. Approximately 80 per

Table 2.19 Checklist for the Phoenix pulp mill project

Items	Nature of likely impacts: Adverse: Short-term*	Long-term	Reversible	Irreversible	Local	Wide	Beneficial: Short-term	Long-term	Significant	Nominal
Ecology	X			X	X					
Fisheries	X		X		X					
Siltation		X		X	X					
Erosion		X		X		X				
Air quality	X			X		X				
Surface water quality		X	X		X					
Surface water hydrology		X	X		X					
Land-use pattern								X	X	
Highways/railways								X		X
Agriculture								X	X	
Housing								X		X
Health								X		X
Socio-economic conditions								X	X	

* Here the short-term impact would mean the impact during the construction period. Impacts persisting during the project life (ten years) are considered long-term effects.

cent of the water will be returned as wastewater. The final discharge will be drained into a small stream (Huai Chot) with treated discharge of 0.63 m^3/sec.

The project is considered to be serving the national interest for the following reasons:

1. providing a reliable income for about 20,000 farmers and 700 workmen;
2. saving foreign exchange;
3. reducing dependency on foreign pulp and paper;
4. providing a new market for kenaf;
5. providing for efficient utilization of kenaf.

It may be emphasized at this point that kenaf is an important cash crop and sometimes the only cash crop of thousands of farmers in north-east Thailand.

Cost-Benefit Presentation

The cost and benefits of the project, as they emerge from the data extracted from the feasibility study of the project, are presented in tabular form. The data have been organised in separate tables under different headings, such as resources used directly, indirectly affected, exhausted, enhanced, etc.

The costs and benefits from an economic point of view are presented separately from those arrived at from an environmental viewpoint. The economic assessment has to be made on the basis of sort of commercial balance sheet, whereas environmental assessment deals with social and other benefits in which some items may be

presented as cost in the economic analysis; for example, wages paid may be a benefit socially in the form of an employment created and consequent expectation of an improved quality of life.

The main difficulty in this technique of analysis is the necessity of assigning money values to every item of cost and benefit. In some instances assumptions are made which are based on individual judgement and can easily introduce considerable error in the cost-benefit results.

Assessment

The Phoenix Pulp Mill as indicated in the cost-benefit analysis comes out as a profitable and socially highly viable enterprise. For an investment cost of US$50 million (Table 2.20), employment is generated for 20,000 farmers and 700 workers. An average of about 200,000 tonnes of kenaf valued at US$5.9 million, will be processed each year.

Economic damage due to the degradation of river water quality is considered to be negligible since the wastewater treatment scheme will meet effluent standards. In addition, the proponent is planning to determine an appropriate technique for wastewater reuse in kenaf plantation and a process for lime mud burning to reclaim calcium oxide for reuse in the pulping process – this may reduce solid waste by approximately 65–70 per cent. It is expected that 75,000 t of pulp will be produced annually, and this corresponds to a foreign exchange saving of US$31.5 million annually. The gain to farmers and workers due to employment generation is estimated to be US$4.24 million and $1.3 million respectively.

From the economic point of view, the benefit/cost ratio is 1.21:1 (Table 2.20). Environmentally, the project is seen to generate benefit of US$5.6 million annually (Table 2.21). This is wholly accounted for by considering incomes of 20,000 farmers in the north-east and wages of 700 workmen in the project and the resulting improvement in the quality of life. Owing to unavailability of data, the cost due to soil erosion is not included in the analysis.

Table 2.20. (a): Economic costs and benefits: investment stage (I)

Reference	Item	Costs US$ million p.a.	Benefit US$ million p.a.
IIa(1)1	Land	0.15	
IIa(1)4	Civil construction	3.5	
IIa(1)5	Plant and machinery	32.5	
IIa(1)6	Erection	2.45	
IIa(1)11	Site development	0.575	
IIa(1)12	Engg. services and technical know-how	1.0	
IIa(1)13	Pre-operative expenses	1.14	
IIa(1)14	Miscellaneous fixed assets	0.40	
IIa(1)16	Start-up expense	1.5	
IIa(1)15	Pre-operational interest and others	6.5	
	Total	50.0	

Table 2.20. (b): Economic costs and benefits: production stage (II)

Reference	Item	Costs US$ million p.a.	Benefit US$ million p.a.
IIa(1)2	Kenaf	5.9	
IIa(1)3	Chemicals		
IIa(1)7&8	Utilities		
IIa(1)9	Labour	1.4	
IIa(1)10	Repair and maintenance	0.42	
IIa(1)17	Contingency	0.829	
IIa(1)18	Overhead and insurance	0.42	
IIa(1)19	Depreciation	3.84	
IIa(1)20	Amortization	10.629	
IIa(1)21	Interest	1.51	
IIa(1)22	Selling expenses	0.499	
IIa(1)23	Transportation charges up to Bangkok	0.56	
	Cost of pulp sold		31.5
	Total	26.021	31.5

Total cost I + II = $86.021 million p.a.; total benefit = $31.5 million p.a.

Table 2.21. Environmental costs and benefits

Reference	Item	Costs US$ million p.a.	Benefit US$ million p.a.
IV–2	Stable source of income created for 20,000 farmers in north-east. Thailand (improved quality of life		4.2
IV–3	Provide direct employment to 700 workmen (improved quality of life)		1.4
IIa(11)3	Lifestyle changes in adjoining area due to noise and other factors	Negligible	–
IIa(11)1	Water pollution (wastewater treatment employed)	Negligible	–
IIb(11)1	Effluent containing wood wastes	Negligible	–
IIb(11)1	Effluent containing sugar and carbohydrates	Negligible	–
III–2	Soil loss	N.A.	
	Total		5.6

N.A. Cost figures not available.

Decision-Making

The Phoenix Pulp Mill producing 70,000 t/year will provide more than half of bleached and unbleached pulp currently imported to Thailand annually and will save exchange of US$31.5 million.

Kenaf as a jute substitute is a foreign exchange earner for Thailand, but the fibre has been subjected to fluctuation in price and demand on the international market, and the long-range trend is not encouraging. The new market for kenaf provided by this project will add stability to this important segment of Thai economy and greatly add to the well-being of the farmers.

Environmentally, the project may result in major negative impacts if pollution abatement measures are not adequate. The major impacts can be minimized by the proposed mitigation measures, and their effectiveness can be determined by the monitoring programme.

The benefit/cost ratio, from both the economic and the environmental point of view, indicates the project to be a profitable one.

Appendix*

Description of the Project

Nature: Industrial

Title: The Phoenix Pulp Mill

Time span: Amortization over ten years

Physical Boundary: The proposed project is located in the Ubolratana Self-Help Resettlement Area near Bank Non Noi, Changwat Khon Kaen, north-east Thailand (Figures 2.8 and 2.9). The project requires a land area of 1,000 Rai(1 km^2 = 625 Rai). About 170,000 Rai of land will be under cultivation for the proposed project.

Cost

Table 1. Products and Values

Products	Quantity	Value (US$ m)
Pulp	70,000 t/year	3.5 p.a.

The various operations involved in pulping are as follows:

1. chipping/cutting
2. chip washing or dust removal
3. cooking/digestion/segregation of fibre
   (a) mechanical pulping
   (b) semi-chemical/chemi-mechanical pulping
   (c) chemical pulp
4. washing of cooked pulp
5. screening and cleaning
6. bleaching
7. finer cleaning for bleached grade pulp.

The basic raw materials include the cellulosic raw kenaf and process chemicals (sodium sulphate, caustic soda, chlorine, chlorine dioxide, lime, sulphur alum and water). The water requirement will not exceed 0.7 m^3/day.

The preliminary wastewater treatment scheme provides a maximum treatment capacity of 48,000 m^3/day, based on projected daily wastewater load of 35,000 m^3/day and a peak load of 48,000 m^3/day.

The resources used are kenaf crop, processing and mill premises and facilities, effluent treatment plant, and water for processing. The main resources indirectly affected are the rivers from which process water is drawn and into which effluents are discharged.

* This section is written as recommended in the UNEP document (UNEP and UN[illegible], 1980).

(a): Resources

Serial no.	Item	Quantity	Rates $/unit	Total (US$ m)
Used directly				
IIa(1)176	Contingency @ 5% (kenaf, chemicals, utilities, labour)			0.829
IIa(1)18	Overhead and insurance			0.42 p.a.
IIa(1)19	Depreciation			
	(11) on building @ 5% (value US$4,128,000)			0.206 p.a.
	(b) on machinery @ 10% (value US$36,350,000)			3.635 p.a.
IIa(1)20	Amortization @ 10% (on US$6,290,000)			0.629 p.a.
IIa(1)21	Interest			
	(a) on purchaser's credit @ 9.5%			1.043 p.a.
	(b) on short-term loan @ 12%			0.463 p.a.
IIa(1)22	Selling expenses, e.g. advertisement			0.494 p.a.
IIa(1)23	Transportation charges			0.56
IIa(1)1	Land for mill premises	1,000 Rai	150/Rai	0.15
IIa(1)2	Kenaf	200,000 t	29.5/t	5.9 p.a.
IIa(1)3	Chemicals	48,920 t		5.6 p.a.
IIa(1)4	Civil work			3.15
IIa(1)5	Equipment and machinery			3.25
IIa(1)6	Erection			2.45
IIa(1)7	Power (purchased) 28×10^6 kWh		0.0225	0.63 p.a.
IIa(1)8	Fuel oil		75/kl	3.02 p.a.
IIa(1)9	Labour			1.4 p.a.
IIa(1)10	Maintenance			1.155 p.a.
IIa(1)11	Site development			0.575
IIa(1)12	Engineering services			1.0
IIa(1)13	Pre-operative expenses			1.14
IIa(1)14	Miscellaneous fixed assets			0.04
IIa(1)15	Pre-operational interest and others			6.5
IIa(1)16	Start-up expense			0.2
IIa(1)17a	Contingency (price escalation, construction and building)			1.5
Affected directly				
IIa(11)1	Reduction in quality of river (Huay Chot) in which the effluents are discharged *		Negligible	

IIa(11)2	Land (due to solid wastes) †	Negligible
IIa(11)3	Lifestyle changes in adjoining areas due to noise and other factors	N.A.
IIa(11)4	Land for kenaf cultivation	25.2‡

* Treated discharge of 0.63 m^3/sec, having BOD: 8 ppm, SS: 10 ppm, DS: 10 ppm. These are lower than the effluent standard for discharge.

† Although cost figures are not available, the proponent planning to reduce 65–70% of solid waste by recycling and reuse.

‡ Unit cost of land is assumed to be the same as that provided for mill premises.

N.A. Cost figures not available.

(b): Products and Residues

Serial no.	Item	Quantity	Rate US$/unit	Total (US$ m)
Products				
IIb(1)1	Pulp	70,000 t/ year	450/t	3.5 p.a.
Residues				
IIb(11)1	Solid wastes			N.A.
IIb(11)2	Effluent containing suspended fibres and soluble organics consisting mainly of sugar, carbohydrates and related compounds			N.A.

N.A. Cost figures not available.

(c): Resources Exhausted, Depleted, Deteriorated

Serial no.	Item	Quantity	Rate	Total (US$ m)
III–1	River into which effluents are discharged: (a) effect on fish and acquatic life and other uses (b) loss of water quality for local purposes			Negligible
III–2	Soil loss due to erosion during the interval between replanting			N.A.

* Wastewater treatment facilities incorporated.

N.A. Cost figures not available.

(d): Resources Enhanced and Residues, Utilized

Serial no.	Related serial no. in section II	Item	How enhanced	Quantity rate	Total US$ m
IV–1	IIa(1)2	Kenaf	More efficient utilization *	Pulp 70,000 t/year	3.5 p.a.
IV–2		Gain to 20,000 farmers in the north-east	Increase the economic well-being of the farmers		4.24 p.a.
IV–3		Provide direct employment	Directly employ 700 workers of all categories		1.4 p.a.

* When used as a jute substitute, only the outer layer of the kenaf stalk can be utilized. For pulping, the entire stalk is consumed.

† As a jute substitute, the price of kenaf is subjected to fluctuations of international markets, and economic repercussions of unstable market have been severe. The project will provide stability and add to the economic well-being of the grower.

(e): Resource Restoration, Maintenance and Expansion

Serial no.	Related serial no. in sections II/III	Item	What should be done	Cost thousand US$ p.a.
V–1	IIb(11)1	Solid wastes	Separation of wood which can be used for energy production through pyrolysis* (reclaiming calcium oxide from lince mud)	N.A.
V–2	IIb(111)2	Effluent containing soluble organics such as sugar, carbohydrates and related compounds	Recovery of sugar, carbohydrates and related compounds which can be used as animal feed	N.A.
V–3	III–2	Soil loss due to erosion during the interval between planting	Establishment of plant cover, e.g. leguminous	N.A.

* The proponent of the project is exploring appropriate techniques for this which would finally reduce solid waste by 65–70 per cent.

N.A. Cost figures not available.

PART D

SELECTED ENVIRONMENTAL LAWS AND REGULATIONS

SELECTED U.S. ENVIRONMENTAL LAWS AND REGULATIONS

- **Facts About the National Environmental Policy Act.** U.S. Environmental Protection Agency. September 1989.

- **Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.** (Source: 40 Code of Federal Regulations Parts 1500 - 1508)

- **Council on Environmental Quality Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations.** (Source: 46 Federal Register 18026 - 18038, March 23, 1981)

- **Summaries of Related U.S. Environmental Laws.** (Source: EPA, Cross-Cutting Environmental Laws: A Guide For Federal/State Project Officers, 21E 4001, January 1991)

- **States with Environmental Policy Acts.** (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

- **States with Limited Environmental Review Requirements Established by Statute, Executive Order, or Other Administrative Directives.** (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

OTHER LAWS AND REGULATIONS (insert state, tribal, or other national laws and regulations as appropriate)

PART E

GLOSSARY

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ANALYSIS — Analysis is a formal, more or less objective task of using quantitative techniques to estimate the changes that are likely to occur as a result of a proposed action.

ASSESSMENT — As used in this sourcebook, assessment refers to analyzing and evaluating the potential impacts of proposed actions on the environment.

BASELINE (EXISTING AND FUTURE) — Existing baseline conditions are the current conditions of an area potentially affected by the proposed action. Existing baselines are established prior to construction and operation of a proposed project in order to evaluate the effects of the project. Future baseline conditions are based on current conditions and reasonably foreseeable future conditions (e.g., 20 to 50 years hence) of an area without the project. Future baselines are the basis for a no-action alternative to which other alternatives are compared.

CATEGORICAL EXCLUSION (CX) — CX means a category of actions which do not individually or cumulatively have a significant effect on the human environment and for which, therefore, an EA nor an EIS is required.

CUMULATIVE EFFECTS — Cumulative effects (impacts) are those resulting from the incremental effects of an action when added to other past, present, and reasonably foreseeable future federal or non-federal actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

EFFECTS/IMPACTS — Effects and impacts as used in this sourcebook are synonymous. Effects can be ecological (such as the effects on components of natural resources, the structure and/or functioning of affected ecosystems), aesthetic, historic, cultural, economic, and social and health, whether direct, indirect or cumulative.

ENDPOINTS — An endpoint is a characteristic of an ecological component that may be affected by the proposed action. Two types of endpoints can be distinguished. Assessment endpoints are explicit expressions of the actual environmental value that is to be protected (e.g. a decline in a sport fish population). Measurement endpoints are measurable responses to a contaminant or disturbance that are related to the valued characteristics chosen as the assessment endpoints (e.g., increased mortality in fish). Effective environmental assessment depends on clearly stated linkages between measurement endpoints, assessment endpoints, and the basic objective of the assessment (e.g., policy goals). Information compiled during the initiation and scoping phases of EA is used to help select endpoints that are relevant to decisions made about protecting the environment.

ENVIRONMENTAL ASSESSMENT (EA) — For purposes of this sourcebook, EA is the process of examining proposed projects and their reasonable alternatives for potential

environmental impacts prior to making decisions on implementation. EA is the most all encompassing of the assessment traditions because of the diversity of activities to which it is applied and because the law requires that it identify the full range of affected environmental components, define the geographical and temporal extent of effects, and identify secondary and even, tertiary effects.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) — For purposes of this sourcebook, an EIA is a report that documents the EA process for a proposed activity. In the U.S., an EIA is a formal document, either an environmental assessment (EA) or an environmental impact statement (EIS). Elsewhere, an EIA has a variety of names; it may be a formal document or the information may be dispersed in different parts of other documentation. In the sourcebook, EIA is used for a document that results from the formal EA process. "EA document" is used when the document can be an EIA or a lesser document.

ENVIRONMENTAL RISK ASSESSMENT — Environmental risk assessment deals with risks that arise in or are transmitted through the air, water, soil or biological food chains to man.

EVALUATION — Evaluation is a subjective task that depends on the application of human values. It involves determining the significance of the potential impacts to the affected and interested parties.

FATE MODELS — Compartmental models that estimate the relative distribution of pollutants among environmental compartments (e.g., air, soil, water, sediment, biota). These models are based on the tendency of a chemical to escape from one chemical phase into another.

FINDING OF NO SIGNIFICANT IMPACT (FNSI) — A document briefly presenting the reasons why a proposed action will not have a significant effect on the environment and thus an EIA will not be prepared.

MULTI-COMPARTMENT MODELS — Models that account for transfers of chemicals among different media (known as partitioning) and exposures from multiple environmental pathways. Most multi-compartment models consist of linked, single-medium models, which may simulate the physical and chemical processes that drive the transport of chemicals across air/water, air/soil, and water/soil interfaces. The data requirements for such models are substantial, and scientific understanding of intermedia transport processes is still embryonic.

INDIRECT EFFECTS — Indirect effects are those caused by an action that are later in time or farther removed in distance, but that are still reasonably foreseeable (e.g., development in undisturbed areas as a result of road building for logging purposes.

NON-GOVERNMENTAL ORGANIZATION (NGO) — NGO is a general term for organizations outside of government agencies such as public organizations and environmental interest groups.

PROPONENT — The entity responsible for a proposed action. For purposes of this sourcebook, agency and proponent are synonymous because in the U.S., NEPA and its EA requirements apply only to federal agencies. Private applicants for federal grants or permits or other federally assisted activities may submit environmental information for use by the agency in preparing an EA document, but the agency must evaluate the information and assume responsibility for its accuracy.

RISK ASSESSMENT — A general term for techniques to estimate the likelihood (or probability) and the severity of harm to human health and the environment occurring from exposure to a risk agent. It includes a variety of quantitative and qualitative techniques used in engineering, toxicology, epidemiology, sociology, and economics.

U.S. ENVIRONMENTAL ASSESSMENT (EA) — In the U.S., an EA is a concise public document that provides sufficient information for determining whether to prepare an EIS or a finding of no significant impact (FONSI).

U.S. ENVIRONMENTAL IMPACT STATEMENT (EIS) — In the U.S., an EIS is a detailed public document that provides full and fair discussion of significant environmental impacts and informs decisionmakers and the public of reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment. It is used by federal officials to plan actions and make decisions.

PART F

COMPUTER SOFTWARE

PART F

ENVIRONMENTAL ASSESSMENT RESOURCE GUIDE*

*Part F is a computer software supplement to this sourcebook. Disks will be provided to recipients of the sourcebook when the computer software program is completed.