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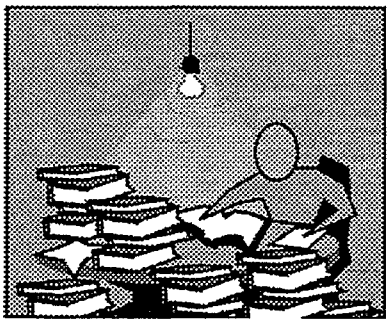

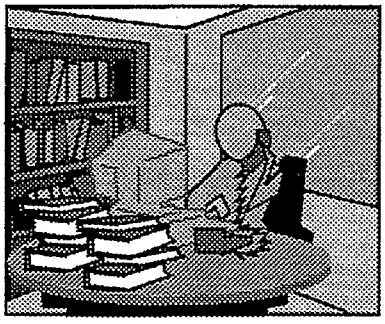

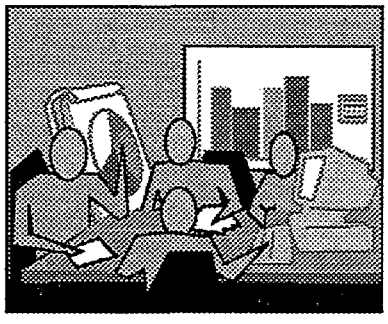

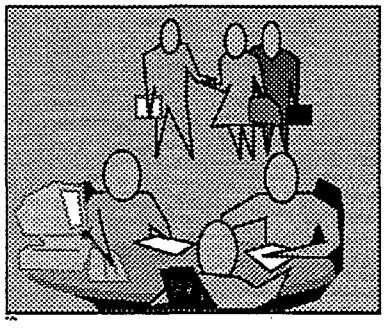

# RESOURCE MANUAL FOR ENVIRONMENTAL IMPACT ASSESSMENT REVIEW

**July 1998**

**U.S. Environmental Protection Agency**
**Office of Federal Activities**
**1200 Pennsylvania Avenue, MC-2251-A**
**Washington, D.C. 20460**

# RESOURCE MANUAL FOR ENVIRONMENTAL IMPACT ASSESSMENT REVIEW OVERVIEW

This Resource Manual was developed as a reference for professionals who expect to be involved in the review and evaluation of environmental impact assessments. It supplements the course student text: *"Principles of Environmental Impact Assessment Review"*.

Generic elements of the environmental impact assessment (EIA) process are emphasized so that the resource manual is of use internationally to federal, state, tribal and local agencies within and outside of the United States and both government officials and non-governmental organizations involved in EIA review.

The resource manual is organized into seven sections:

**Section 1** covers the major activities that are required for a successful environmental impact assessment. These include: project initiation, scoping, assessment, decision-making, and post-decision analysis. Section 1 is based upon the *Sourcebook For The Environmental Assessment Process*, September 1993 (Second printing, November 1994). This document was prepared by USEPA with the Oakridge National Laboratories in an interagency effort to provide, for the first time, a one-stop reference source to meet the demand for information on the environmental impact assessment process. It benefitted from international peer review as well. Minor modifications made to the original Sourcebook text bring it up to date and make it consistent with the *Principles of Environmental Impact Assessment Review* Student Text.

Under each activity, there is a **subsection** which describes needs, tools, issues, linkages and references:

- The **needs** subsection highlights planning, information/data, and resources;
- The **tools** subsection describes methods and techniques that have been proven useful;
- The **issues** subsection identifies important points, concerns and areas where conceptual and analytical uncertainties exist;
- The **linkages** subsection calls attention to the nexus of environmental impact assessment activities;
- The **references** subsection provides citations to published information found to be particularly useful.

Because the sourcebook was developed in 1993, Section 1 contains some references that may not be readily available, particularly to those in foreign countries or those just starting environmental impact assessment programs.

**Section 2** showcases a matrix of environmental assessment methodologies and contains an example Environmental impact assessment evaluation checklist when conducting an Environmental impact assessment review which is also printed in the Student text. Since the Environmental impact assessment should rely on existing data, when feasible, to characterize the existing environment, the matrix of methodologies also displays various techniques that can be used to obtain the appropriate data.

**Section 3** contains a list of specific characteristics of various types of industrial discharges and a World Bank Table of project specific mitigation measures.

**Section 4** is a placeholder for information on country-specific laws and background. It now includes selected materials from the U.S. program including the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA and the CEQ responses the Forty Most Asked Questions Concerning the NEPA Regulations. During the Environmental impact assessment process, there are related environmental review and consultation requirements (*e.g.,* endangered and threatened species, historic and cultural resources) which are frequently integrated with the requirements of the National Environmental Policy Act (NEPA). This reduces duplicative effort and the potential for delays. The requirements of such laws are not addressed in this resource manual, but brief summaries of the laws are included in this section.

**Section 5** includes a list of relevant environmental impact assessment guidance developed by EPA and two examples in their entirety.

**Section 6** is a glossary of terms.

**Section 7** describes internet sites and also the contents of a compact disc resource which is included in the resource manual pocket.

The resource manual is designed to be an easy-to-use reference manual, hence there is some overlap or repetition with the student text. It is formatted to facilitate ease in updating or addition of new material.

Permission to use copyrighted materials which were included in the original *Sourcebook* was received from the following publishers as identified in the Sourcebook: Academic Press (pg. 1.6.14-1); Elsevier Science Publishing Company, Inc. (pgs.. 1.6.6-1, 1.6.10-1, 1.7.1-1 and Fig. 1.6.8-B); Environmental Law Institute

(pg. 1.4.1-1); International Association for Impact Assessment (pg. 1.8.1-1); Lewis Publishers (pg. 1.6.8-4 and Fig. 1.6.8-A); National Association of Environmental Professionals (pgs.. 1.2-1, 1.6.11-1, and 1.6.16-1); and Unwin Hyman, Ltd. (Fig. 1.6.8-C).

Slight modifications to format and content of the *Sourcebook For The Environmental Assessment Process* have been made for consistency with the *Principles of Environmental Impact Assessment Review* course including manual footnotes reference the term environmental impact assessment process to be used in lieu of the term environmental assessment process.

# RESOURCE MANUAL FOR PRINCIPLES OF ENVIRONMENTAL IMPACT ASSESSMENT REVIEW

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## PREFACE

The United States Environmental Protection Agency [U.S. EPA] is increasingly being asked for information on the environmental impact assessment decision-making process [EIA] by foreign governments, states, localities and others. In partial fulfilment of this need, the Office of Federal Activities [OFA], which has responsibility for environmental impact assessment in EPA under the National Environmental Policy Act [NEPA] and for review and comment on environmental impact statements [EISs] produced by all other U.S. federal agencies under Section 309 of the Clean Air Act [§309], produced a series of documents explaining the U.S. approach to EIA in order to meet this increased demand for information.

The purpose of the OFA/EIA program is to develop explanatory and training materials in a generic sense which convey the collective knowledge and rationale for the way the environmental impact assessment decision-making process is carried out in the United States. Documents produced by the OFA/EIA program include:

- **Bibliography and Abstract of Environmental Impact Assessment Methodologies**, December 1990 (included in Resource Manual). The bibliography focuses on the English literature in this area. The purpose of the bibliography was to assist OF in designing its program of technical assistance in the EIA process.

- **Environmental Assessment Process**, Technical Information Packet [TIP], March 1992 (EPA/600/M-91/037). This TIP is a part of a series of information packages prepared for, and distributed by EPA's INFORTERRA office. Aimed at the international community, the packages focus on key environmental and public health issues being investigated by EPA.

- **Principles of Environmental Impact Assessment**, an international training course module, September 1992, revised March 1998, English and Spanish editions. This course, consisting of a Student Text and a Facilitator's Manual, was produced in cooperation with EPA's Office of International Activities and funded through the Agency for International Development. This is one of a series of EPA training "modules" on various environmental topics, including Risk Assessment and Environmental Enforcement. All were initially targeted for delivery to Central European countries and have since then been delivered in Central and South America and Asian countries. The objective of the EPA training is to encourage host countries to use the module in turn to train others within their country.

- **Principles of Environmental Impact Assessment Review**, an international training course module, May 1998. This course, consisting of a Student Text, Facilitator's Manual and Resource Manual is designed as a follow-on to EPA's Principles of Environmental Impact Assessment training course. The purpose of this course is to instruct professionals who expect to be involved in the review and evaluation of EISs how to review these documents for consistency and completeness.

# 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 |

# SECTION 1.1

# EVOLUTION OF THE ENVIRONMENTAL IMPACT ASSESSMENT

# EVOLUTION OF ENVIRONMENTAL IMPACT 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



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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.

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# SECTION 1.2

# OVERVIEW OF THE ENVIRONMENTAL IMPACT 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.

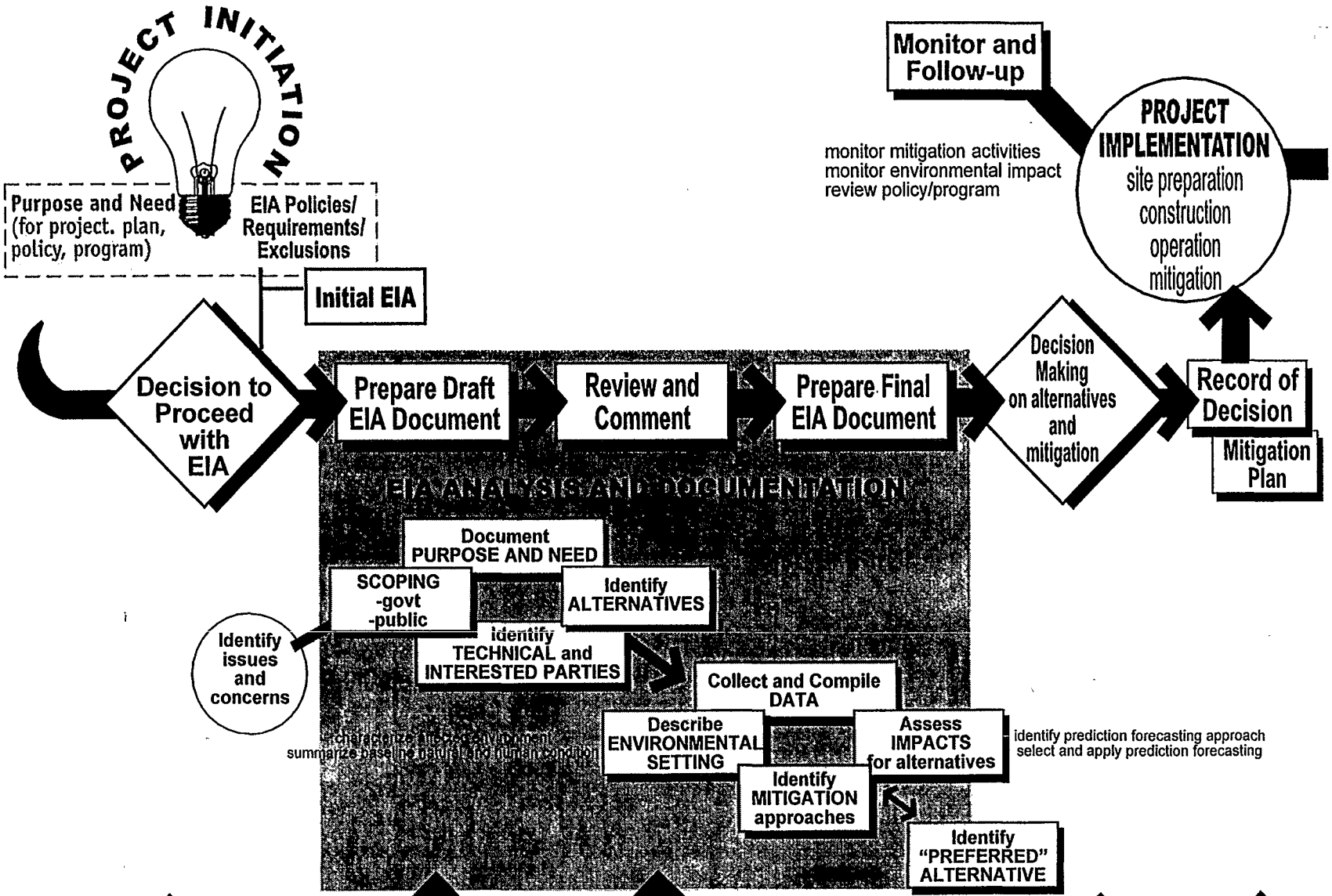
Once a decision is made that EA is necessary for a proposed action, a team is assembled and the formal **scoping** process begins. This process usually includes consultation within and between governmental departments and public and government participation in one or more scoping meetings. The purpose 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



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

# THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

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writing responsibilities and draft and final EA documentation is prepared. 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). 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 an EIA (ECE 1990). Ideally post-decision analysis encompasses evaluation of scientific and technical issues 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.

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# SECTION 1.3

# PROJECT INITIATION

# CHAPTER 2

# PROJECT INITIATION

Project 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 US., 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 througout 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 project initiation phase requires a clearly stated proposal, succinct statements of purpose and need, 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.



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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 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. 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).

- **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 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.

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).

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# 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.



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

## 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 EIA 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 EIA (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 EIA 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.

1.3.2-1

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.

1.3.2-2

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. 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 (198

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]

1.3.2-3

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 [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.

1.3.2-5

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 reason 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

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.

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.

1.3.2-6

# TECHNIQUES FOR COMMUNICATING WITH THE PUBLIC

**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.

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

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).



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

NEEDS

- Clear purpose and need statements, 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.
- 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.



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

## 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.

# 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)

- **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)



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

**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.<br>• 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.<br>• 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.<br>• Select appropriate technology.<br>• Design for reliability, ease of maintenance.<br>• 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.<br>• Use mathematical models for siting surface water discharges and determining required level of treatment, and for siting and designing ocean outfalls.<br>• Take full advantage of appropriate land application alternatives, especially in water-short areas.<br>• 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.<br>• Ensure preapplication treatment and operating guidelines for land application and other water reuse systems are adequate to safeguard health of humans and livestock.<br>• Restrict access to wastewater or sludge disposal sites where health hazards are unavoidable. |
| 6. Contamination at land application sites:<br>soil and crops by toxic substances and pathogens<br>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.<br>• Implement monitoring program and effective industrial waste pretreatment program (see text for guidelines).<br>• 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.<br>• 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.<br>• Select appropriate technology.<br>• Include odor control and low-noise equipment in design.<br>• 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.<br>• Implement effective industrial waste pretreatment program (see text for guidelines).<br>• Ensure preapplication treatment and operating guidelines for land application and other reuse or disposal systems are adequate to safeguard health of humans and livestock.<br>• 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.<br>• Implement effective industrial waste pretreatment program (see text for guidelines).<br>• Provide appropriate safety equipment and monitoring instruments.<br>• 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.<br>• 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.<br>• Clean sewers as necessary.<br>• Provide monitoring system with alarms for pump station failure.<br>• Provide alternate power supply at critical pump stations.<br>• 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.<br>• Strengthen land use control regulations and institutions.<br>• 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.<br>• Implement industrial waste pretreatment program. |
| 21. Loss of fisheries productivity. | 21. • Evaluate importance of receiving water in local and regional fisheries.<br>• 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.<br>• Implement mitigating measures for direct impacts 3, 4, 5, 7, 8 and 14. |

Source: New York State Department of Environmental Conservation. 1992. 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: Gender, age, ethnic composition
  Gender, age, ethnic

☐ 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 contr
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 | | | |

# SECTION 1.4

# DECISION TO PROCEED

## 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 9e.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 and one of the 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.

# SECTION 1.5

# DRAFT/FINAL ENVIRONMENTAL IMPACT ASSESSMENT ANALYSIS AND DOCUMENTATION

# 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,



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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.

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# 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.

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 possible planning to mitigate for harm to protected lands. 49 U.S. §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 this mandate."[39] Notwithstanding his view that it would be improper for the court itself to define the agency's goals,[40] Judge Thomas did precisely that in order to conclude that

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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. 1055 (1984)).
32. 938 F.2d at 196, 21 ELR at 21145; Toledo EIS, *supra* note 14, at 2-1 ("the Federal government's consideration of alternatives may accord substantial weight to the preferences of the applicant and/or sponsor").
33. 938 F.2d at 197, 21 ELR at 21146 (citing 49 U.S.C. app. §2201(a)(7), (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 th 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.2 633, 642, 17 ELR 20429, 20434 (7th Cir. 1986) (criticizing agei for its "blind reliance" on information submitted by an applican 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 Counc. 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 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).

# ASSESSMENT

In this part of the Resource Manual, "assessment" is used narrowly and includes tasks associated with the preparation of EIA 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 impact assessment (EIA) 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).

## Description of Environmental Setting

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.

| | | | II B. b. Industrial sites and buildings | II B. d. Highways and bridges | II B. h. Transmission lines | II C. a. Blasting and drilling | II C. b. Surface excavation | II D. f. Mineral processing | II G. c. Trucking | II H. c. Emplacement of tailings | II J. b. Spills and leaks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | A. 2. d. | Water quality | | | | | ✓ | ✓ | | ✓ | ✓ |
| I | A. 3. a. | Atmospheric quality | | | | | | ✓ | | | |
| I | A. 4. b. | Erosion | | ✓ | | | ✓ | | | ✓ | |
| I | A. 4. c. | Deposition, Sedimentation | | ✓ | | | ✓ | | | ✓ | |
| I | B. 1. b. | Shrubs | | | | | ✓ | | | | |
| I | B. 1. c. | Grasses | | | | | ✓ | | | | |
| I | B. 1. f. | Aquatic plants | | | | | ✓ | | | ✓ | ✓ |
| I | B. 2. c. | Fish | | | | | ✓ | | | ✓ | ✓ |
| I | C. 2. e. | Camping and hiking | | | | | ✓ | | | | |
| I | C. 3. a. | Scenic views and vistas | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | |
| I | C. 3. b. | Wilderness qualities | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| I | C. 3. h. | Rare and unique species | | ✓ | | ✓ | ✓ | ✓ | ✓ | | |
| I | C. 4. b. | Health and safety | | | | | | | ✓ | | |

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.

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# 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)



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

**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
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## 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)**

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**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.

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United States
Environmental Protection
Agency

Policy, Planning,
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# A Guide To Selected National Environmental Statistics In The U. S. Government

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# COMPUTER-AIDED ENVIRONMENTAL ASSESSMENT

- Luhar, A. K., and P. Khanna. 1988. Computer-aided rapid environmental impact assessment. Environmental Impact Assessment Review 8:9-25.



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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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. It is most relevant to developing countries.



The process of EIA can be divided into three parts: identification and evaluation of impacts (Canter 1977). The computer algorithm is 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.

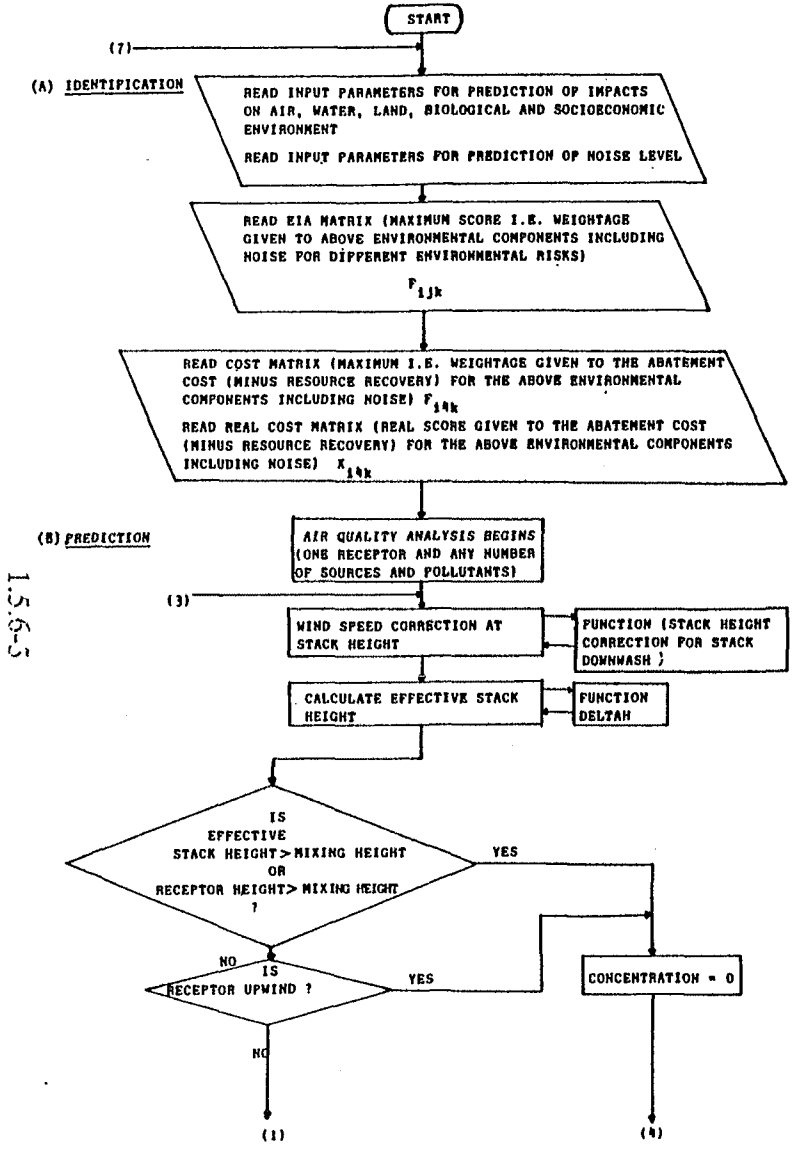


**FIGURE 1.** General Flow Chart of Computer-Aided Rapid Environmental Impact Assessment. (A) Identification; (B) Prediction; (C) Cost-Effective Evaluation.

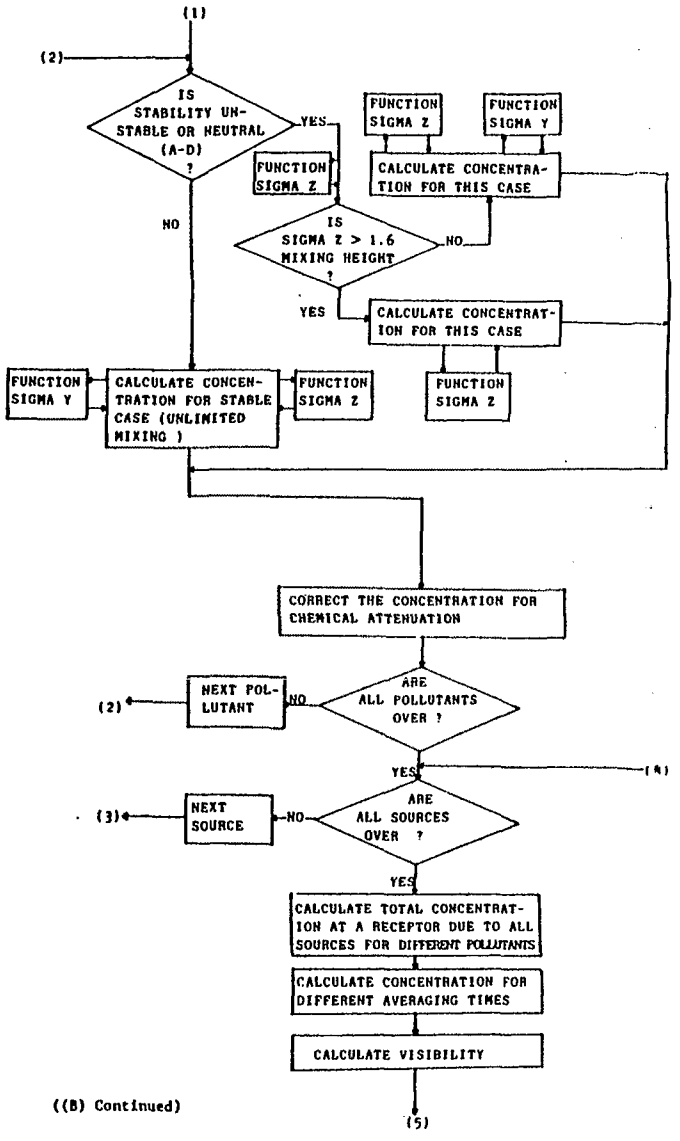


**FIGURE 1.** (Continued)

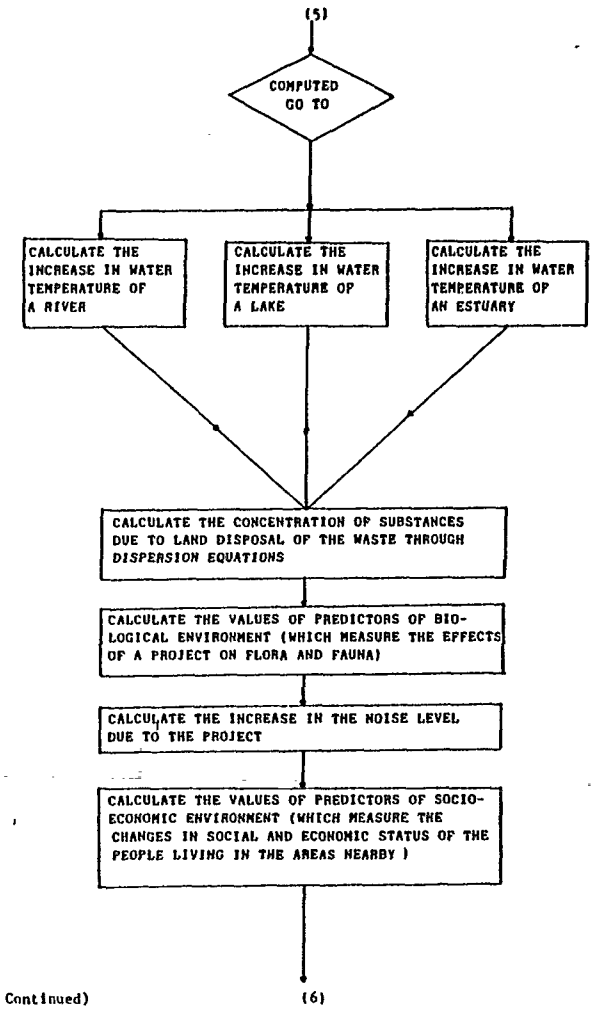


**FIGURE 1.** (Continued)



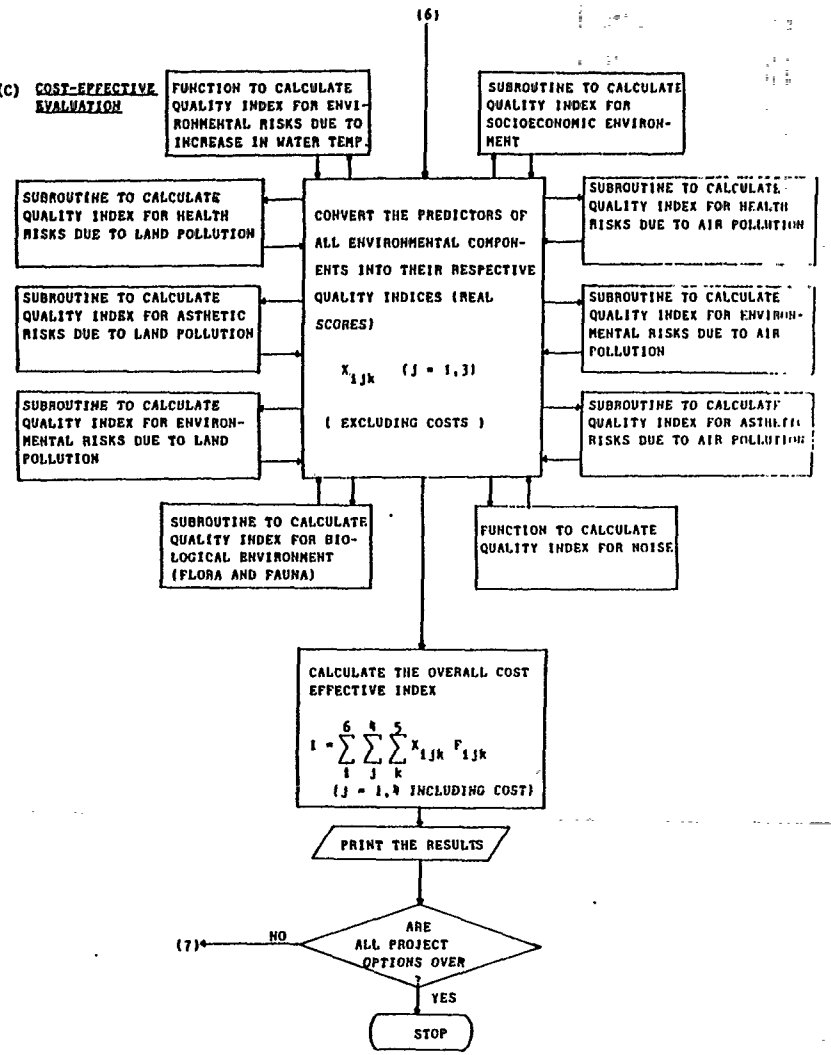


**FIGURE 1.** (Continued)

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 CRAM 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).

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### 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 prediction 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 | Importance value,[1] census index[1] |
| | Cost of control[2] | 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

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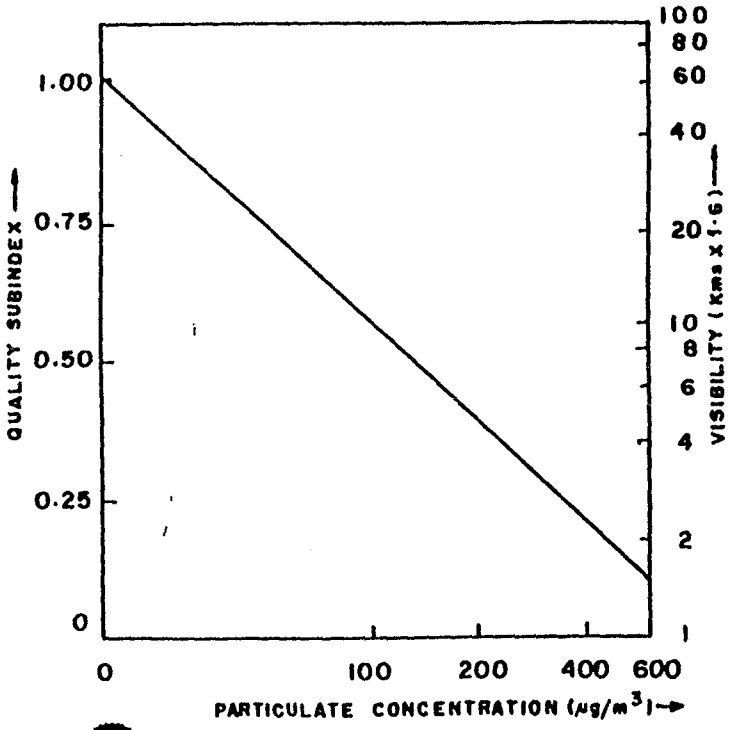


FIGURE alue Function Curve for Visibility (Aesthetic Risk)



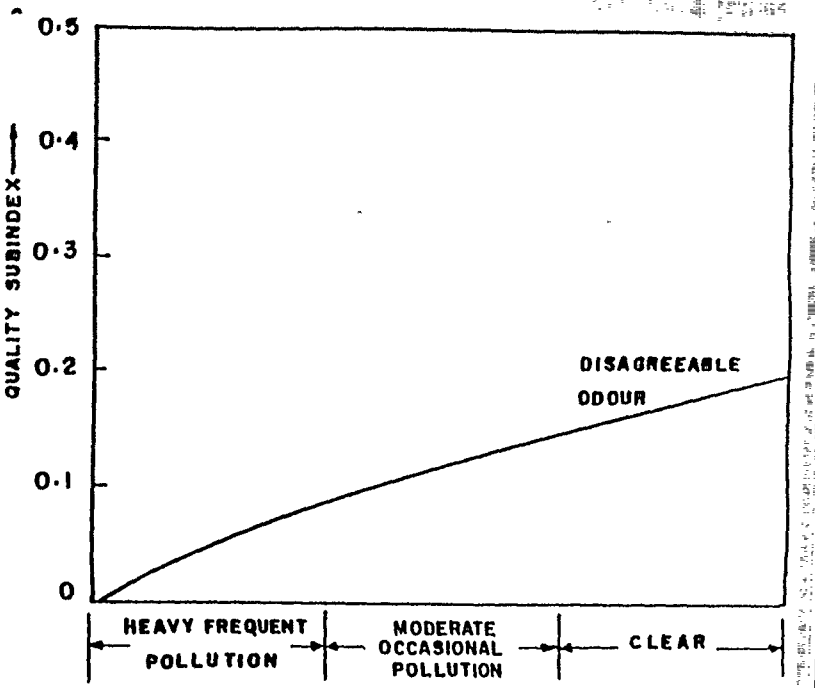


**FIGURE 3.** Value Function Curve for Odor (Aesthetic Risk)

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

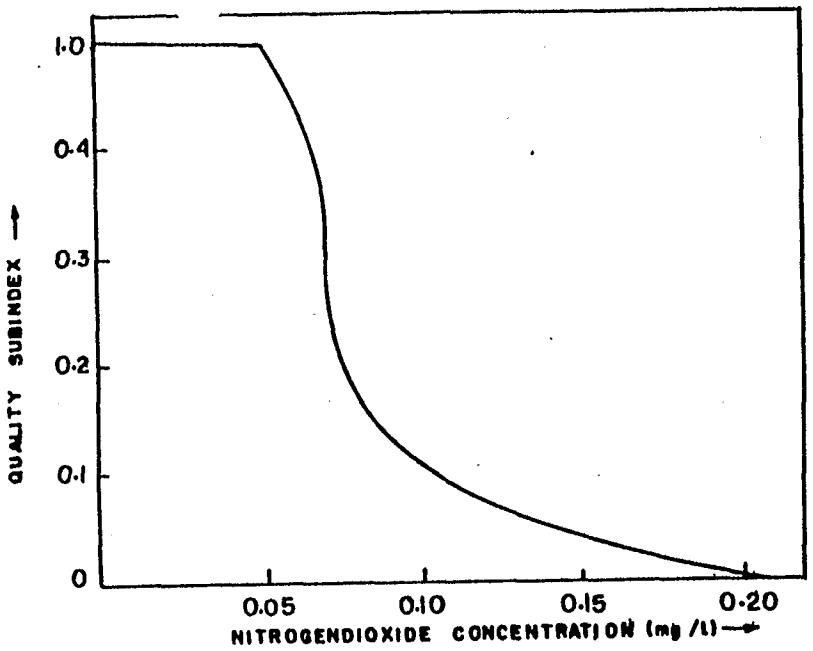


FIGURE 4. Value Function Curve for $NO_2$ (Environmental Risk)

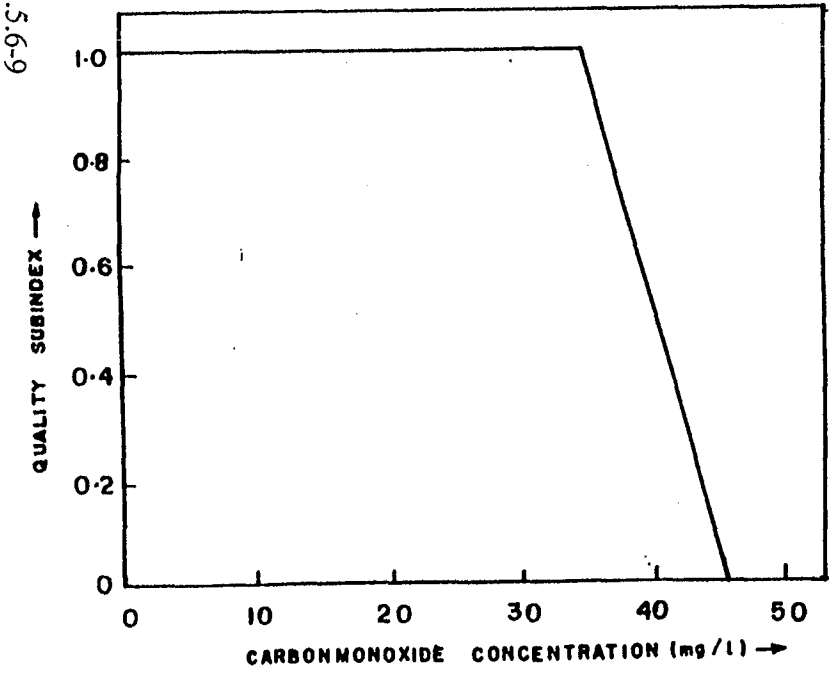


FIGURE 5. Value Function Curve for CO (Environmental Risk)

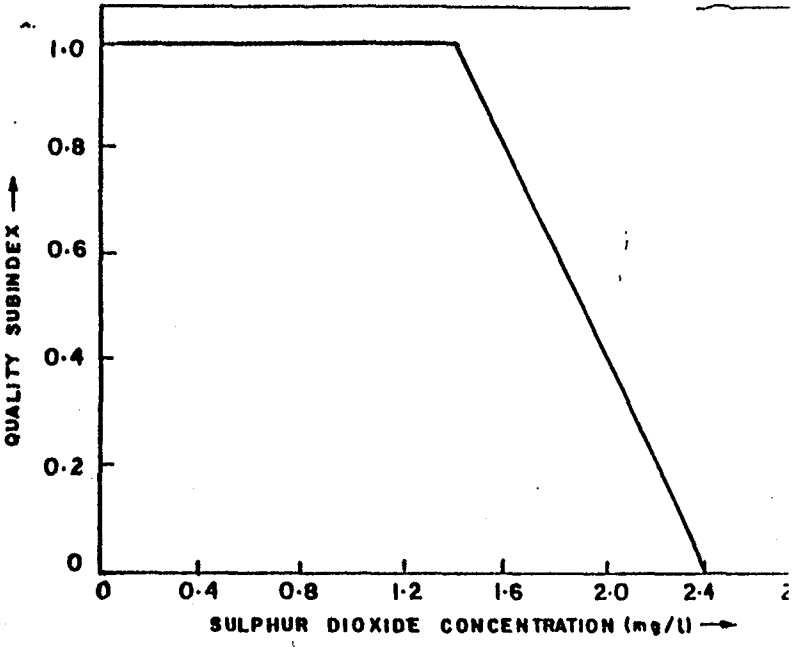


FIGURE 6. Value Function Curve for $SO_2$ (Environmental Risk)

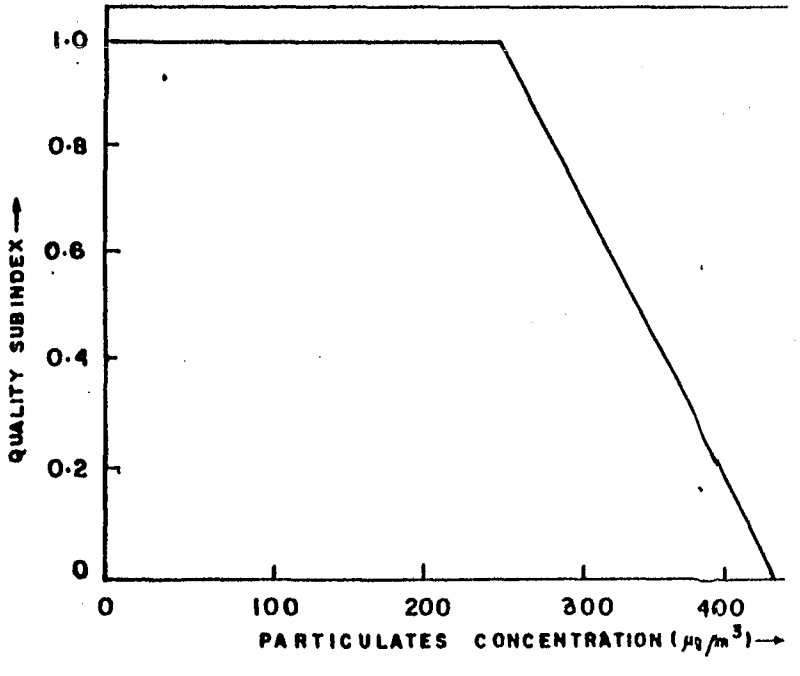


FIGURE 7. Value Function Curve for Particulates (Environmental Risk)

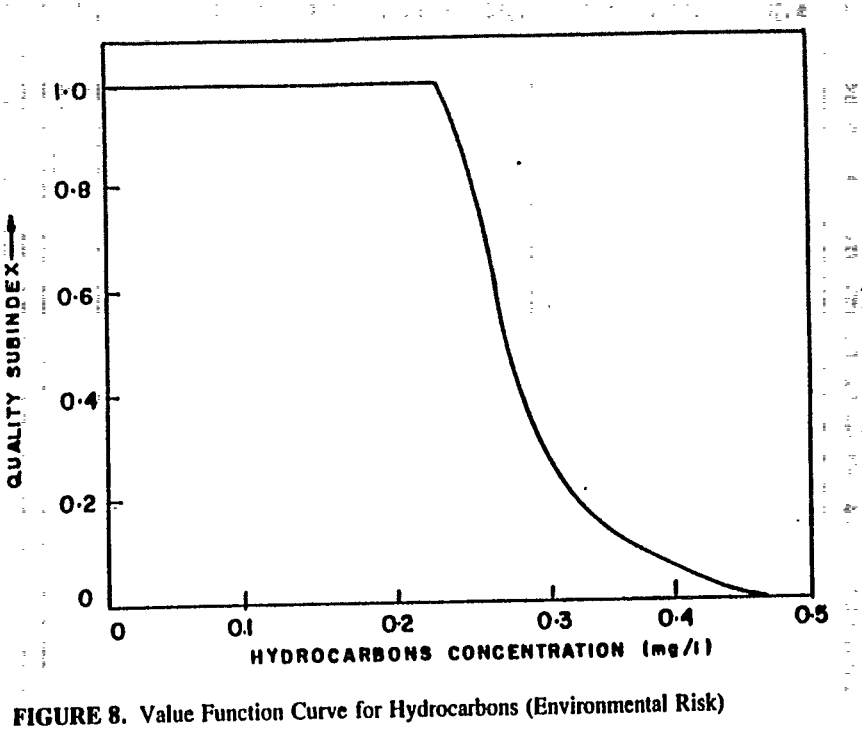


**FIGURE 8.** Value Function Curve for Hydrocarbons (Environmental Risk)

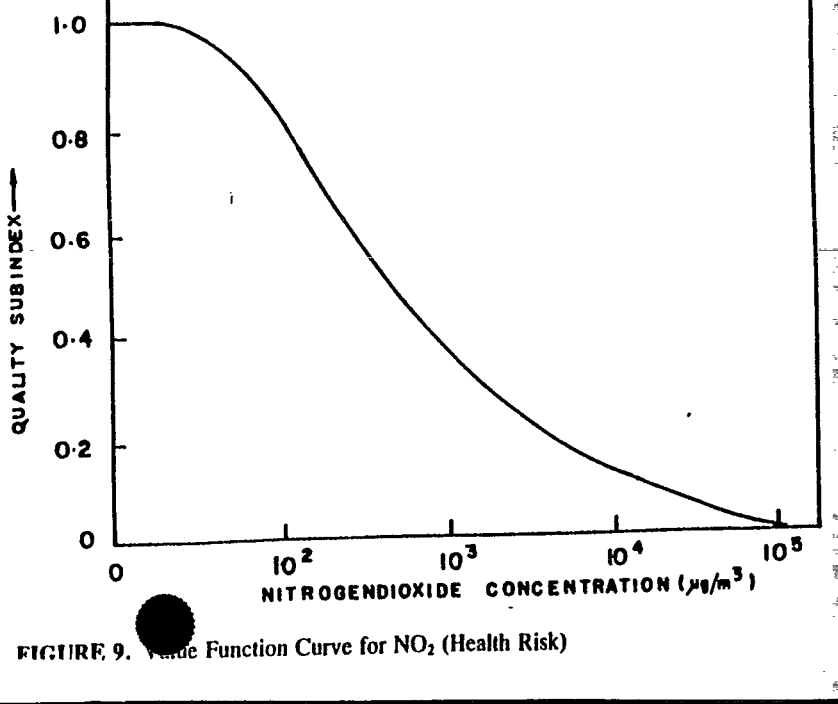


**FIGURE 9.** Value Function Curve for $NO_2$ (Health Risk)

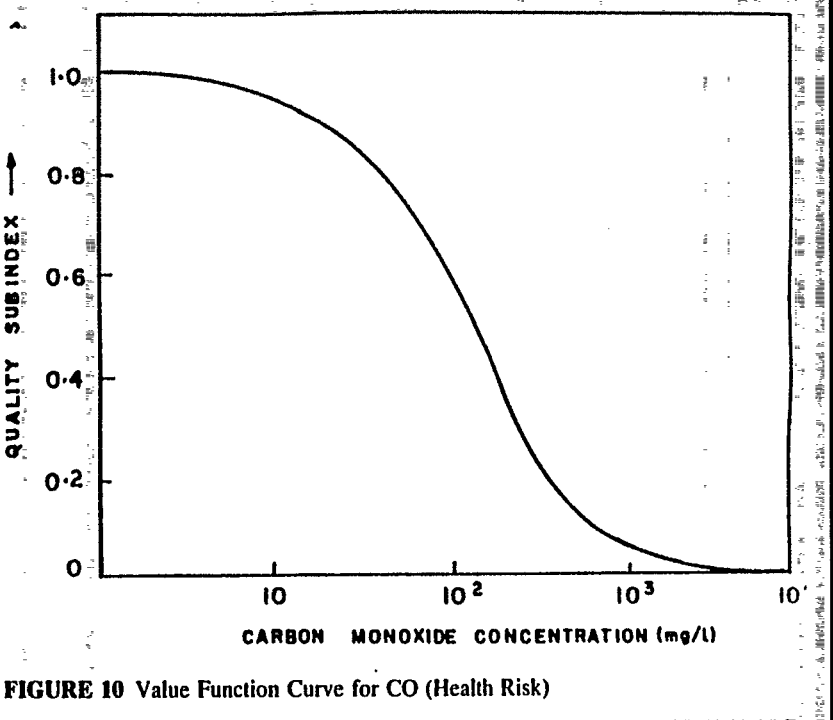


**FIGURE 10** Value Function Curve for CO (Health Risk)

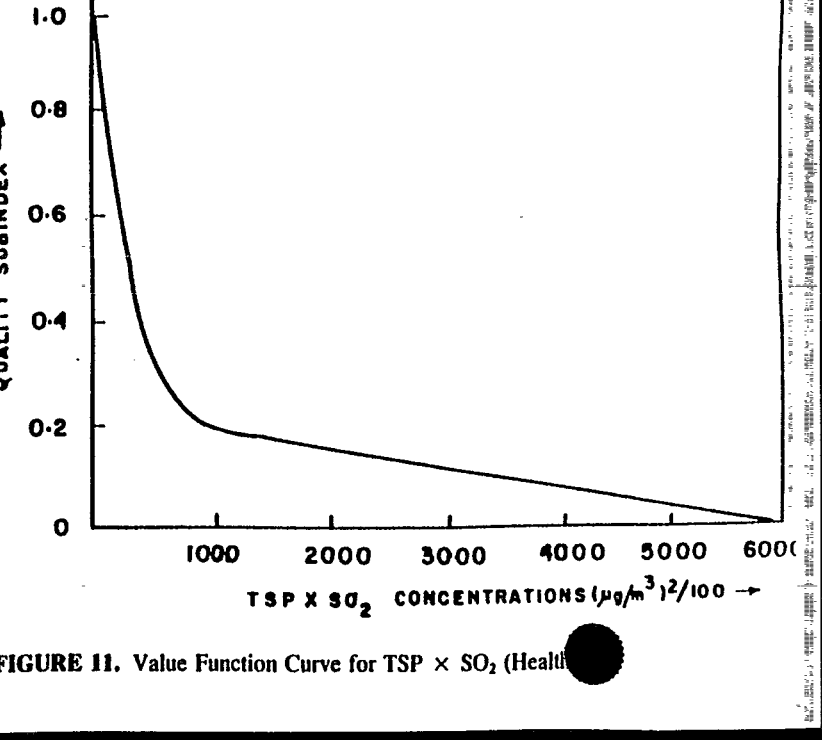


**FIGURE 11.** Value Function Curve for TSP × $SO_2$ (Health

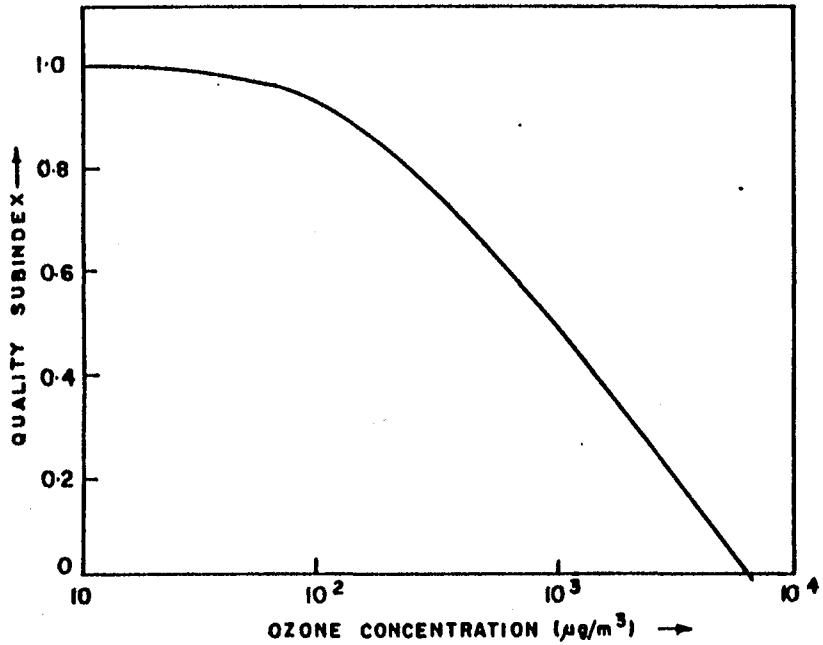


**FIGURE 12.** Value Function Curve for $O_3$ (Health Risk)

1.5.6-11

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.

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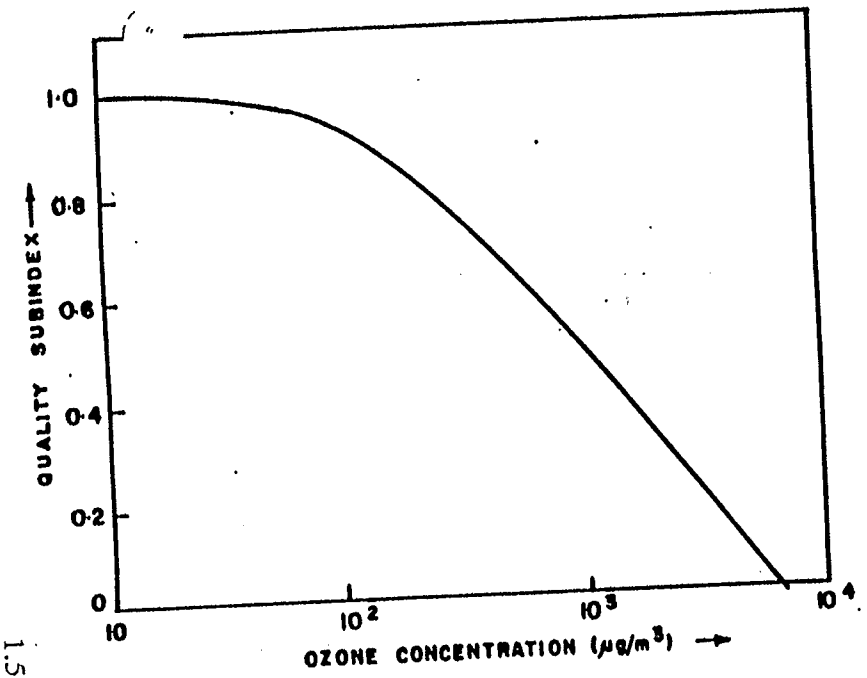


**FIGURE 12.** Value Function Curve for $O_3$ (Health Risk)

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1.5.6-13

# 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,



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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 | Land Use |
| Topography | Demography |
| Soils | Noise |
| Ground Water Resources | Socioeconomics |
| Surface Water Resources | Infrastructural Services |
| Terrestrial Ecology | Transportation |
| Aquatic Ecology | Cultural Resources |
| Environmentally Sensitive and Species | Economics |
| Air Quality | 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.

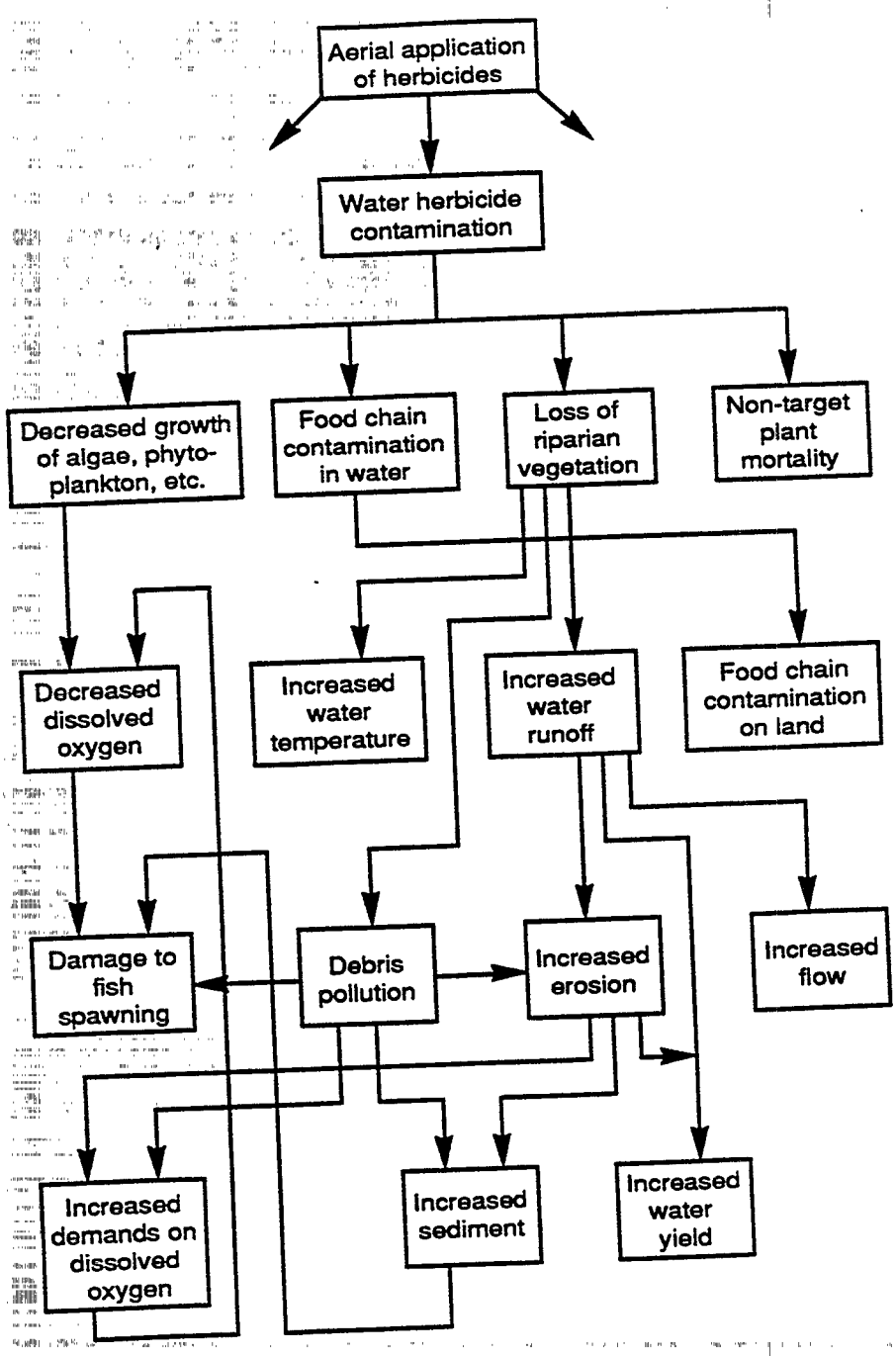


Figure 4.2-1. Example of a network to identify the potential impacts of herbicide application [Source: Thor et al. (1978)]

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.

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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



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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).

| | | II B. b. Industrial sites and buildings | II B. d. Highways and bridges | II B. h. Transmission lines | II C. a. Blasting and drilling | II C. b. Surface excavation | II D. f. Mineral processing | II G. c. Trucking | II H. c. Emplacement of tailings | II J. b. Spills and leaks |
|---|---|---|---|---|---|---|---|---|---|---|
| I A. 2. d. | Water quality | | | | | 2/2 | 1/1 | | 2/2 | 1/4 |
| I A. 3. a. | Atmospheric quality | | | | | | 2/3 | | | |
| I A. 4. b. | Erosion | | 2/2 | | | 1/1 | | | 2/2 | |
| I A. 4. c. | Deposition, Sedimentation | | 2/2 | | | 2/2 | | | 2/2 | |
| I B. 1. b. | Shrubs | | | | | 1/1 | | | | |
| I B. 1. c. | Grasses | | | | | 1/1 | | | | |
| I B. 1. f. | Aquatic plants | | | | | 2/2 | | | 2/3 | 1/4 |
| I B. 2. c. | Fish | | | | | 2/2 | | | 2/2 | 1/4 |
| I C. 2. e. | Camping and hiking | | | | | 2/4 | | | | |
| I C. 3. a. | Scenic views and vistas | 2/3 | 2/1 | 2/3 | | 3/3 | | 2/1 | 3/3 | |
| I C. 3. b. | Wilderness qualities | 1/4 | 1/4 | 2/2 | 1/1 | 3/3 | 2/5 | 3/5 | 3/5 | |
| I C. 3. h. | Rare and unique species | | 2/5 | | 5/10 | 2/4 | 5/10 | 5/10 | | |
| I C. 4. b. | Health and safety | | | | | | | 3/3 | | |

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

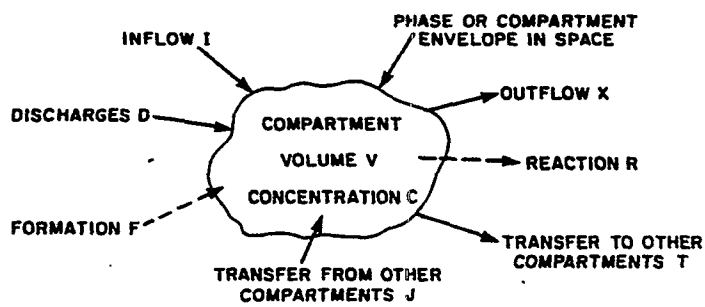


**Figure 4.3-2.** Fundamental mass balance equation. (Source: Mackay and Paterson 1993)

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.

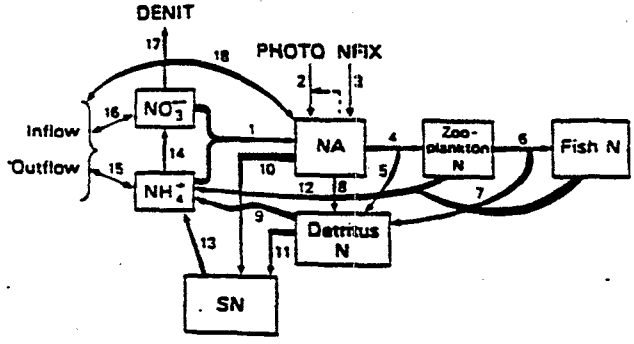


Figure 4.3-3. The conceptual diagram of a nitrogen cycle in an aquatic ecosystem is shown. The processes are: 1) uptake of nitrate and ammonium by algae, 2) photosynthesis, 3) nitrogen fixation, 4) grazing with loss of undigested matter, 5), 6) and 7) are predation and loss of undigested matter, 8) mortality, 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.

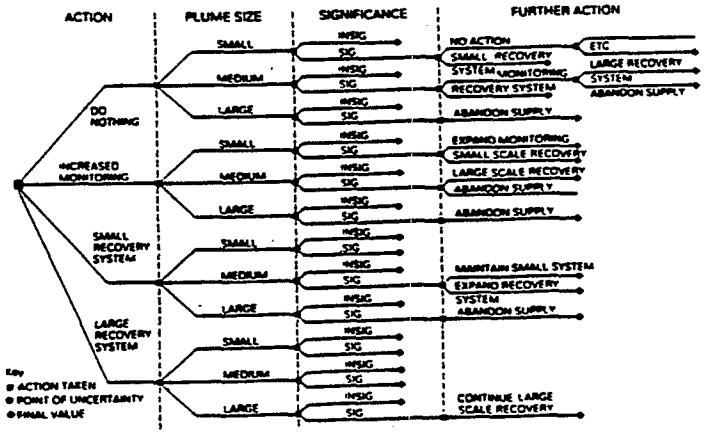


Figure 4.3-4.

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.

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# 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., 198_) 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

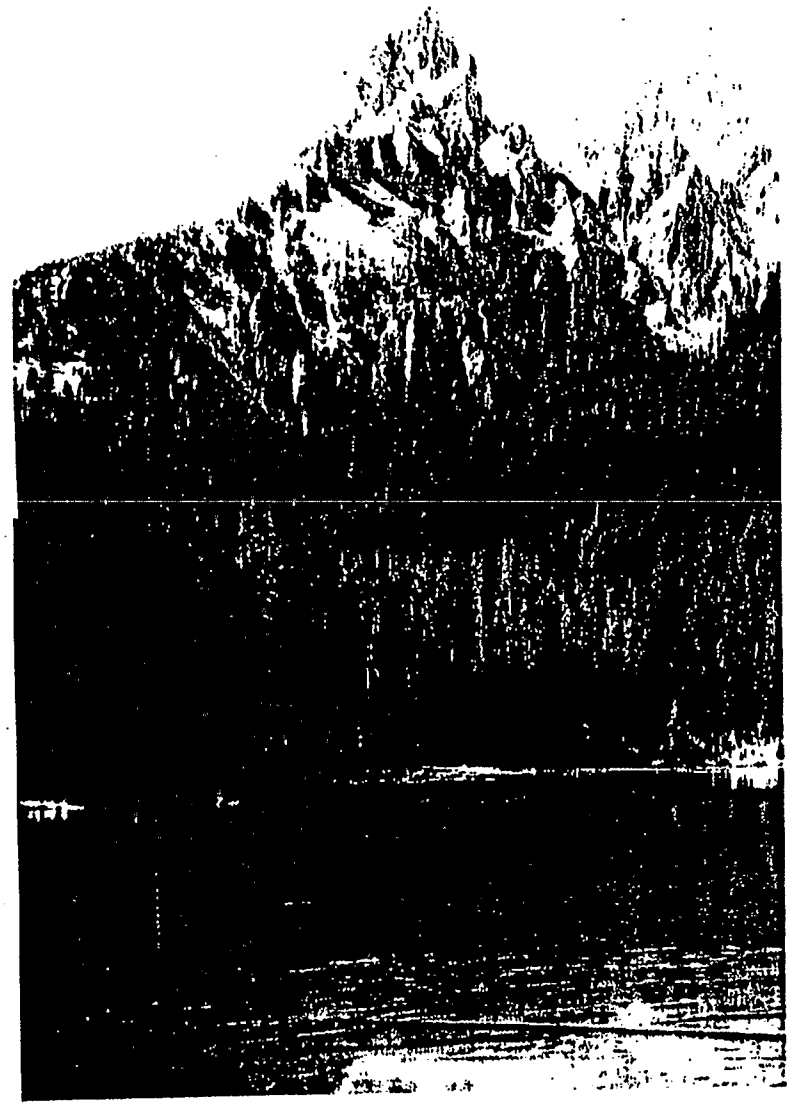
Numerous air dispersion models with general or limited geographic applicability have been developed with the objective of deducing ground level concentrations, and hence exposures, from stack emissions. Most texts or handbooks on air pollution contain full descriptions of such models. Models range from 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.

# 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

1.5.10-3

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-

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.



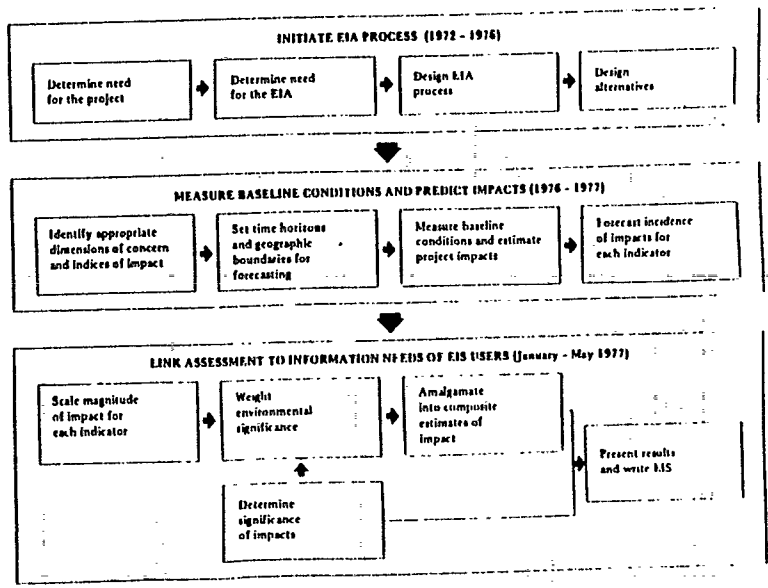
## THE JACKSON EIA PROCESS: KEY ANALYTIC PROBLEMS

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 s...ance the project had multiple effects, data on environmental conditions 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 is both scaling and significance in any process of amalgamation that starts with m[illegible]an 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 umber-

**Figure 2.** 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 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 (3)* | 1 (1) | 10 (4) | 4 (2) |
| Improved depressed employment and income | 7 (3) | 2 (2) | 9 (4) | 1 (1) |
| Improve community services | 10 (4) | 4 (2) | 8 (3) | 2 (1) |
| Improve travel safety | 8 (3) | 3 (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 | Environmental Issues | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ecology | Landscape | Agriculture | Recreation | Transport | Local Economy | Communities |
| Intakes and Aqueducts | | | | | | | |
| Regulated River Abstraction | | | | | | | |
| Borrowbeck 210 Ha 41 m 5.6 km 10 km 65,000 ml | ■▼ | ■▼ | ●▼ | ■▼▲ | ○?▼ | ●▼ | |
| Low Borrowbridge: Brigflatts pipeline/tunnel | ○▼ | ○▼ | ○▼ | | | | ○▼ |
| Lune below Low Borrowbridge/Halton | ■?▼ | | | ●?▼ | | | |
| Hellifield 840 ha 18 m 7.2 km 18 km 50,000 ml | ●▲▼ | ■▲▼ | ■▼ | ■▲▼ | □▼ | ■▲▼ | ■▼ |
| None: Direct Impoundment | | | | ■▼ | | | |
| Ribble below Hellifield-Milton or Samlesbury | ■▼ | ■▼ | ●▼ | ●?▼ | | | |
| New Dam 160 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 requirement.

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.

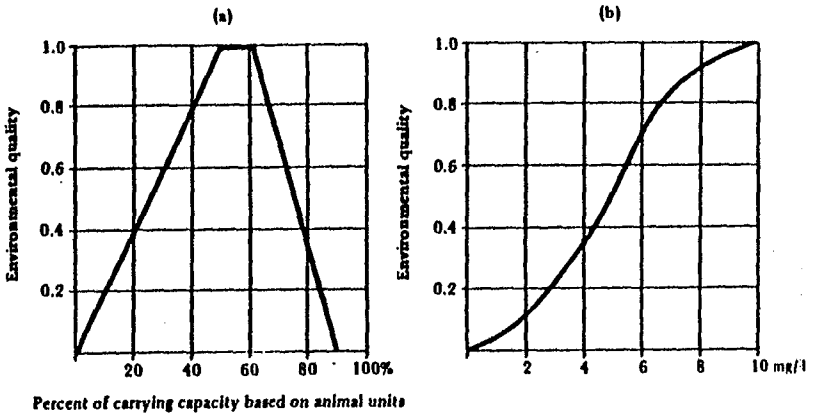
Two approaches to the unequal interval problem have been developed by environmental analysts:[12] standardized proportions and quality scaling. Proportions are calculated using a standard level selected by the analyst. The standard can be a target level (possibly established by environmental regulations) 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 dimension, 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<br>Nature of adjacent uses<br>Location of major recreational areas | ○ | ○ | ○ | ● | ● |
| Disruption to Other Shipping Activities | Ship traffic | ○ | ○ | ◑ | ◑ | ◑ |
| Presence of Factors Affecting Safety | Shipping accidents<br>Channel and berth depths<br>Channel width<br>Length of approach channel<br>Configuration of channel<br>Hazards of obstructions<br>Ship traffic volume | ◔ | ○ | ◔ | ◑ | ◔ |
| | Accidents at land facility<br>Seismic conditions<br>Exposure to storm tides and floods | ◔ | ○ | ◑ | ● | ◔ |
| Consequences of Accidents | Population density<br>Proximity of incompatible facilities | ◔ | ○ | ◑ | ● | ◑ |
| Presence of Factors Affecting System Outage | Exposure to waves<br>Exposure to winds<br>Visibility conditions | ◕ | ◔ | ◔ | ◔ | ○ |
| Environmental Impact | Critical environmental areas<br>Pipeline construction distance | ● | ● | ● | ◑ | ◑ |
| Economic Cost | Dredging volume<br>Pipeline construction distance<br>Ship transit time<br>Ship to tank distance | ● | ● | ◕ | ◑ | ◔ |

Key

- ○ Excellent
- ◔ Good
- ◑ Fair
- ◕ Poor
- ● Very poor

Screening 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

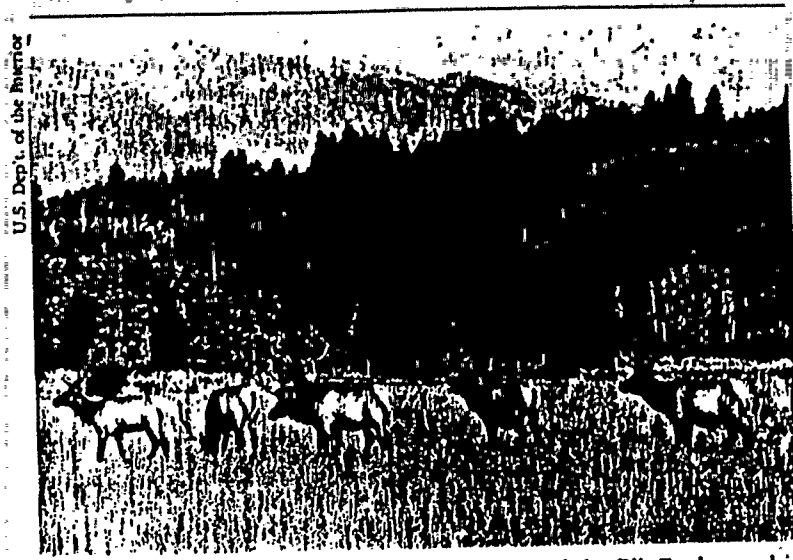
The environmental analysts who produced the Jackson EIS approached the problem of presentation with care. Most importantly, they wrote a clear, concise draft EIS of two hundred pages. But the EPA project manager felt that an explicit comparison of the alternatives was needed to convince the EPA Regional 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. Only this conflict of *values* is buried in the EIS evaluation matrix.






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 September 1977 appointment of Alan Merson as Regional Administrator. EPA

**Figure 7a.** 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 / -1 | -1 / -2 | 0 / -2 | 1 |
| Water Quality (surface) | -3 / -3 | -3 / -1 | -3 / -3 | -3 / -3 | 3 |
| Water Quality (ground) | 0 / -4 | 0 / -2 | 0 / -4 | 0 / -4 | 2 |
| Wildlife | -3 / -10 | 0 / 0 | -1 / -4 | 0 / 0 | 2 |
| Fisheries | +1 / 0 | +1 / +4 | +1 / 0 | -1 / -4 | 2 |
| Vegetation and Habitat | -1 / -6 | 0 / 0 | -1 / -4 | 0 / 0 | 2 |
| Rare and Endangered Species | -1 / -1 | 0 / 0 | 0 / 0 | 0 / 0 | 1 |
| Natural Hazards | -1 / -3 | -1 / -1 | 0 / -2 | 0 / 0 | 1 |
| TOTAL | -13 | 10 | -5 | -19 | |
| **ECONOMIC VALUES** | | | | | |
| Local Capital Cost | -3 / -4 | -1 / -2 | -3 / -4 | 0 / -6 | 2 |
| O & M Cost | -1 / -2 | -3 / -6 | -1 / -2 | 0 / 0 | 2 |
| Induced Development Costs | 0 / -6 | 0 / -2 | 0 / -6 | 0 / 0 | 2 |
| Individual Cost | -1 / -2 | -3 / -2 | -3 / -2 | 0 / -6 | 2 |
| Loss of Ag. Productivity | 0 / -6 | 0 / 0 | -1 / -6 | 0 / 0 | 2 |
| TOTAL | -22 | -12 | -22 | -12 | |
| **SOCIAL-CULTURAL VALUES** | | | | | |
| Historic-Archaeological | -1 / -3 | 0 / -1 | -1 / -3 | 0 / 0 | 1 |
| Public Acceptability | -3 / -3 | -1 / 0 | -1 / -2 | -3 / -4 | 1 |
| Regulatory/Legal | -1 / -6 | +1 / +4 | -1 / -2 | -3 / -6 | 2 |
| Cultural Pattern (life style) | 0 / -4 | 0 / 2 | 0 / -4 | -1 / -2 | 2 |
| Aesthetics Values | -1 / -6 | -1 / 0 | 0 / -4 | -3 / -4 | 2 |
| Recreational Values | -1 / -2 | +1 / +1 | -1 / 0 | 0 / -1 | 1 |
| TOTAL | -24 | 6 | -16 | -17 | |
| **LAND USE PLANNING VALUES** | | | | | |
| Adherence to the Planning Proc. | 0 / -6 | 0 / 6 | 0 / -6 | 0 / -6 | 2 |
| Growth Inducement | 0 / -6 | 0 / 6 | 0 / -6 | 0 / 0 | 2 |
| Growth Regulation | 0 / -6 | 0 / 6 | * / * | 0 / -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 significance) 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 mo[illegible]l in a second summary chart. An attempt at displaying im[illegible] 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 | | | Modified Blue | Modified Green | Comments |
|---|---|---|---|---|---|
| Sub group | Effect | Units | 13 | 3 | Properties demolished on Blue route are Circa 1900. |
| Residential | Properties demolished | Number | | | |
| | 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 300m 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 | | Most effective | Effective | |
| | a. Relief to existing severance | | Some new severance | Greatest new severance | |
| | b. Imposition of new severance | | | | |
| | Disruption during construction | | Slight | Slight | |
| | | Number of Farms affected by land take | 12 | 10 | |
| Farming | | | | | |
| | Land take | Hectares of land: | | | Based on MAFF Land Classification. Compensation included in Group 6 |
| | | Grade II | 6.8 | 10.3 | |
| | | Grade III | 25 | 19.5 | |
| Open Space | | | | | |
| a. Horton 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 [illegible] 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 effective are those that not only use techniques that are valid and reliable, but also explicitly examine the range of values that ex[illegible] 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.




1.5.10-15

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 [illegible] 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 div[illegible]y 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).

- Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14: 50-59.

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).

# 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

ce 1970, the National Environmental Policy Act (NEPA) d 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 kilovol: (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**

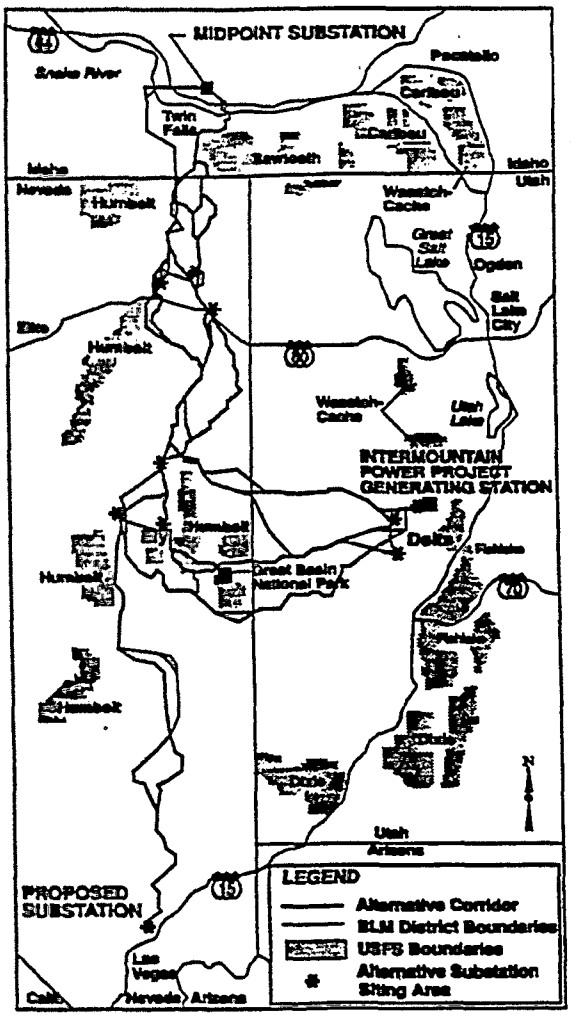
western Nevada, and eastern Utah (USDI, 1989b). The purpose of the regional study was to identify alternative corridors that would be considered "reasonable and feasible" for routing transmission line alternatives (Figure 2).

## 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 Phase 1 studies and modifying these data to accommodate the refined 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:

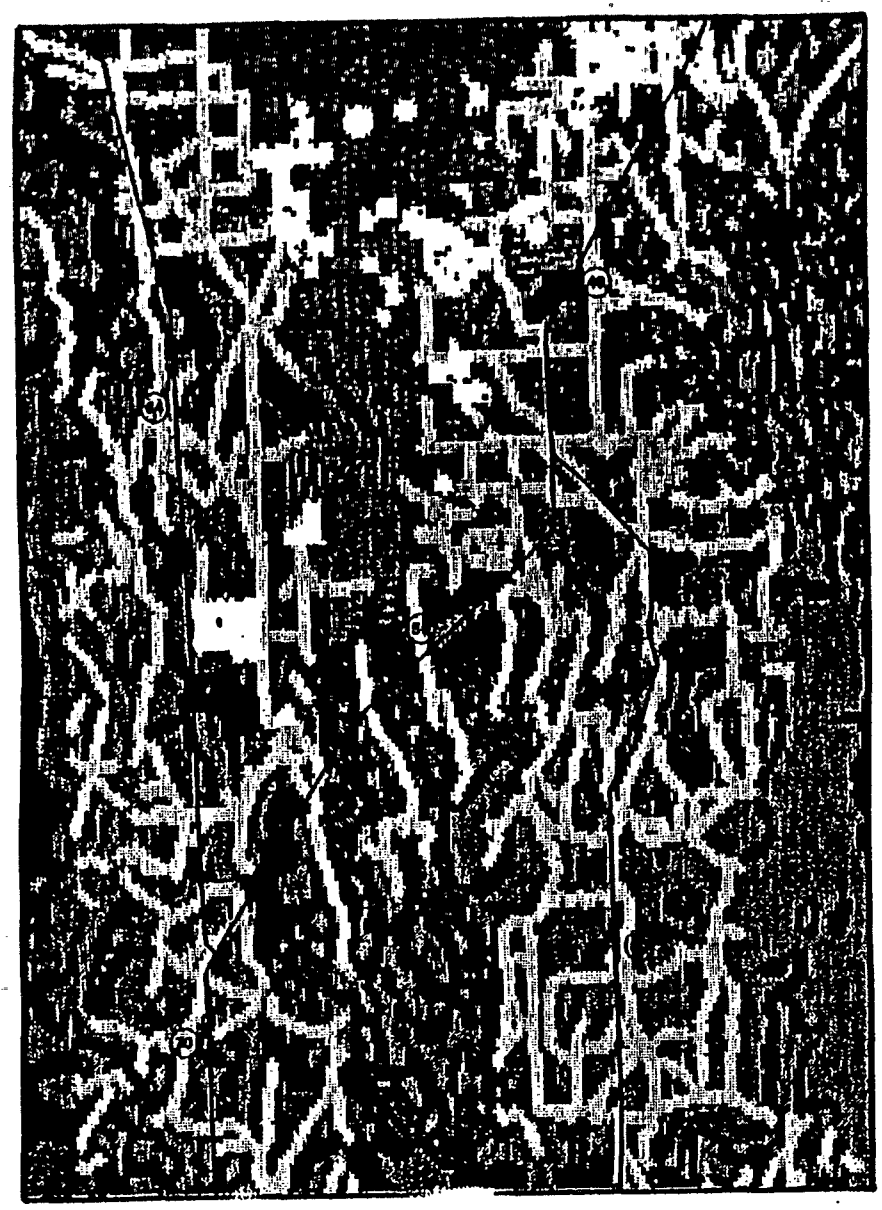
- visibility from sensitive viewpoints (e.g., residences, parks, recreation areas, scenic overlooks)
- visual contrast from vegetation removal, changes in landform from road construction, and presence or absence of structures such as buildings or other transmission lines
- cultural resources predictive 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 distur-

Figure 3. Ground Disturbance Model



## GROUND DISTURBANCE

LEVEL

1
2
3
4
5

LINK DESIGNATION

0 2 4 8 Miles

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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 resource 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.

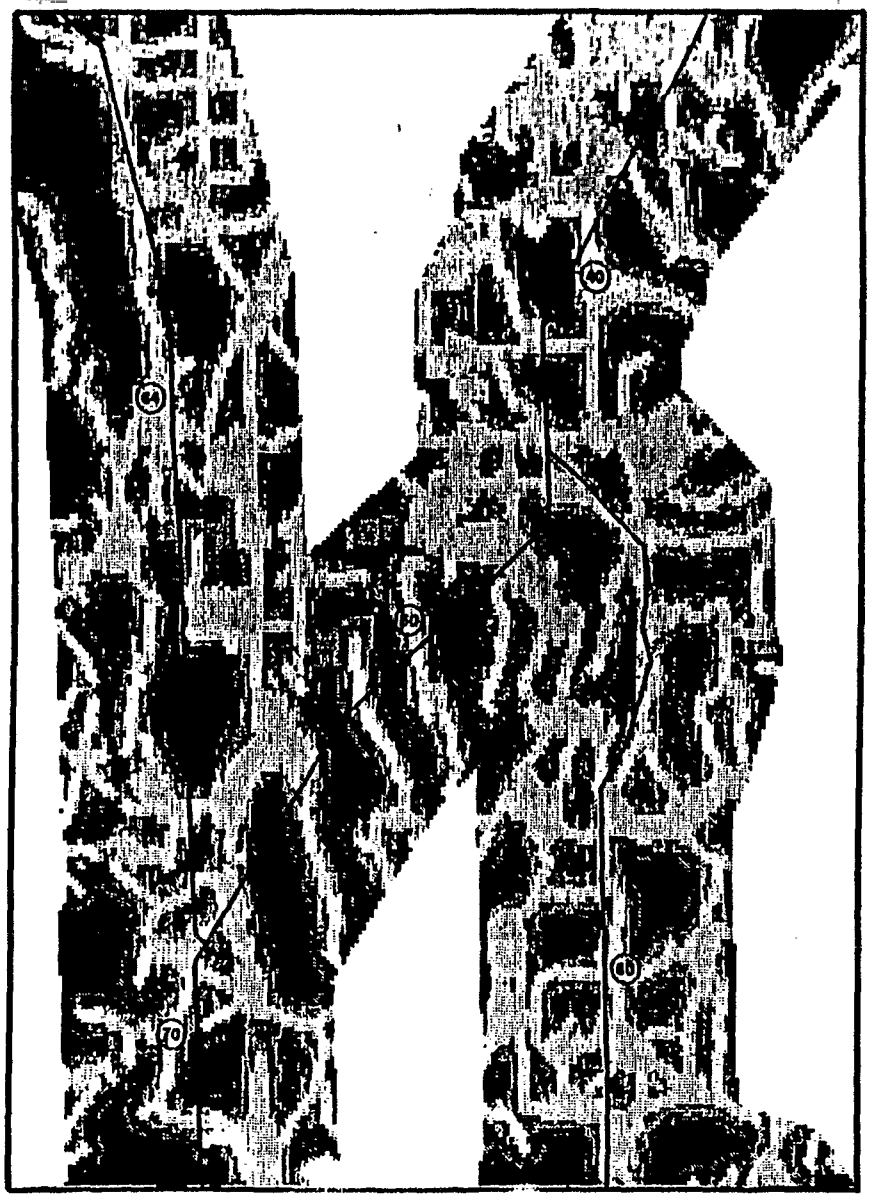
*Slope* - Five slope categories were mapped using the 1:250,000 scale USGS digital elevation mapping. The slope categories were selected based upon degree of soil erosion potential, construction difficulty, and other environmental and construction parameters. These categories were important in the development 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

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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 spec location and quantified severity of residual impacts w. 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 buf: |
| 1.3 | 1.5 | 0.2 | Level 2 | Sage grouse lek | 4 | 30 | 4 | crosses with:. 1/4 mile of lel. |
| 1.5 | 1.7 | 0.2 | Level 2 | Sage grouse lek | 4 | 30 | 3 | crosses edge o: 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 | |

## Table 3. Resource Discipline Impacts

| Resource Discipline | Individual Impact Assessment | |
|---|---|---|
| | Ground Disturbance | Public Accessibility |
| Biological Resources | Wildlife<br>Botanical | Wildlife<br>Botanical |
| Cultural Resources | Known Sites<br>Predictive Model | Known Sites<br>Predictive Model |
| Earth Resources | Soil Erosion<br>Water Resources | |
| Land Uses | Parks, Recreation, and Preservation<br>Existing and Planned Land Uses<br>Agricultural Lands<br>Military Operating Areas | |
| Visual Resources | Views from Residences<br>Views from Sensitive Recreation Areas<br>Views from Sensitive Travel Routes<br>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%) ter: " |
| 40.9 | 45.5 | 40.1 | 42.9 | 43.7 | 37.4 | 40.1 | New access roads in steep (35-65%) ter |
| | | | 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 |
| 0.0 | 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 our planning, environmental, and development missions. As a data management and analysis tool, GIS can help guide those missions into the future.

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# 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



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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.

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.

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# 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.

# 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.

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# 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

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## 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

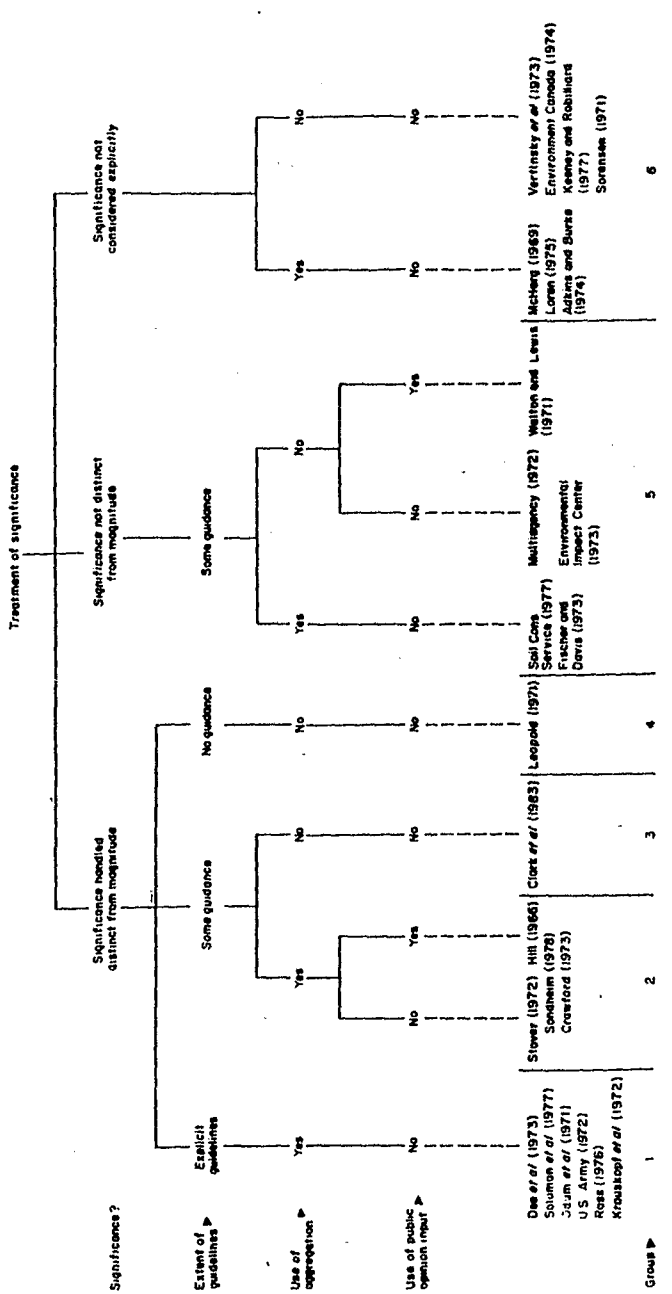


Figure 1. The treatment of significance amongst the initial group of EIA methodologies.



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 valu ment of the evaluator. (Leopold, 1971 p. 2).

1.5.14-4

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 2[illegible]odologies 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.

1.5.14-5

### 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 wi[illegible] more immediate socio-economic needs of large sections of society, but, if the EIA p[illegible] is to gain the support o[illegible] general public, then their immediate needs cannot be overlooked.

1.5.14-6

TABLE 1. Performance of 24 methodologies against the 15 evaluation criteria

| | Methodology | Group 1 | | | | | | | | Group 2 | | | | | | | | Group 3 | Group 4 | Group 5 | | | | | | Group 6 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Evaluative criteria | Dee *et al* (1973) | Tulsa US Army (1972) | Odum *et al* (1971) | U.S. Army (1972) | Ross (1976) | Krauskopf and Bunde (1972) | Slover (1972) | Hill (1966) | Sondheim (1978) | Crawford (1973) | Clark *et al* (1983) | Leopold *et al* (1971) | Service (1977) | Soil Cons. | Davis (1973) | Fisher and | Multiagency Task force (1972) | Env. Impact Center (1973) | Lewis (1971) | Walton and | McHarg (1967) | Lorah (1975) | Burke (1974) | Adkins and | Vertinsky *et al* (1973) | Canada (1974) | Environment | Robillard (1973) | Keeney and | sn (1971) |
| 1 | Significance is considered discrete from magnitude | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | | X | | | | | | | | | | | | | | | |
| 2 | Semi-aggregation is the end result of the process | | | | | | | | X | | X | | | | | X | | | | | | | | | | | | | | | | | |
| 3 | Methods proposed to ensure public participation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Level of qualification is restricted to be adequate | | | | X | | X | | X | | X | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Quantitative and qualitative data presented together | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Study team influence on the outcome not excessive | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Structured group decision-making technique suggested | X | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Development of low impact alternatives encouraged | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | When weighting performed a number of iterations used | | | X | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Methodology easily adapted for any type of project | | | | X | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Progression through stages of assessment is explicit | | X | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Promotes targeting resources to a decision | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Trade-offs are presented clearly | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Contains a technique that is a useful analytical tool | | X | X | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Resource needs unlikely to be excessive | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

X = qualifies in criterion.

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.

1.5.14-7

### 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 [illegible] are likely to be presented. The extent to which they are segregated to allow eq[illegible]onsideration 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.

1.5.14-8

### 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 low impact

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.

1.5.14-9

### 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.

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1.5.14-10

## 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. |



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

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.

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# 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 the usefulness, examples for United States projects in three



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 impacts of concern for wastewater treatment plants. Basic information necessary for estimating erosion in-

1.5.15-12

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, 1983b); (4) Benzie County, Michigan (U.S. Environmental Protection Agency, 1979); (5) Norman, Oklahoma (U.S. Environmental Protection Agency, 1982a); (6) Tulsa, Oklahoma (U.S. Environmental Protection Agency, 1982b); (7) Monterey, California (Monterey Peninsula Water Pollution Control [illegible] Protection Agency, 1977); and (8) Bloomington, Indiana (U.S Environmental Protection Agency, 1976).
‡ The tick sign denotes mitigation measure mentioned in the FIS 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 [illegible] |

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. |

1.5.15-14



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: we[illegible]s; alpine areas; deserts; and areas that are habitats for endangered species. Mitig[illegible]rocedures 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. Usag[illegible]ESIS, and the 66 data items of information for each species record, would enable the systematic identification of potential mitigation measures for threatened [illegible] plant or animal species in a project study area.

1.5.15-15

TABLE 6. Comparison of mitigation measures used in eight highway construc[illegible]ojects

| 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 uplaid 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 Transp[illegible]tion, 1988*a*); (6) Virginia-Maryland, District of Columbia, George Washington Memorial Parkway [illegible] National Park Service, 1985); (7) Mays County Oklahoma, SH-33 (U.S. Department of Transportation, [illegible]); and (8) Tulsa

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 filling | Deepening and filling | Land grading | Velocity alteration | Impoundment | Clearing and burning of terrestrial vegetation | Shading or exposure to sunlight | Water level fluctuation | Sluicing for flushing | 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

15.15-16



### 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 [illegible]on; (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<br>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<br>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<br>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<br>Plan access roads carefully; improve them if necessary; then restrict development of all other roads and paths. |
| 1064 | Ramifications<br>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<br>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 acco[illegible]ed as a part of the EIS process. This evaluation should enable the selection and i[illegible]mentation of the most cost-effective mitigation program. This pre-proje[illegible]



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 plan[illegible] appropriate. [illegible] to identify measures that would offset unavoidable [illegible]osses due to

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measures to existing habitat to effect a net increase in HUs. The existing habitat may 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 [illegible]. The structured nature of the HEP is conducive to its use as an evaluation tool for ecological 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.

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# AN UNREADABLE EIS IS AN ENVIRONMENTAL HAZARD

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# An Unreadable EIS is an Environmental Hazard

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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.

# 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)

**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)

## 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.

# SECTION 1.6

# DECISION MAKING

# DECISIONMAKING

For the purpose of this Resource Manual, 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.



*For purposes of this document, the term Environmental Assessment (EA) will refer to the Environmental Impact Assessment (EIA) process.

- 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.

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# 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.

ENVIRON IMPACT ASSESS REV 1991;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 ma ECD 1991a, 1991b).

1.6.1-4



## 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)?

1.6.1-5



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.

1.6.1-6

## 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.



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# SECTION 1.7

# FOLLOW-UP

# FOLLOW-UP

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.

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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 Bonanza, 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 recognized 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 analyzed 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-mo[illegible]. See *The Strategy of Conflict*, Cambridge, Mass: Harvard University Press, 1[illegible]



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*, 1977, 21(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 organize 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] Ozawa, 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 economies: 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.

1.7.1-5

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]



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-

1.7.1-6

[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. 445 (see in particular S. 16) and Massachusetts Hazardous Waste Facility Siting Act, Ch. 508, 0, Mass. Acts 673, 111, 21c. (see in particular S. 5, 8, 12).

[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 zero-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.

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(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]S a 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.

1.7.1-8

## 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 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.

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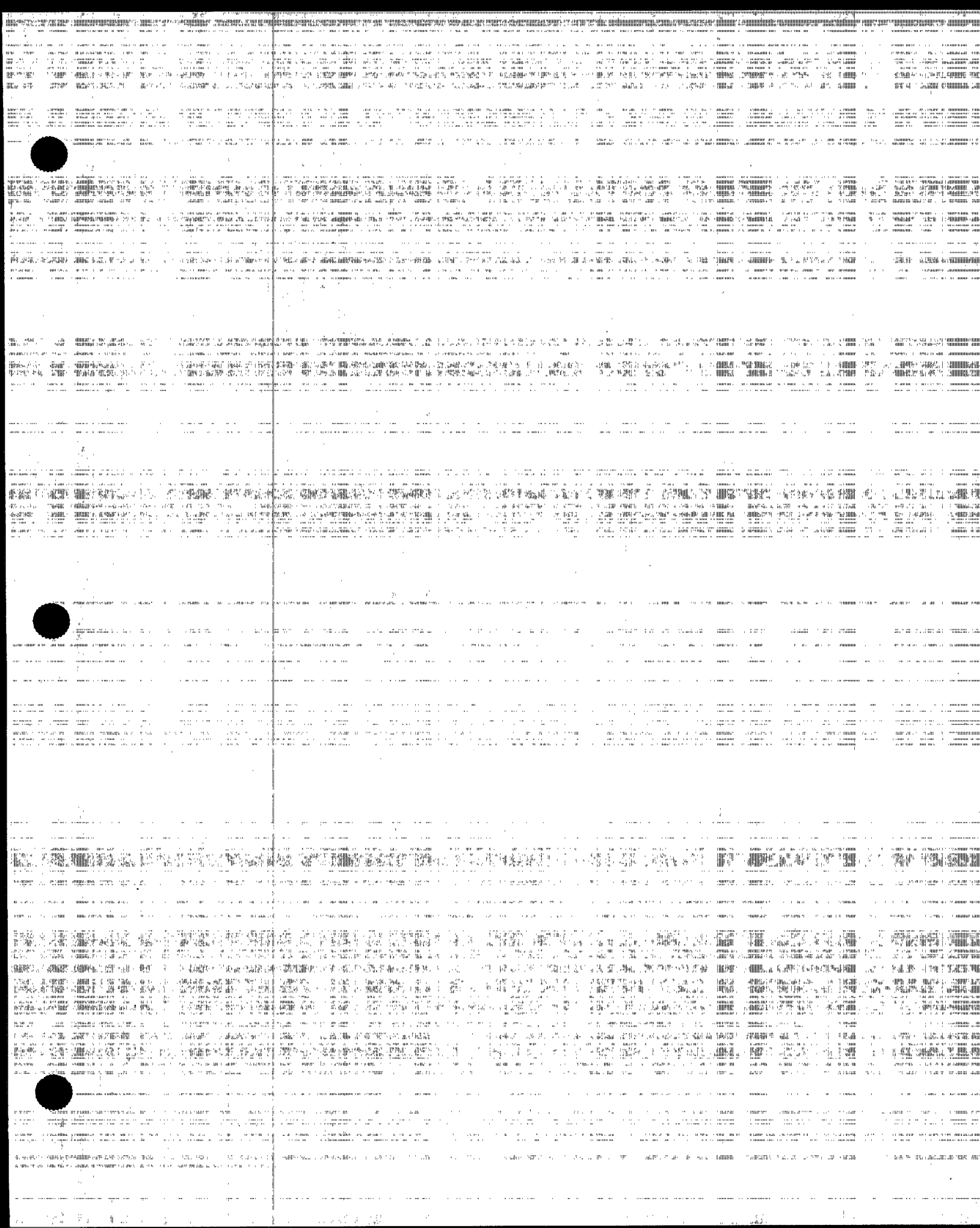
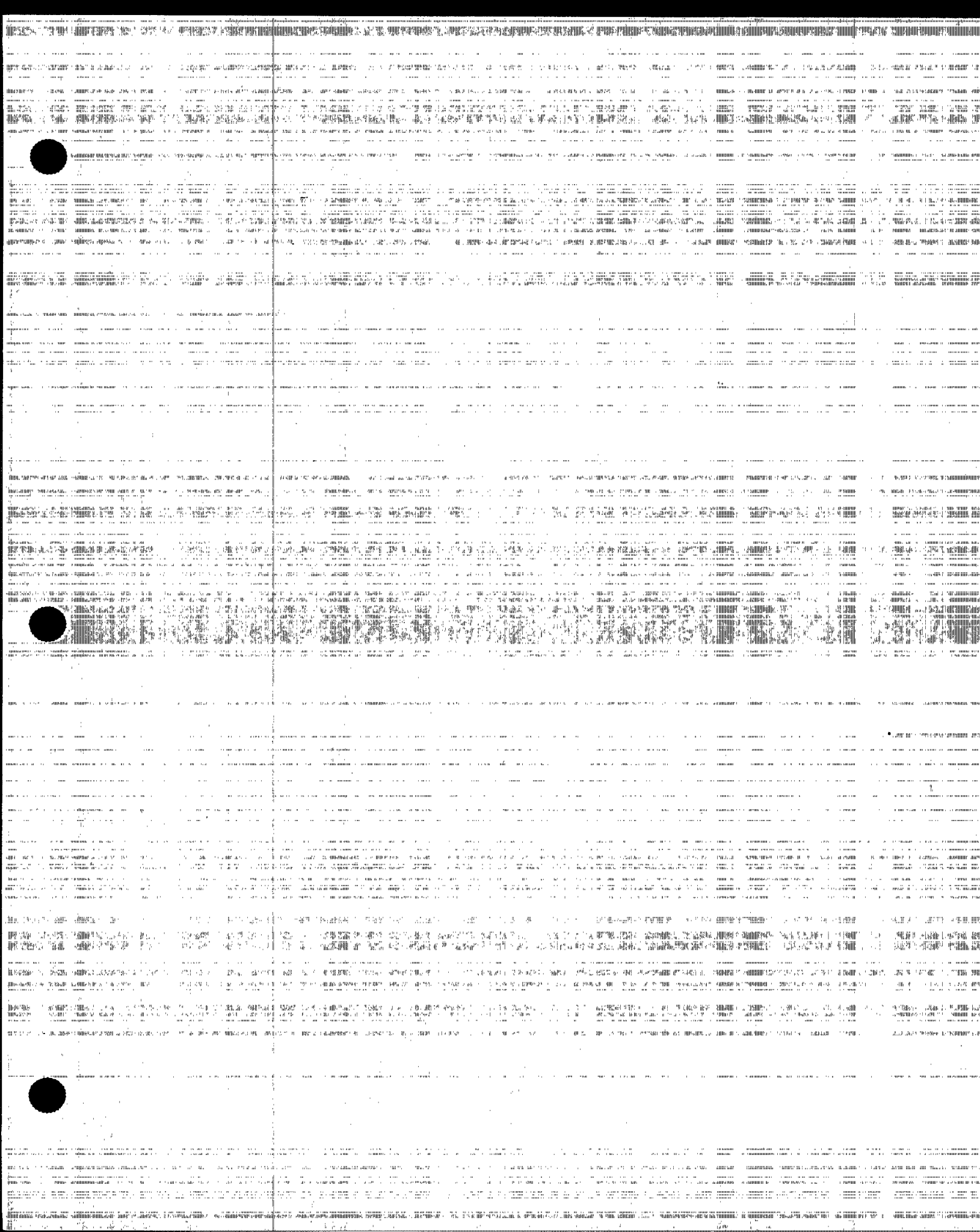
[34]Western Fuels Agreement, Article XII.

[35] - L. & Todd, H.F. Jr. Supra note 12



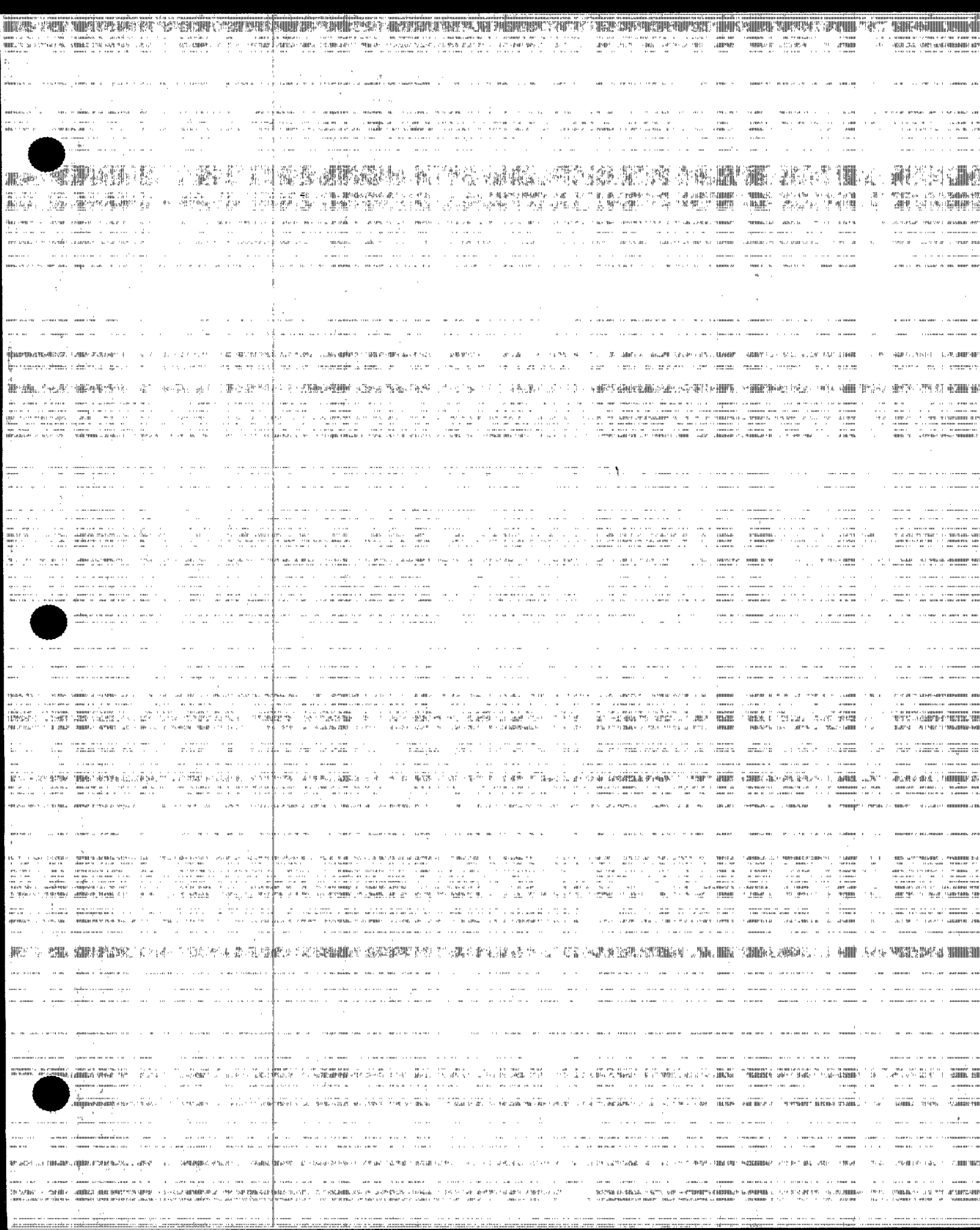
# SECTION 2

# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES AND EVALUATION CHECKLIST



# SECTION 2.1

# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES



# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES

| Name | Application | Description | Reference |
|---|---|---|---|
| **Economic Tools** | | | |
| Cost-Benefit Analysis | Decision-Making | Variety of economic tools that assign value to project components and perceived benefits, and are used to determine relative cost and benefit of development or project. | Westman, W.E. 1985. Ecology, Impact Assessment and Environmental Planning. John Wiley & Sons, New York. 532 pp. |
| Cost-Effectiveness Analysis | Decision-Making | Economic analysis that focuses on cost of providing services and achieving objectives. The technique emphasizes achievement of least-cost approach. | Leistritz, F.L., and S.H. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Westview Press, Boulder, Colorado. 286pp. |
| Trade-Off Analysis | Decision-Making | This socioeconomic tool involves comparison of a set of alternatives relative to a series of decision factors arrayed on a matrix. Approaches used can include qualitative, quantitative, ranking, rating, scaling, weighing. | Canter, L. W., S. F. Atkinson, and F. L. Leistritz. 1985. Impact of Growth. Lewis Publishers Inc., Chelsea, Michigan.<br><br>Canter, L. W. 1979. Water Resources Assessment - Methodology and Technology Sourcebook. Ann Arbor Science, Ann Arbor, Michigan. |
| **Checklists** | | | |
| World Bank Environmental Impact Checklist | Scoping, Development of Alternatives, Mitigation | These checklists are designed to be used in identifying significant environmental impacts, project alternatives, and special issues associated with development projects. They are qualitative and predictive in nature. More than 35 types of projects are represented, including housing, agriculture, and industrial development. | World Bank, 1991. Environmental Assessment Sourcebook. Volumes II and III. |
| Model EIS scoping checklist NY DEC | Scoping | This is a checklist of topics intended to initiate development of a detailed scope for an EIS. The checklist helps identify topic areas to be addressed in the EIS. | New York State Department of Environmental Conservation, 1982. State Environmental Quality Review Handbook. |
| Checklist of potential environmental impacts of transportation project | Scoping | This checklist was designed to help identify environmental impacts associated with planning, design, construction, and operation of a transportation project. | Arthur D. Little, Inc. 1971. Transportation and the 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. |

# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES

| Name | Application | Description | Reference |
|---|---|---|---|
| **Matrices** | | | |
| Leopold Matrix | Impact Assessment | This matrix is used to identify potential impacts associated with a project or alternatives. It assists performing a comprehensive review of the variety of interactions between project elements and environmental parameters, to identify important environmental factors, data needs, and less damaging alternatives. | 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. |
| Loran Methodology (Matrix) | Impact Assessment | This method uses a matrix of 234 project activities and 27 environmental features to identify critical environmental areas. Each element in the matrix is scaled and results input to an algorithm that aggregates impact scores. It is used to identify critical environmental areas. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal ob Environmental Management 30:235-250. |
| **Scaling or Weighing Techniques** | | | |
| Crawford Methodology | Impact Assessment | Methodology was devised for use in highway route planning. It makes extensive use of public involvement and the Delphi Technique. The technique is used as a basis for analyzing the value trade-offs involved in a decision between project alternatives. Results show each alternative as a percentage of maximum possible positive or negative impact. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250. |
| PADC Methodology | Impact Assessment | This tool evaluates the significance of impacts based on 5 polarities: adverse/beneficial, short/long term, reversible/irreversible, direct/indirect, local/strategic. No numerical method of evaluating responses is presented. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250. |
| Water Resources Assessment Methodology | Impact Assessment | This methodology produces scores for evaluating effects of alternatives on specific environmental components. The methodology uses scaling and weighing methods for environmental social and economic components. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250. |
| Fischer and Davis Methodology | Impact Assessment | This method is used for determination of impact, although it does not differentiate between impact magnitude and significance. Impacts are assigned a positive(+) or negative(-), and the degree of impact is assigned subjectively. Designators are used to indicate short-term or long-term impacts. Scores achieved are used to compare alternatives. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250. |

| Name | Application | Description | Reference |
|---|---|---|---|
| **Overlay Mapping and GIS** | | | |
| Overlay Mapping | Impact Assessment, Environmental Characterization | This method is useful in displaying and identifying areas of environmental sensitivity, succession, development, and landscape impacts due to multiple projects. | McHarg, I. 1969. Design with Nature. Natural History, New York. |
| Geographic Information Systems (GIS) | Impact Assessment, Environmental Characterization | GIS consists of digitized maps and overlays that are used to show spatial dimensions of impacts and areas of concern. | Westman, W. E., 1985. Ecology, Impact Assessment and Environmental Planning. John Wiley & Sons, New York. 532 pp. |
| Landscape Mapping (GIS) | Impact Analysis and Prediction | This tool is used to assess the suitability or vulnerability of an area for various uses. | Hopkins, L. D. 1977. Methods for generating land suitability maps: a comparative evaluation. Journal of the American Institute of Planners 43:386-400.<br><br>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. |
| Ground Disturbance Model | Impact Assessment | This GIS-based tool is a model that combines GIS database layers of land-cover, slope categories, and transportation to quantify and map the area of potential land disturbance into 5 levels of magnitude. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Visual Contrast | Impact Assessment | This GIS-based tool provides a measure of visible change in the landscape. It combines GIS data for landcover, terrain, land-sue and the proposed project description to map a visual contrast representing the level of change in the characteristic landscape. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Cultural Resources Predictive Model | Impact Assessment | This GIS-based tool uses data on landcover, terrain, and water resources to determine the probability of finding culturally-sensitive sites. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Sensitive Habitats | Impact Assessment | This GIS-based tool applies GIS buffering capacity to establish zones of potentially sensitive habitats associated with known habitat locations. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Slope (GIS) | Impact Assessment | This GIS-based tool uses USGS data to map 5 slope categories. The slope categories are important in the development kf access levels for use in ground-water disturbance and public accessibility pre-impact assessment models. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |

| Name | Application | Description | Reference |
|---|---|---|---|
| Visibility Model | Impact Assessment | This GIS model is constructed using digital terrain data and selected land-uses to map "viewsheds' over digitally modeled terrain in the project study area. Resulting maps show visibility as distance thresholds of visual perception, and can be used by GIS impact models to determine potential visual impacts of construction and operation of the project. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Public Accessibility Model | Impact Assessment | This GIS-based tool estimates the degree of remoteness of areas along transmission line routing alternatives. It uses GIS data on transportation and ground disturbance to estimate the increase in area accessible by roads in remote areas. | Jensen, J., and G. Gault. 1992. Electrifying the impact assessment process. The Environmental Professional 14:50-59. |
| Ecological Risk Assessment | Impact Analysis and Prediction | Identifies and quantifies risks to ecological receptors from chemical, physical, and biological agents. Evaluates the likelihood that an adverse ecological effect will occur as a result of exposure to contaminant or disturbance. Uses exposure and effects models. | Suter, G. W. II 1993. Ecological Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 538pp. |
| Human Health Risk Assessment | Impact Analysis and Prediction | Provides quantitative estimates of cancer and non-cancer risk associated with exposure to chemicals or biological agents. This tool includes a source/release assessment, fate and transport models, exposure assessment, toxicological assessment and risk characterization. | Cohressen, 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. # PB89-137772. |
| Economic-Demographic Assessment Models | Impact Analysis and Prediction | Numerous models used to integrate economic, demographic, public service and fiscal projections to estimate public costs and revenues, and public service demands. | 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. |
| **Chemical Fate and Transport Models** | | | |
| Fugacity Models | Impact Analysis and Prediction | Numerous models used to predict fate of chemicals in multimedia systems. Complexity varies from steady-state to time-varying models. Outputs from these models are used in risk assessments. | 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. |
| GEOTOX | Impact Analysis and Prediction | This compartmental model calculates chemical partitioning, degrading reactions, and interphase transport. It is used in conjunction with human exposure models. | 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. |

| Name | Application | Description | Reference |
|---|---|---|---|
| ENPART | Impact Analysis and Prediction | Environmental PARTitioning is a fugacity-based screening-level model estimates partitioning of organic chemicals among environmental compartments, identifies dominant pathways and data gaps, and provides estimates of a chemical's persistence and bioconcentration potential. | 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. |
| TOXSCREEN | Impact Analysis and Prediction | This time-dependent multimedia model is a screening tool that assesses the potential for environmental transport and accumulation of chemicals released to the air, surface water and soil. | 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. |
| SIMPLESAL | Impact Analysis and Prediction | This screening level multimedia fugacity compartmental model is used to estimate steady-state or time dependent concentrations of chemicals, and determine dominant environmental pathways and processes. | 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. |
| AERIS | Impact Analysis and Prediction | This multimedia risk assessment model estimates environmental concentrations and human exposures in the vicinity of contaminated land sites. It is a menu-driven model with built-in default values. | 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.<br><br>Senes Consultants. 1989. Contaminated Soil Cleanup in Canada, Volume 5, Development of the AERIS Model, Final Report prepared for the Decommissioning Steering Committee. |
| Persistence | Impact Analysis and Prediction | This screening-level model is used to estimate the fate of organic chemicals, especially pesticides, released into the aquatic environment. It provides a steady-state, fixed, or time dependent solution using default environmental parameters. | 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. |
| EXAMS | Impact Analysis and Prediction | Exposure Analysis Modeling System. This is a mass-balance model that predicts the fate of organic chemicals in stratified surface waters as a result of continuous or intermittent releases. | 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.<br><br>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. |

| Name | Application | Description | Reference |
|---|---|---|---|
| EXWAT | Impact Analysis and Prediction | This is a steady-state model used to describe chemical fate in water bodies and assess comparative hazards. It is applicable to continuous single-point sources. | 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. |
| Metal Speciation Models | Impact Analysis and Prediction | Models such as MINTEQAI are used to determine equilibrium speciation of metals in surface and groundwaters. Outputs include equilibrium aqueous speciation, adsorption, gas-phase partitioning, solid-phase saturation states and precipitation-dissolution states. | 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. |
| Fish Uptake and Food Chain Models | Impact Analysis and Prediction | Variety of models used to estimate concentrations of chemicals in aquatic biota. | 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.<br><br>Thomann, R. V. 1989. Bioaccumulation model of organic chemical distribution in aquatic food chains. Environmental Science and Technology 23:699-707.<br><br>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.<br><br>Connell, D. W. 1989. Bioaccumulation of Xenophobic Compounds. CRC Press, Boca Raton, Flori |

| Name | Application | Description | Reference |
|---|---|---|---|
| Soil Models | Impact Analysis and Prediction | Variety of models used to predict fate and transport of chemicals in soil. Model outputs are used in Risk Assessment. | Bonazountas, M., and J. M. Wagner. 1984. SESOIL - A seasonal soil compartment model. Arthur D. Little Co., Cambridge, Massachusetts.<br><br>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.<br><br>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.<br><br>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. |
| Atmospheric Models | Impact Analysis and Prediction | Variety of models used to calculate ground-level concentrations of chemicals from emission sources. Model outputs are used in Risk Assessment. | 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. |

# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES

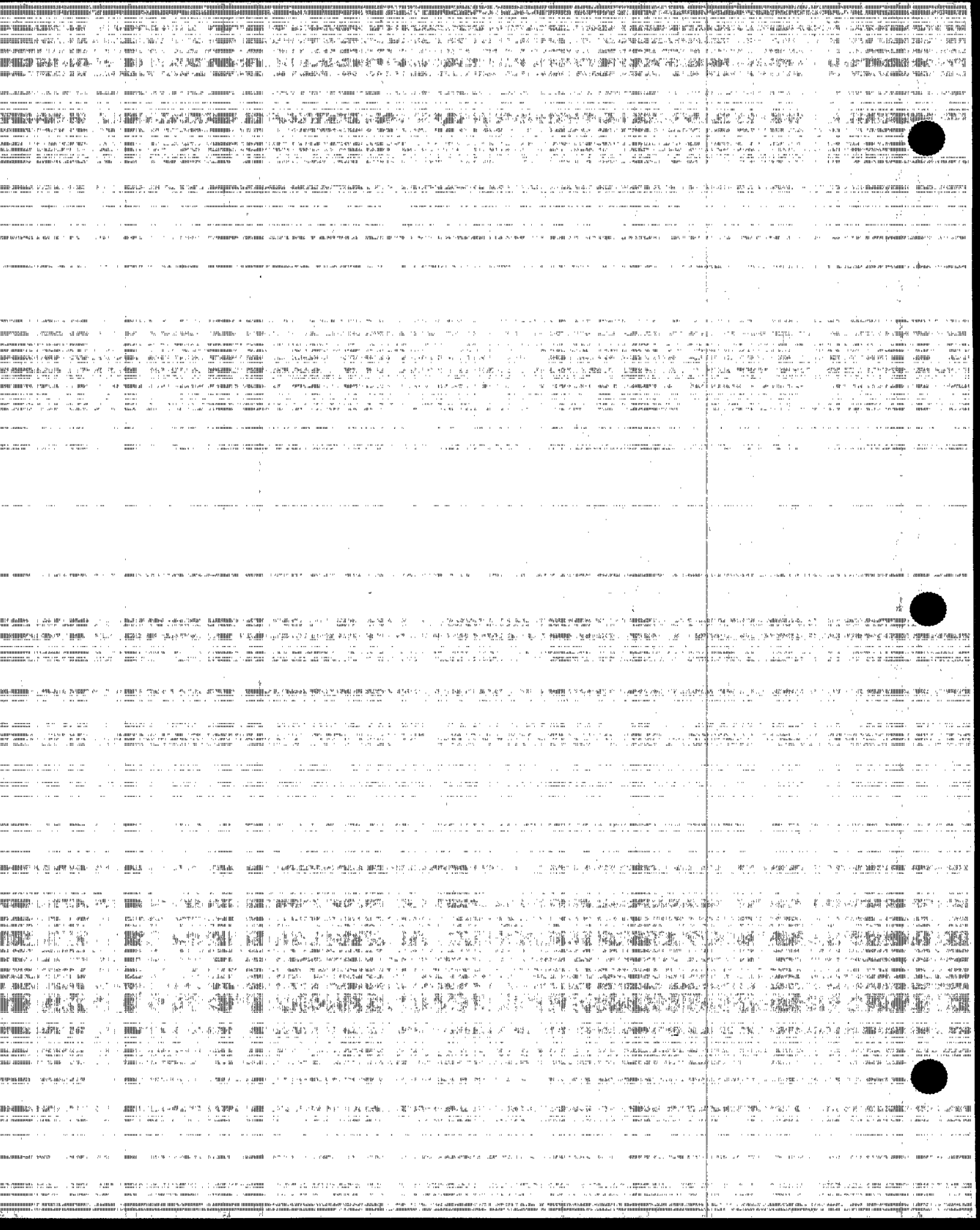
| Name | Application | Description | Reference |
|---|---|---|---|
| Habitat Evaluation Models | Impact Analysis and Prediction | This refers to a variety of models that are used to develop a quantitative index value for existing habitats, and determine change in that index resulting from the project. | U.S. Environmental Protection Agency (EPA). 1993. Habitat Evaluation: Guidance for the Review of Environmental Impact Assessment Documents.<br><br>Farmer A. 1980. Habitat Evaluation Procedures (HEP). ESM 102. Division of Ecological Sciences, U.S. Fish and Wildlife Service, Washington, D.C.<br><br>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.<br><br>U.S. Department of the Interior. 1987. Type B technical information documents PB88-100128-PB88-100169.<br><br>Atkinson, S. F. 1990. A simplified habitat evaluation for use with remote sensing data. The Environmental Professional 12:122-130. |
| Sensitivity Analysis | Decision Making | This technique identifies the parameter or variable of a model that is most sensitive to change. Use of this technique helps modelers and decision-makers understand how changes to input of an analysis affects the predicted impact of a proposed action. | Jorgensen, S. E. 1991. Environmental management modeling. In: Introduction to Environmental Management (eds. P. E. Hansen and S. E. Jorgensen). Elsevier, New York. 403 pp. |
| Expert Systems | Impact Analysis and Prediction | Expert systems refer to programs developed using IF-THEN codes. There is no reference to specific expert systems used for the EA process. | Lein, J. 1989. An expert system approach to environmental impact assessment. International Journal of Environmental Studies 33:13-27.<br><br>Lein, J. K. 1993. Formalizing expert judgement in the environmental impact assessment process. The Environmental Professional 15: 95-102. |
| Computer-Aided Environmental Impact Assessment | Impact Assessment | This conceptual model provides a general outline for development of computer-aided environmental impact assessment. It has not been developed into a useful program. The tool is intended for use in evaluating different environmental components and costs of mitigation measures. | Luhar, A. K., and P. Khanna. 1988. Computer-aided rapid environmental impact assessment. Environmental Impact Assessment Review 8:9-25. |

| Name | Application | Description | Reference |
|---|---|---|---|
| **Field Studies** | | | |
| Field Reconnaissance | Impact Identification | This tool consists of a qualitative reconnaissance of field conditions and is used to confirm and complement information provided in literature and background documentation. | Krebs, C.J. 1989. Ecological Methodology. Harper & Row, NY. 654 pp.<br><br>Smith, R. 1966. Ecology and Field Biology. Harper & Row, NY. 686 pp. |
| Field Survey | Impact Identification, Baseline Characterization | This tool consists of a variety of techniques designed to address particular endpoints and objectives. Complexity can also vary based on study objectives. Environmental field studies document environmental conditions and trends. | Suter, G. 1993. Ecological Risk Assessment. Lewis Publishers, Chelsea, MI. 538 pp. |
| Laboratory Testing | Impact Analysis and Identification | This tool consists of establishing testing protocols, or microcosms that model processes in the field. Results are used to predict impacts of actions on endpoints selected. Testing protocols vary because of the multitude of potential endpoints and test parameters. | Sourcebook for the EA Process |
| **Additional Assessment Tools/Techniques** | | | |
| Ad Hoc Procedures | Impact Analysis and Prediction | Qualitative tool used to assemble information, compare alternative sites, and develop strategy | Sourcebook for the EA Process |
| Professional Judgement | Impact Analysis and Prediction | Qualitative tool involving an experienced multidisciplinary team. Professional Judgement is used to design an EA, evaluate and select methods/models, determine relevance of data, develop assumptions to fill data gaps, interpret predicted/observed effects. | Lein, J. K. 1993. Formalizing expert judgment in the environmental impact assessment process. The Environmental Professional 15:95-102. |
| Analog Studies/ Case Studies | Impact Analysis and Prediction | This tool involves the use of information from studies that are analogous to the project being evaluated by virtue of geography, action, etc. It assumes that observed impacts at the analog site will be similar to the study site. | National Research Council. 1986. Ecological Knowledge and Environmental Problem-Solving: Concepts and Case Studies. National Research Council, National Academy Press, Washington, D.C. |
| Public Opinion | Scoping, Issue Identification, Impact Analysis, Determination of Significance | This qualitative tool helps to identify and determine the relative significance of environmental impacts. It is based on providing information to the public on the proposed action, alternatives and potential impacts. | Thompson, M. A. 1990. Determining impact significance in EIA: a review of 24 methodologies. Journal of Environmental Management 30:235-250. |
| Regulations, Guidelines and Thresholds | Determination of Significance | This screening tool consists of identifying applicable regulations and criteria for a particular project or action | 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. |

| Name | Application | Description | Reference |
|---|---|---|---|
| Professional Standards and Design Specifications | Determination of Significance | This tool consists of comparing project parameters to professional standards. | Leistritz, F. L., and S. H. Murdock. 1981. The Socioeconomic Impact of Resource Development: Methods for Assessment. Westview Press/ Boulder, Colorado. 286 pp. |
| Inter-disciplinary team development | Scoping | This tool is used to select an interdisciplinary team and describe the role of team members | Sourcebook for the EA Process |

# SECTION 2.2

# ENVIRONMENTAL IMPACT ASSESSMENT EVALUATION CHECKLIST



## Environmental Impact Assessment Evaluation Checklist

(Note page numbers refer to Student Text
*Principles of Environmental Impact Assessment Review)*

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| PURPOSE AND NEED | | | | |
| 1. Clear description of underlying need for the proposed project (p. 4-4) | | | | |
| 2. Clear description of purpose of proposed project (p. 4-4) | | | | |
| 3. Adequate description of the proposed project (p. 4-4) | | | | |
| PROJECT ALTERNATIVES | | | | |
| 1. Consideration of all relevant alternative types. (p. 4-7) | | | | |
| a. No Action | | | | |
| b. Alternative Sites | | | | |
| c. Alternative Designs | | | | |
| d. Alternative Controls | | | | |
| e. Structural Alternatives | | | | |
| f. Non-structural Alternatives | | | | |
| 2. All alternatives satisfy the stated purpose and need for the project. (p. 4-8) | | | | |
| 3. Description of all alternative actions or projects that were, or are, being considered. (p. 4-8) | | | | |
| a. Size and location of facilities | | | | |
| b. Land requirements | | | | |
| c. Operations and management requirements | | | | |
| d. Auxiliary structures | | | | |
| e. Construction schedules | | | | |
| 4. Description of initial environmental impact assessment processes and results (p. 4-7) | | | | |
| DESCRIPTION OF THE ENVIRONMENTAL SETTING | | | | |
| 1. Region of Concern defined, including boundary areas (p. 4-12) | | | | |
| 2. Physical-Chemical Environment (p. 4-12) | | | | |
| a. Air Resources (p. 4-13) | | | | |
| 1) meteorological data (e.g., temperature, wind) | | | | |
| 2) ambient air quality (e.g., particulates, ozone) | | | | |
| 3) stationary sources of emissions (e.g., power plants) | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| 4) mobile sources of emissions (e.g., cars and trucks) | | | | |
| b. Water Resources (p. 4-14) | | | | |
| Surface Water:<br>1) location and type (e.g.,estuaries, streams, lakes, and their position relative to the site) | | | | |
| 2) water quality information (e.g., dissolved oxygen, temperature, nutrients) | | | | |
| 3) existing pollutant sources (location and amount of discharges) | | | | |
| 4) future uses | | | | |
| 5) discussion of flooding events | | | | |
| Ground Water:<br>6) description of key factors (e.g., depth to water table, overlying soils, geologic features) | | | | |
| 7) water quality information (e.g., pH, solids) | | | | |
| c. Soils and Geology (p. 4-16) | | | | |
| 1) topography | | | | |
| 2) soil structure | | | | |
| 3) ground water movement | | | | |
| 4) erosion potential | | | | |
| 5) subsidence | | | | |
| 6) seismic activity (e.g., proximity to faults, history of earthquakes and volcanic eruptions) | | | | |
| 7) mineral resources (e.g., locations of deposits, types and quantities, ownership of mining rights) | | | | |
| 2. Biological Conditions | | | | |
| a. Wildlife and Vegetation (p. 4-18) | | | | |
| 1) description and listing of aquatic, wetland, and terrestrial flora and fauna (e.g., species lists, abundances) | | | | |
| 2) description and listing of native species of wildlife and vegetation present | | | | |
| 3) description and listing of particularly invasive exotic species of wildlife and vegetation | | | | |
| 4) description and listing of rare and threatened species | | | | |
| b. Community and Habitat Characterization (p. 4-22) | | | | |
| 1) maps and descriptions of the aquatic, wetland, and terrestrial communities found in and around the project site | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| c. Ecologically Significant Features (p. 4-24) | | | | |
| 1) support of broader ecosystems by the project site (e.g., if located along a flyway or other biological corridor) | | | | |
| 2) important ecological functions of the project site (e.g., nutrient source through flooding, stormwater retention) | | | | |
| 3) characterization of relevant disturbance regimes, natural and project-induced (e.g., floods, fire, potential impact of logging) | | | | |
| 4) description of hydrologic processes (e.g., ground and surface water flows and durations) | | | | |
| 5) description of important biotic interactions (e.g., interdependence of plants and animals at the site and with other sites) | | | | |
| 4. Waste Management and Pollution Prevention (p. 4-27) | | | | |
| a. Locations of expected waste disposal or discharge | | | | |
| b. Description of waste management techniques (e.g., treatment, storage, transport, recycling) | | | | |
| c. Projected waste characteristics (e.g., types, quantities, toxicity) | | | | |
| 5. Socioeconomic Environment (p. 4-28) | | | | |
| a. Land Use (p. 4-29) | | | | |
| 1) description of present and historic land use | | | | |
| 2) map of present and historic land use | | | | |
| b. Population and Housing (p. 4-29) | | | | |
| 1) demographic information (e.g., average household size, average age, age/sex distributions, ethnic composition, and community cohesion) | | | | |
| c. Economic Activity (p. 4-30) | | | | |
| 1) description of present economic activity (e.g., number and type of businesses, annual revenues, ownership patterns) | | | | |
| 2) description of unique features of business community (e.g., high seasonality of trade, high outflow of profit, declining of trade, or downtown revitalization) | | | | |
| 3) consideration of interplay among economic activity, capacity of public services, and fiscal ability of community to respond to capacity needs | | | | |
| d. Community Services and Public Finance (p. 4-31) | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| 1) description of existing public facilities and services within vicinity of project, including existing level of use and remaining capacity to accommodate growth | | | | |
| e. Transportation (p. 4-32) | | | | |
| 1) description of all relevant forms of transportation for facility | | | | |
| 2) current traffic volumes | | | | |
| 3) current traffic capacity | | | | |
| 4) provision of public transportation | | | | |
| 5) assessment of the adequacy of the systems for meeting peak demands during construction and operation | | | | |
| f. Health and Safety (p. 4-32) | | | | |
| 1) description of present health and safety issues (e.g., statistics on industrial accidents, emissions data from prior and existing facilities, present levels of noise) | | | | |
| 2) identification of special populations or areas more likely to be exposed to adverse impacts | | | | |
| 6. Cultural Resources (p. 4-33) | | | | |
| a. Archaeological sites in relation to the project | | | | |
| b. Paleontological sites in relation to the project | | | | |
| c. Historic sites in relation to the project | | | | |
| d. Educational, religious, scientific, or cultural sites in relation to the project | | | | |
| *ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS* | | | | |
| The Environmental Impact Assessment discusses primary, secondary, and cumulative impacts during all stages, including initial site preparation and construction; facility operation, and post-facility or site closure for the following (p. 4-36): | | | | |
| 1. Pollutant Generation, Transport, and Receptors (p. 4-40) | | | | |
| a. Air Resources (p. 4-40) | | | | |
| 1) identification of emission sources and project emission rates and comparison to national, state, and local standards and limitations | | | | |
| 2) comparison of predicted atmospheric levels with national, state, or local ambient levels | | | | |
| 3) description of stack emissions during operation and maintenance activities and comparison with existing national, state, and local standards | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| 4) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| b. Water Resources (p. 4-42) | | | | |
| 1) address potential for water quality to be degraded by various factors | | | | |
| 2) prediction of pollutant concentrations in water bodies and comparison with existing national, state, and local water quality standards and criteria | | | | |
| 3) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| c. Geological Resources (p. 4-45) | | | | |
| 1) determination of potential soil loss and mitigation activities | | | | |
| 2) identification of potential contamination sources and mitigation measures | | | | |
| d. Biological Resources (p. 4-46) | | | | |
| 1) consideration of potential losses of biological resources within site boundaries | | | | |
| 2) description of effluent and emission concentrations and their potential effects to vegetation and wildlife | | | | |
| 3) discussion of bioaccumulative effects from facility emissions and discharges | | | | |
| 4) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| 2. Habitat Alteration (p. 4-46) | | | | |
| a. Biological Resources (p. 4-47) | | | | |
| 1) address potential for construction and site preparation activities to alter critical habitats for wildlife | | | | |
| 2) consideration of potential for secondary changes in habitats following construction and site preparation activities | | | | |
| 3) assessment of possible permanent loss or displacement of vegetation habitat due to operation | | | | |
| 4) identification of changes in local species composition, diversity, and abundances resulting from loss of specific habitats | | | | |
| 5) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| 3. Waste Management and Pollution Prevention (p. 4-52) | | | | |
| a. description of facility waste management plan with procedures for treatment, handling, and disposal | | | | |

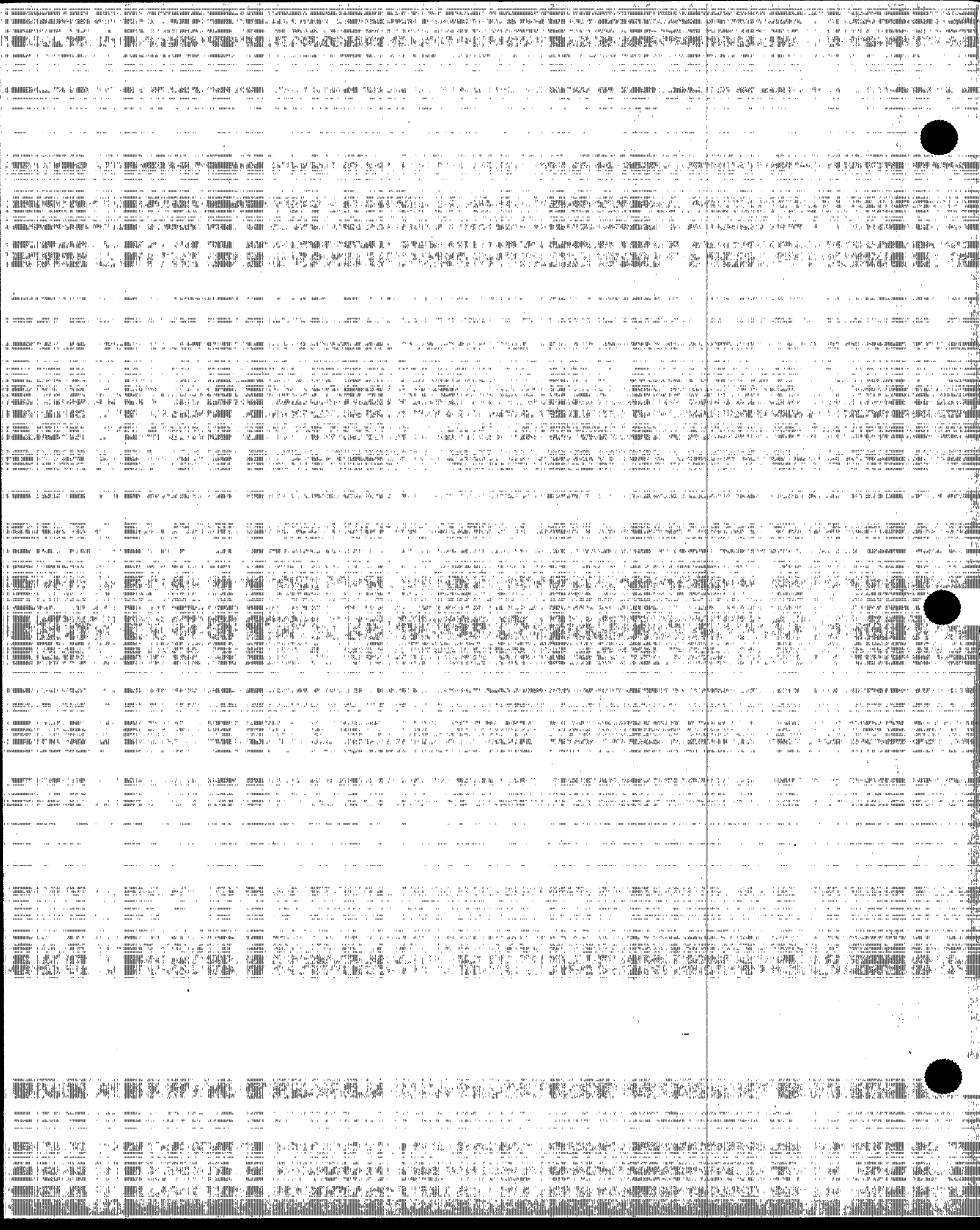
| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| b. discussion of projected facility waste characteristics | | | | |
| c. identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| 4. Socioeconomic Impacts (p. 4-53) | | | | |
| a. Land Use (p. 4-54) | | | | |
| 1) identification of the existing or planned land use areas lost due to site preparation and construction activities | | | | |
| 2) determination of conflicting zoning requirements and land uses with site preparation and construction activities | | | | |
| 3) description of anticipated changes in near by land use as a result of the facility and evaluation of conflicts that could arise during operations | | | | |
| 4) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| b. Economic Activity (p. 4-57) | | | | |
| 1) address changes in employment patterns | | | | |
| 2) address ability of available labor pool to meet project-related employment needs | | | | |
| 3) identification of economic multipliers used in analysis and their source | | | | |
| 4) discussion of potential change in overall economic activity in region | | | | |
| 5) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| c. Population and Housing (p. 4-58) | | | | |
| 1) address the relationship between employment increases and population in-migration | | | | |
| 2) identification of deficiencies in available housing for the potential increased workforce and their families | | | | |
| 3) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| d. Community Services and Public Finance (p. 4-59) | | | | |
| 1) identification of deficiencies in community services and infrastructure during project construction and operation | | | | |
| 2) identification of shortfalls in transportation capacity due to either primary or secondary impacts of the project | | | | |
| 3) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| e. Transportation (p. 4-61) | | | | |
| 1) assessment of proposed project's consistency with local and/or regional transportation plans | | | | |
| 2) evaluation of changes in LOS resulting from the proposed project and alternatives | | | | |
| 3) evaluation of the effect of heavy vehicle traffic on affected pavement and bridges | | | | |
| 4) description of mitigation measures to offset adverse impacts to structural integrity and public safety | | | | |
| f. Health and Safety (p. 4-62) | | | | |
| 1) evaluation of whether construction, operation, and maintenance activities present health and safety hazards to humans working or living at or near the project site | | | | |
| 2) discussion of potential effects of facility noise levels on workers, local communities, and local flora and fauna | | | | |
| 3) analysis of potential long-term contaminant bioaccumulation within the food chain | | | | |
| 4) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| g. Environmental Equity (p. 4-63) | | | | |
| 1) determination of the equity of changes in employment patterns attributable to site preparation and construction activities | | | | |
| 2) determination of the equity of community structure changes caused by project construction and operation | | | | |
| 3) identification of best mitigation measures to avoid or minimize adverse impacts | | | | |
| 5. Cultural Resources (p. 4-63) | | | | |
| a. identification of any historical or cultural resources in close proximity to the site following correspondence with appropriate authorities | | | | |
| b. discussion of mitigation measures necessary to preserve items of archaeological, historical, or cultural interest | | | | |
| c. determination of the extent to which construction, operation, and maintenance activities disrupt the aesthetic or sensory attributes of the site | | | | |
| d. determination of whether the facility components are designed with consideration given to human factors | | | | |
| MITIGATION MEASURES | | | | |
| 1. Mitigation Measures (p. 4-68) | | | | |

| Issue and Text Reference | N/A | Adequately Covered | Not Adequately Covered | Comments |
|---|---|---|---|---|
| a. description of mitigation activities for all significant impacts to both the natural and human (socioeconomic) environments | | | | |
| b. description of mitigation measures with adequate information to evaluate environmental consequences and residual impacts | | | | |
| c. identification of best mitigation measures to avoid or minimize potential impacts during all stages of the project, including siting and design, facility operation, and post facility closure. | | | | |
| d. support of the following types of mitigation measures, in the following decreasing order of preference:<br>- Avoidance or prevention<br>- Minimization<br>- Reduction or elimination over time<br>- Correction<br>- Compensation. | | | | |
| e. implementation plan (schedule) and criteria for performance for all mitigation measures. | | | | |
| f. responsible entity assigned to carrying out each mitigation measure. | | | | |
| g. measures are socially and culturally acceptable. | | | | |
| h. adequate financial and non-financial resources to implement the measures. | | | | |

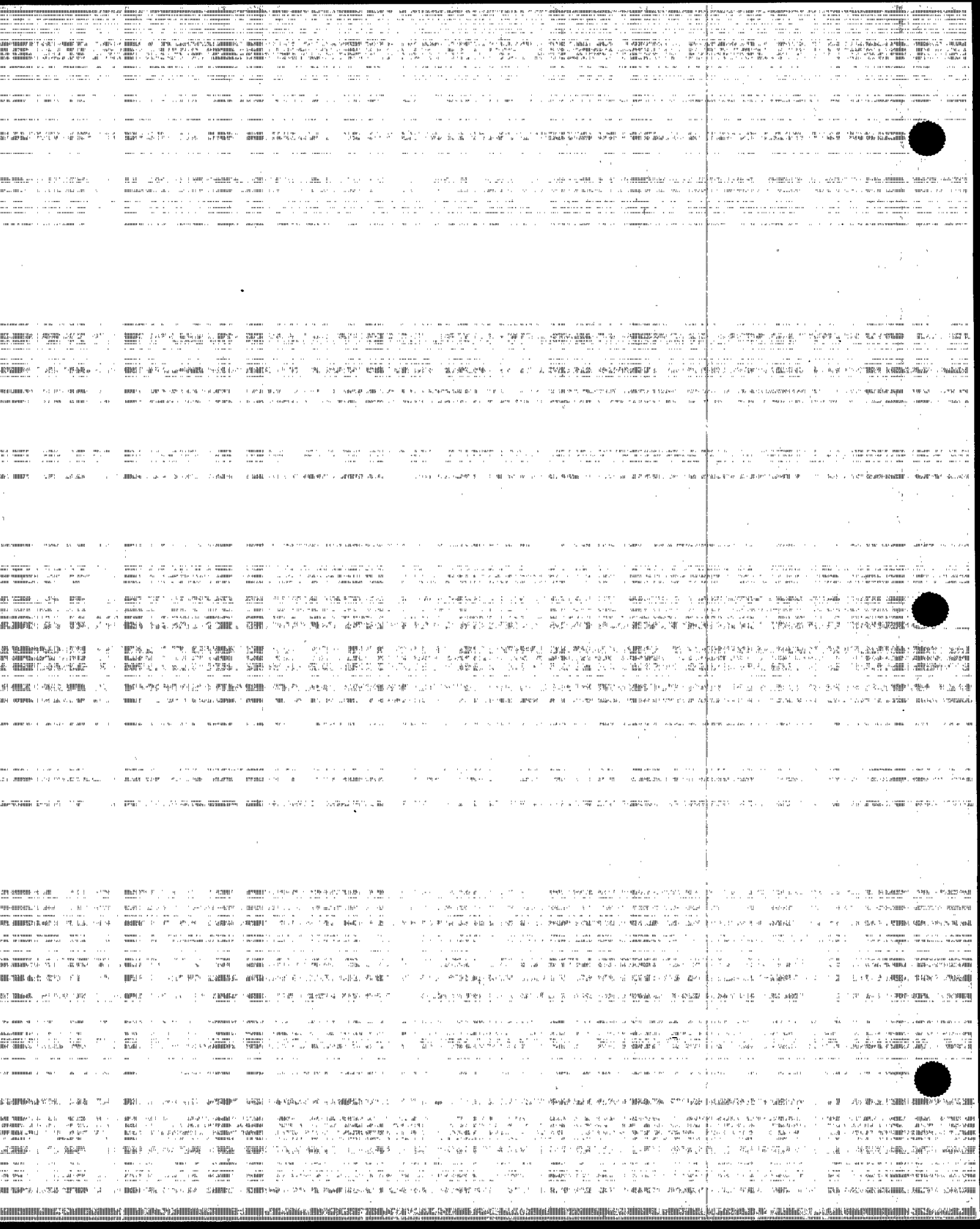
# SECTION 3

# WORLD BANK PROJECT-SPECIFIC IMPACTS AND MITIGATION MEASURES



# SECTION 3.1

# INDUSTRIAL IMPACTS



## INDUSTRIAL DISCHARGES

| Industries Producing Wastes | Origins of Major Wastes | Major Characteristics |
|---|---|---|
| Food and Drugs | | |
| Canned goods | Trimming, culling, juicing, and blanching of fruits and vegetables | High in suspended solids, colloidal and dissolved organic matter |
| Dairy products | Dilutions of whole milk, separated milk, buttermilk, and whey | High in dissolved organic matter, mainly protein fat, and lactose |
| Brewed and distilled beverages | Steeping and pressing of grain, residue from distillation of alcohol condensate from stillage evaporation | High in dissolved organic solids, containing nitrogen and fermented starches or their products |
| Meat and poultry products | Stockyards, slaughtering of animals rendering of bones and fats, residues in condensates, grease and wash water, picking of chickens | High in dissolved and suspended organic matter, blood, other proteins, and fats |
| Beet sugar | Transfer, screening and juicing waters, drainings from lime sludge, condensates after evaporator, juice, extracted sugar | High in dissolved and suspended organic matter, containing sugar and protein |
| Pharmaceutical products | Mycelium, spent filtrate and wash waters | High in suspended and dissolved organic matter including vitamins |
| Yeast | Residue from yeast filtration | High in solids (mainly organic) and BOD |
| Pickles | Lime water, brine, alum and turmeric, syrup, seeds and pieces of cucumber | Variable pH, high suspended solids, color, and organic matter |
| Coffee | Pulping and fermenting of coffee bean | High BOD and suspended solids |

| | | |
|---|---|---|
| Fish | Rejects from centrifuge, pressed fish, evaporator and other wash water wastes | Very high BOD, total organic solids, and odor |
| Rice | Soaking, cooking, and washing of rice | High in BOD, total and suspended solids, (mainly starch) |
| Soft drinks | Bottle washing, floor and equipment cleaning, syrup-storage-tank drains | High pH, suspended solids and BOD |
| **Apparel** | | |
| Textiles | Cooking of fibers, desizing of fabric | Highly alkaline, colored, high BOD and temperature, high suspended solids |

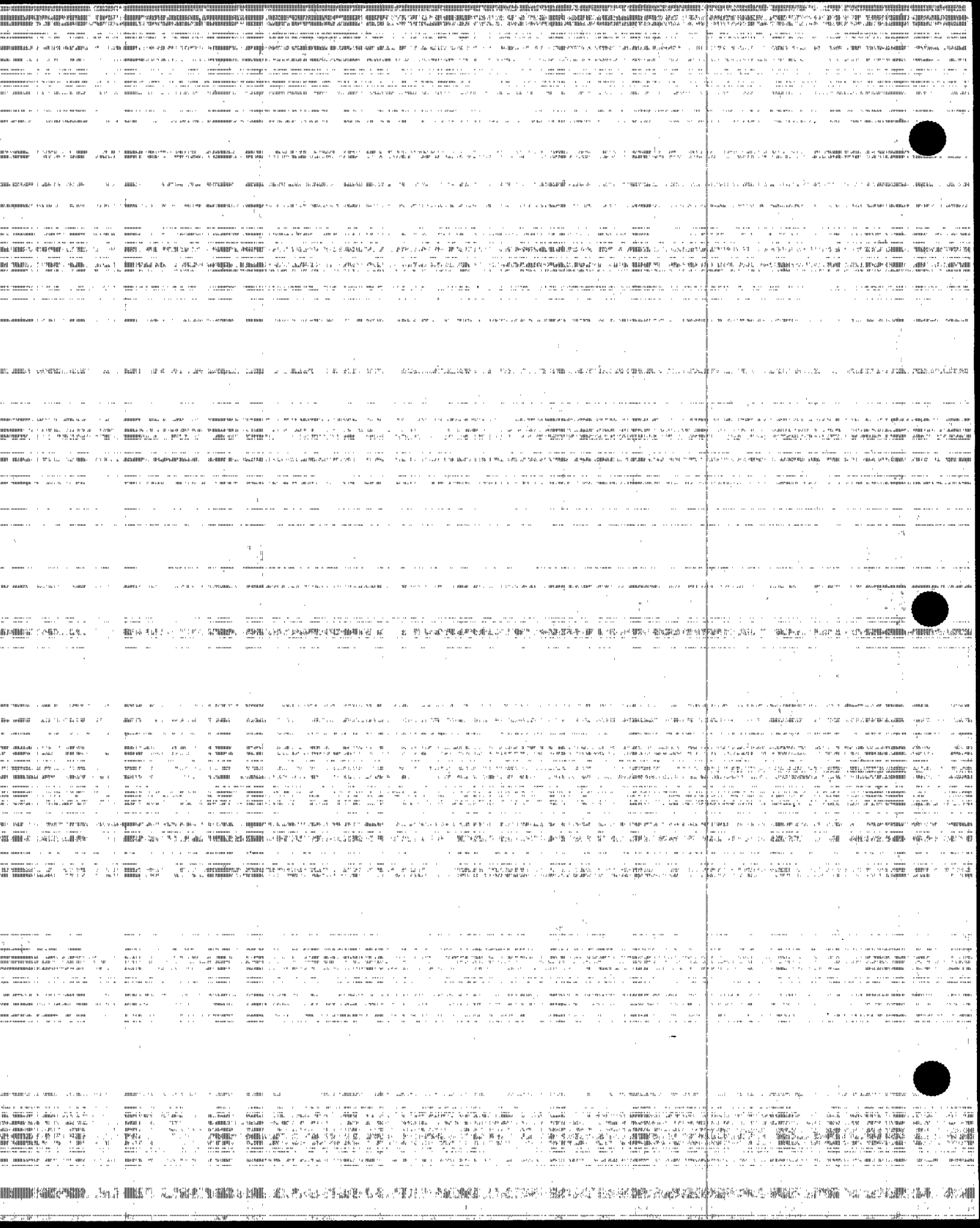
## INDUSTRIAL DISCHARGES

| Industries Producing Wastes | Origins of Major Wastes | Major Characteristics |
|---|---|---|
| Leather goods | Unhairing, soaking, deliming and bating hides | High total solids, hardness, salt, sulfides, chromium, ph, precipitated lime and BOD |
| Laundry trades | Washing of fabrics | High turbidity, alkalinity, and organic solids |
| Chemicals | | |
| Acids | Dilute wash waters; many varied dilute acids | Low pH, low organic content |
| Detergents | Washing and purifying soaps and detergents | High in BOD and saponified soaps |
| Cornstarch | Evaporator condensate, syrup from final from final washes, wastes from "bottling up" process | High BOD and dissolved organic matter; mainly starch and related material |
| Explosives | Washing TNT and guncotton for purification, washing and pickling of cartridges | TNT, colored, acid, odorous, and contians organic acids and alcohol from powder and cotton, metals, acid, oils& and soaps |
| Insecticides | Washing and purification products such as 2,4D and DDT | High organic matter, benzene ring structure, toxic to bacteria and fish, acid |
| Phosphate and phosphorous | Washing, screening, floating rock, condenser bleed-off from phosphate reduction plant | Clays, slimes and tall oils, low pH, high suspended solids, phosphorous, silica, and fluoride. |
| Formaldehyde | Residues from manufacturing synthetic resins, and from dyeing synthetic | Normally has high BOD and HCHO, toxic to bacteria in |

| | | |
|---|---|---|
| | fibers | high concentrations |
| Materials | | |
| Pulp and paper | Cooking, refining, washing of fibers screening of paper pulp | High or low pH; colored, high suspended, colloidal, and dissolved solids, inorganic fillers |
| Photographic products | Spent solutions of developer and fixer | Alkaline, contains organic and inorganic reducing agents |
| Steel | Coking of coal, washing of blast-furnace flue gases, and pickling of steel | Low pH, acids, cyanogen, phenol, ore, coke, limestone, alkali, oils, mill scale, and fine suspended solids |
| Metal-plated products | Stripping of oxides, cleaning and plating of metals | Acid, metals, toxic, low volume, mainly mineral matter |

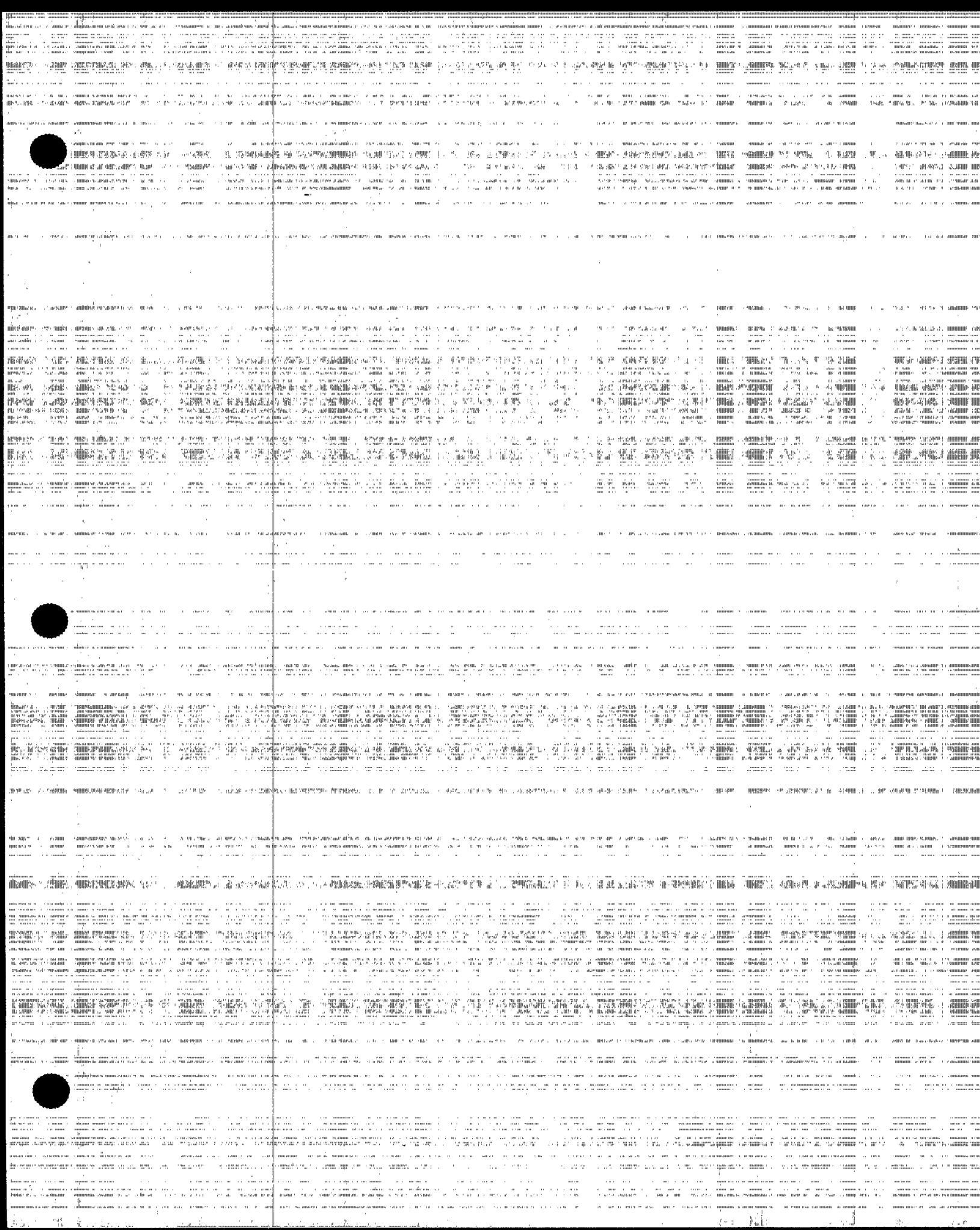
## INDUSTRIAL DISCHARGES

| Industries Producing Wastes | Origins of Major Wastes | Major Characteristics |
|---|---|---|
| Iron-foundry products | Wasting of used sand by hydraulic discharge | High suspended solids, mainly sand; some clay and coal |
| Oil | Drilling muds, salt, oil, and some natural gas, acid sludges and and miscellaneous oils from refining | High dissolved salts from field, high BOD, odor, phenol, and sulfur compounds from refinery |
| Rubber | Washing of latex, coagulated rubber exuded impurities from cured rubber | High BOD and odor, high suspended solids, variable pH, high chlorides |
| Glass | Polishing and cleaning of glass | Red color, alkaline non-settleable suspended solids |
| Naval stores | Washing of stumps, drop solution, solvent recovery, and oil recovery water | Acid, high BOD |
| Energy | | |
| Steam power | Cooling water, boiler blowdown coal drainage | Hot,high volume, high inorganic and dissolved solids |
| Coal processing | Cleaning and classification of coal leaching of sulfur strata with water | High suspended solids, mainly coal; low pH, high $H_2SO_4$ and $FeSO_4$ |
| Nuclear power and radio-active materials | Processing ores, laundering of contaminated clothes, research-lab wastes processing of fuel, power-plant cooling waters | Radioactive elements, can be very acid and "hot" "hot" |



# SECTION 3.2

# PROJECT SPECIFIC MITIGATION MEASURES
## WORLD BANK TABLES



## Table 8.1. Agroindustry

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant or facility complex on/near sensitive habitats. | 1. • Location of plant in rural area away from estuaries, wetlands, or other sensitive or ecologically important habitats, or in industrial estate to minimize or concentrate the stress on local environment and services.<br>• Involvement of natural resource agencies in review of siting alternatives. |
| 2. Siting of agroindustry along water courses leading to their eventual degradation. | 2. • Site selection examining alternatives which minimize environmental effects and not preclude beneficial use of the water body using the following siting guidelines:<br>• on a watercourse having a maximum dilution and waste absorbing capacity<br>• in an area where wastewater can be reused with minimal treatment for agricultural or industrial purposes<br>• within a municipality which is able to accept the plant wastes in their sewage treatment system |
| 3. Siting of agroindustry so that air pollution problems are aggravated. | 3. Location of plant at a high elevation above local topography, in an area not subject to air inversions, and where prevailing winds are away from populated areas. |
| **Direct: Agricultural Practices** | |
| 4. Environmental deterioration (erosion, contamination of water and soil, loss of soil fertility, disruption of wildlife habitat, etc.) from intensification of agricultural land use. | 4. Control of agricultural inputs and cropping/grazing practices to minimize environmental problems. |

**Table 8.1. Agroindustry (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. *Aggravation of solid waste problems in the area.* | 5. • *For facilities producing large volumes of waste, incorporation of the* following guidelines in site selection:<br>• plot size sufficient to provide a landfill or on-site disposal<br>• proximity to a suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal |
| 6. • Water pollution from discharge of liquid effluents.<br>• Plant: TSS; temperature; pH<br>• Materials storage piles runoff: TSS; pH | 6. Laboratory analysis of liquid effluent (including cooling water runoff from waste piles) in O/G, TDS, TSS, BOD, COD and in-situ temperature monitoring.<br><u>All plants, or as indicated by agroindustry type</u><br>• No cooling water discharge; if recycling not feasible, discharge cooling water only if receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to EPA specified limitation (40 CFR 405-409;432) for specific process.<br>• Land application of waste effluents where appropriate; the "Industrial Hazard Management" section should be consulted for guidelines regarding industrial hazardous materials. |
| 7. Particulate emissions to the atmosphere from all plant operations. | 7. Control of particulates by fabric filter collectors or electrostatic precipitators. |

Table 8.1. Agroindustry (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 8. Gaseous and odor emissions to the atmosphere from processing operations. | 8. Control by natural scrubbing action of alkaline materials; an analysis of raw materials during feasibility stage of project can determine levels of sulfur to properly design emission control equipment. |
| 9. Accidental release of potentially hazardous solvents, acidic and alkaline materials. | 9. Maintenance of storage and disposal areas to prevent accidental release; provide spill mitigation equipment. |
| **Indirect** | |
| 10. • Occupational health effects on workers due to fugitive dust, materials handling, noise, or other process operations.<br>• Accidents occur at higher than normal frequency because of level of knowledge and skill. | 10. • Development of a Safety and Health Program in the facility designed to identify, evaluate, and control safety and health hazards at a specific level of detail to address the hazards to worker health and safety and procedures for employee protection, including any or all of the following:<br>• site characterization and analysis<br>• site control<br>• training<br>• medical surveillance<br>• engineering controls, work practices and personal protective equipment<br>• monitoring<br>• information programs<br>• handling raw and process materials<br>• decontamination procedures<br>• emergency response<br>• illumination<br>• regular safety meetings<br>• sanitation at permanent and temporary facilities |

## Table 8.1. Agroindustry (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage. | 11. Plan for adequate on-site disposal areas assuming screening for hazardous characteristics of the leachate is known. |
| 12. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials and products to/from facility. | 12. Site selection can mitigate some of these problems, but special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts; transporter regulation and development of emergency contingency plans to minimize risk of accidents. |
| 13. Disease transmission from inadequate waste disposal. | 13. Develop specifications for product preparation and/or processing, and waste disposal processes; monitor fecal coliform or other bacteria; and require documentation of waste disposal site monitoring. |

**Table 8.1. Agroindustry (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|

**The following guidelines are World Bank guidelines. If they cannot be achieved, the appraisal and/or supervisory mission should fully document the reasons for deviations. Where local regulations differ from those below, the stricter regulations should prevail.**

Leather Tanning and Finishing

Waste constituents:

| | |
|---|---|
| Washing and soaking | $BOD_5$, TSS |
| Degreasing | $BOD_5$, TSS, O/G |
| Dehairing | $BOD_5$, TSS, pH, sulfides, nitrogen |
| Bating | Ammonia nitrogen |
| Pickling | Acids, salt |
| Tanning | Chromium, vegetable tannins |
| Retanning, coloring | Color, oil |
| Finishing | none |

Leather Tanning and Finishing

EPA Effluent Guidelines and Standards or use the following general guidelines.

| Constituent | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| $BOD_5$ | 2.8 | 3.2 | 2.6 | 1.0 | 3.2 | 1.4 |
| TSS | 3.0 | 3.6 | 2.8 | 1.2 | 3.6 | 1.6 |
| O/G | 1.1 | 1.3 | 1.0 | 0.48 | 1.3 | 0.68 |
| Sulfides | 0.010 | 0.012 | 0.010 | 0.004 | 0.012 | 0.006 |
| Tot. Cr. | 0.10 | 0.12 | 0.10 | 0.04 | 0.12 | 0.06 |
| TKN | 0.54 | 0.64 | 0.50 | 0.20 | 0.62 | 0.28 |
| pH | | | 6.0 to 9.0 | | | |
| Fecal Col. | | | Not over 400 per 100 ml | | | |

Plant Categories by Primary Process

A: Beamhouse - pulp hair; tanning-chrome; finishing
B: Beamhouse - save hair; tanning-chrome; finishing
C: Beamhouse - save hair; tanning-vegetable; finishing
D: Beamhouse - hair previously removed; tanned previously; finishing
E: Beamhouse - hair previously removed or retained; tanning-chrome; finishing
F: Beamhouse - pulp or save; tanning-chrome or no tanning; no finishing

**Table 8.1. Agroindustry (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Palm Oil Mills**<br><br>Waste streams are acidic and have high TSS, O/G, and $BOD_5$. | **Palm Oil Mill Effluent Control**<br><br>Limitations for liquid effluent include:<br><br>pH 6 to 9<br>BOD <100 mg/l<br>COD <1000 mg/l<br>TSS <500 mg/l<br><br>It is feasible to achieve 100 percent reduction of pollutant and waste effluent discharged to surface waters by one of the following:<br><br>• spray irrigation<br>• land application<br>• evaporation ponds<br>• discharge to municipal sewage treatment systems |
| **Slaughterhouses**<br><br>Most important liquid effluent parameters are: $BOD_5$, TSS, O/G, pH, and fecal coliform organisms. | **Slaughterhouse Maximum Daily Effluent Limitations**<br><br>Plant Type — BOD (a) — TSS (b) — O/G — pH<br>simple — 0.12 — 0.20 — 0.06 — 6-9<br>complex — 0.21 — 0.25 — 0.08 — 6-9<br><br>a) per kg<br>Live wt killed b) per megagram<br><br>MPN fecal coliform count <400 per 100 ml |

**Table 8.1. Agroindustry (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| Wool Scouring | |
| Raw waste contains significant quantities of O/G whose biodegradability constituents a special problem. | Grease recovery step is necessary to decrease potential pollution from O/G. |
| Sulfur is brought in with wool, as well as phenolic and other organic compounds; this could be discharged to receiving waters. | Liquid Effluent Guidelines: Mg = megagram; mg = milligram<br>$BOD_5$ 5 Kg/Mg product<br>TSS 4 Kg/Mg product<br>COD 20 Kg/Mg product<br>O/G 7.2 mg/l<br>Total Chromium 0.1 mg/l<br>Phenol 0.1 mg/l<br>Sulfide 0.2 mg/l<br>Pesticides 0.01 mg/l |

## Table 8.2. Dams and Reservoirs

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. • Negative environmental effects of construction:<br>• air and water pollution from construction and waste disposal<br>• soil erosion<br>• destruction of vegetation, sanitary and health problems from construction camps | 1. • Measures to minimize impacts:<br>• air and water pollution control<br>• careful location of camps, buildings, borrow pits, quarries, spoil and disposal sites<br>• precautions to minimize erosion<br>• land reclamation |
| 2. Dislocation of people living in inundation zone. | 2. Relocation of people to suitable area, provision of compensation in kind for resources lost, provision of adequate health services, infrastructure, and employment opportunities. |
| 3. Loss of land (agricultural, forest, range, wetlands) by inundation to form reservoir. | 3. Siting of dam to decrease losses; decrease size of dam and reservoir; protect equal areas in region to offset losses. |
| 4. Loss of historic, cultural or aesthetic features by inundation. | 4. Siting of dam or decrease of reservoir size to avoid loss; salvage or protection of cultural properties. |
| 5. Loss of wildlands and wildlife habitat. | 5. Siting of dam or decrease of reservoir size to avoid/minimize loss; establishment of compensatory parks or reserved areas; animal rescue and relocation. |
| 6. Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation systems, navigation and fisheries and increasing water loss through transpiration. | 6. Clearance of woody vegetation from inundation zone prior to flooding (nutrient removal); provide weed control measures; harvest of weeds for compost, fodder or biogas; regulation of water discharge and manipulation of water levels to discourage weed growth. |

Table 8.2. Dams and Reservoirs (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 7. Deterioration of water quality in reservoir. | 7. • Clearance of woody vegetation from inundation zone prior to flooding.<br>• Control of land uses, wastewater discharges, and agricultural chemical use in watershed.<br>• Limit retention time of water in reservoir.<br>• Provision for multi-level releases to avoid discharge of anoxic water. |
| 8. Sedimentation of reservoir and loss of storage capacity. | 8. • Control of land use in watershed (especially prevention of conversion of forests to agriculture).<br>• Reforestation and/or soil conservation activities in watersheds (limited affect).<br>• Hydraulic removal of sediments (flushing, sluicing, release of density currents). |
| 9. Formation of sediment deposits at reservoir entrance creating backwater effect and flooding and waterlogging upstream. | 9. Sediment flushing, sluicing. |
| 10. Scouring of riverbed below dam. | 10. Design of trap efficiency and sediment release (e.g., sediment flushing, sluicing) to increase salt content of released water. |
| 11. Decrease in floodplain (recession) agriculture. | 11. Regulation of dam releases to partially replicate natural flooding regime. |

Table 8.2. Dams and Reservoirs (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 12. Salinization of floodplain lands. | 12. Regulation of flow to minimize effect. |
| 13. Salt water intrusion in estuary and upstream. | 13. Maintenance of at least minimum flow to prevent intrusion. |
| 14. Disruption of riverine fisheries due to changes in flow, blocking of fish migration, and changes in water quality and limnology. | 14. Maintenance of at least minimum flow for fisheries; provision of fish ladders and other means of passage; provide protection of spawning grounds; aquaculture and development of reservoir fisheries in compensation. |
| 15. Snagging of fishing nets in submerged vegetation in reservoir. | 15. Selective clearance of vegetation before flooding. |
| 16. Increase of water-related diseases. | 16. • Design and operation of dam to decrease habitat for vector.<br>• Vector control.<br>• Disease prophylaxis and treatment. |
| 17. Conflicting demands for water use. | 17. Planning and management of dam in context of regional development plans; equitable allocations of water between large and small holders and between geographic regions of valley. |
| 18. Social disruption and decrease in standard of living of resettled people. | 18. Maintenance of standard of living by ensuring access to resources at least equalling those lost; provision of health and social services. |

Table 8.2. Dams and Reservoirs (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 19. Environmental degradation from increased pressure on land. | 19. • Choice of resettlement site to avoid surpassing carrying capacity of the land.<br>• Increase of productivity or improve management of land (agricultural, range, forestry improvements) to accommodate higher population. |
| 20. Disruption/destruction of tribal/indigenous groups. | 20. Avoid dislocation of unacculturated people; where not possible, relocate in area allowing them to retain lifestyle and customs. |
| 21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos, tsetse). | 21. Vector control. |
| **Indirect** | |
| 22. Uncontrolled migration of people into the area, made possible by access roads and transmission lines. | 22. Limitation of access, provision of rural development and health services to try to minimize impact. |

Table 8.2. Dams and Reservoirs (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 23. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth). | 23. Basin-wide integrated planning to avoid overuse, misuse, and conflicting uses of water and land resources. |
| **External** | |
| 24. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality. | 24. Land use planning efforts which include watershed areas above dam. |

## Table 8.3. Fisheries

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct Impacts: Capture Fisheries** | |
| 1. Overexploitation of fisheries stock and long-term degradation of the resource base. | 1. • Fisheries management for optimum sustained yield:<br>• restricted harvests (minimum size limits, catch quotas, seasonal closures)<br>• gear restrictions (trawl bans, specified net mesh sizes)<br>• closure of areas (permanent reserves, periodic closures)<br>• limited entry systems (licensing, exclusive access)<br>• prohibited practices (use of explosives, drift nets)<br>• consideration of sustainable traditional fishery practices and incorporation to extent possible in modern fisheries management systems |
| 2. Capture of non-target species and habitat damage through use of certain equipment and fishing practices. | 2. • Limitation or prohibition of use of such equipment and fishing practices.<br>• Testing and pilot scale use prior to large scale introduction of new technologies.<br>• Expanded use of fish by development of new products and markets. |
| 3. Pollution from oil and fuel spills and leakage, and from bilge flushing. | 3. • Public education programs on proper fuel and oil handling and bilge waste disposal.<br>• Provision of storage and handling facilities, bilge evacuation and disposal services.<br>• See "Inland Navigation" and "Port and Harbor Facilities" sections in Chapter 9. |

**Table 8.3. Fisheries (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct Impacts: Capture Fisheries (continued)** | |
| 4. Diver and anchor damage. | 4. • Public education programs for fishermen on effects of damage and ways to avoid it.<br>• Installation of mooring buoys.<br>• Designation of anchoring locations. |
| 5. "Ghost-fishing" and navigational hazards from abandoned or lost fishing nets and traps. | 5. Public education programs for fishermen on hazards of abandoning gear. |
| 6. Use of explosives and poison. | 6. Prohibition of practices and enforcement of regulations. |
| 7. Introduction of exotics leading to degradation of native stocks. | 7. Prohibition of exotics introduction. |
| **Direct: Culture Fisheries** | |
| 8. Clearing/conversion of coastal wetlands for construction of ponds. | 8. • Prohibition of ponds in area of particular ecological significance.<br>• Limitation of area converted to ponds.<br>• Intensified management in existing and new ponds to discourage "shifting aquaculture" and low-input, extensive aquaculture which converts large areas. |

Table 8.3. Fisheries (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Culture Fisheries (continued)** | |
| 9. Erosion and siltation problems arising in construction phase. | 9. • Restriction of clearance to area needed for ponds.<br>• Pond construction during dry seasons.<br>• Stabilization of exposed soil with grasses or other ground covering. |
| 10. Competition of ponds for water and land resources demanded by other users. | 10. • Assessment of existing traditional land and water use and agricultural, industrial and municipal demands.<br>• Planning, management and continuing negotiations to reach acceptable distribution of resources.<br>• Siting of pond to avoid disruption of traditional uses of water for washing and drinking.<br>• Coordination of aquaculture ponds with other activities to double-up on water use (e.g., pond water reused for irrigation). |
| 11. Loss of productivity or formation of toxic conditions in ponds from high temperatures, low oxygen and waste accumulation. | 11. Adequate pond water exchange and frequent pond flushing. |
| 12. Acidification of pond water due to hydrogen sulfide formation. | 12. • Siting in areas not susceptible to acidification (avoid waterlogged soils high in pyrite and organic matter).<br>• Adequate pond water exchange and flushing. |

Table 8.3. Fisheries (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Culture Fisheries (continued)** | |
| 13. Local depletion of larval and juvenile organisms for pond stocking. | 13. Production of larvae and juveniles in nursery. |
| 14. Water pollution from pond effluent (nutrient-rich and with varying chemical content depending on intensity of pond management). | 14. • Release into water body with adequate dilution and dispersal capability.<br>• Dilution prior to release.<br>• Timing of release with period of high water.<br>• Shorter retention time of water in pond: more frequent pond water exchange and flushing.<br>• Treatment of water prior to release. |
| 15. Introduction of exotics with subsequent damage to native stocks by competition, predation, spread of disease and parasites. | 15. • Avoidance of exotic introductions except where adequate knowledge of biology and life history of species indicates low risk of negative impacts and where adequate safeguards against escape are taken.<br>• Regular monitoring for disease and parasites; if present and spreading, elimination of infected populations.<br>• Consideration of using sterile hybrids. |

Table 8.3. Fisheries (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Culture Fisheries (continued)** | |
| 16. Spread of disease in aquaculture stocks and into natural stocks when stocking becomes too dense. | 16. • Monitoring of disease incidence.<br>• Limitation of numbers when disease is positively correlated with fish densities.<br>• If disease spreads, elimination of diseased individuals. |
| 17. Concentration of pens, pilings, and rafts in natural (non-pond) water bodies to extent that navigation is hampered, water circulation is restricted, water quality is decreased, and capture fisheries precluded. | 17. Regulation of aquaculture activity to limit it to acceptable intensity. |
| **External Impacts: Capture Fisheries and Culture Fisheries** | |
| 18. Dams which alter water quality and stream flows and disrupt riverine and floodplain fisheries. | 18. • Establishment of reservoir fishery. Water release management to minimize damage to fisheries (see "Dams and Reservoirs" section). |
| 19. Irrigation schemes which alter water quality and quantity. | 19. • Development of fishery activities in conjunction with irrigation systems (e.g., use of pond water for irrigation, traps and nets in irrigation canals).<br>• Management of irrigation schemes to minimize damage to fisheries (see "Irrigation and Drainage" section). |

**Table 8.3. Fisheries (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **External Impacts: Capture Fisheries and Culture Fisheries (continued)** | |
| 20. Land use and agricultural practices in watersheds affecting sediment content and water quality. | 20. • Integrated watershed planning and management.<br>• Close coordination between fisheries and government agencies responsible for resource management in watersheds to alert them to impacts on fisheries. |
| 21. Flood control measures damaging to water quantity and quality and aquatic habitats. | 21. See "Flood Protection" section. |
| 22. Pollution from industrial effluent, sewage and agrochemicals affecting fish survival and tainting fish. | 22. See "Wastewater Collection, Treatment, Reuse, and Disposal Systems" section in Chapter 9; see also the sections on "Plant Siting and Industrial Estate Management" and "Industrial Hazard Management" in Chapter 10. |
| 23. Air pollution and acid rain affecting fish survival. | 23. See "Atmospheric Pollution" section in Chapter 2. |
| 24. Coastal development involving dredging, filling, destruction of mangrove swamps, construction and infrastructure development. | 24. See "Coastal Zone Management" section; "Port and Harbor Facilities" projects are discussed in Chapter 9. |
| 25. Oil pollution from coastal and inland navigation, and spills from drilling, transport operations, and oil tankers (cleaning of tanks). | 25. See the following sections in Chapter 9: "Inland Navigation" and "Port and Harbor Facilities"; "Oil and Gas Development--Offshore" and "Oil and Gas Development--Onshore" are examined in Chapter 10. |
| 26. Water-based tourism development which conflicts with fishing activities. | 26. See "Tourism Development" section in Chapter 9. |

**Table 8.3. Fisheries (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect Impacts: Capture Fisheries and Culture Fisheries** | |
| 27. Creation or expansion of port areas, shore facilities and infrastructure (roads, water, power) for processing and transport of fish products. | 27. See "Plant Siting and Industrial Estate Management"; "Coastal Zone Management"; and "Port and Harbor Facilities." |
| 28. Pollution from effluent discharged from industrial fish processing plants. | 28. • Discharge into waters with adequate dilution and dispersal capabilities.<br>• Water quality monitoring for suspended solids, oil and grease, dissolved oxygen, nitrogen and coliform.<br>• Reduction of wastes by recycling into usable products, reduction of water use.<br>• Treatment of waste prior to release. |

## Table 8.4. Flood Protection

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Flooding of lesser magnitude, but greater duration of floodplain downstream due to dam releases. | 1. Adaptation by changes in agricultural practices. |
| 2. Potential for structural failure and floodwaters higher than capacity of control structures/measures, leading to increased risk to life and property because local pre-project adaptations are relaxed or abandoned or increased development on the floodplain has occurred post-project. | 2. Implementation of non-structural measures to prevent increased flood risk, and of a flood warning system. |
| 3. Cycle of enrichment and groundwater recharge in floodplain soils broken. | 3. Where dams are present, partial mitigation of effect by regulation of discharge to imitate natural flooding in a controlled way. |
| 4. Resettlement of populations and other negative socioeconomic effects on populations and communities affected by the project. | 4. • Identification of at-risk population groups or groups who may be adversely affected by flood control measures.<br>• Incorporation of their interests and protection into project planning and cost analysis to minimize losses or provide in-kind compensation for losses. |
| 5. Adverse effects on fisheries and other aquatic resources by disruption of migratory routes, deterioration of habitat and changes in water quality (e.g., sediment load), leading to reduced productivity of riverine, coastal and marine fisheries. | 5. • Installation of fish passageways. Protection of reproductive sites for fish.<br>• Incorporation of fishery management, including hatchery and restocking programs. |

**Table 8.4. Flood Protection (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. • Negative impacts of channelization measures:<br>• disruption of fish habitat by elimination of pools, riffles and channel irregularities<br>• increased water temperature by removal of vegetation on banks and in stream<br>• increased erosion and sedimentation problems<br>• bed and bank erosion<br>• downstream flooding and sedimentation | 6. • Careful selection of engineering options at planning stage.<br>• Limitation of degree of channel modification or maintenance.<br>• Mitigating measures after construction phase.<br>• Minimize reduction of channel length and preserve some meanders.<br>• Limit excavation and fill.<br>• Limit destruction of bank and streamside vegetation.<br>• Replant/reseed banks.<br>• Excavate only one and not both banks, etc. (See Brookes 1988.) |
| 7. Adverse effects of construction. | 7. • Minimization of effects by avoiding impediments to natural drainage, uncontrolled run-off and soil erosion, and air pollution.<br>• Provision for adequate filling of borrow areas, control of land clearing, and disposal of spoil.<br>• Limitation of access of vehicles to stream bank. |

**Table 8.4. Flood Protection (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 8. Reduction of floodplain grazing, both through ecological changes on the floodplain and intensified development (e.g., irrigated agriculture). | 8. • Production of fodder crops and usage of byproducts of irrigated food crops and development of alternative water sources.<br>• Integration of existing rangeland use (e.g., semi-nomadic herding) with planned developments, to ensure substantial grazing and watering possibilities in valley during dry season. |
| 9. Reduction of recession agriculture. | 9. Maintenance of natural flooding regime to extent possible in most productive lands (and intensification of production) by maintaining water courses free of flood control structures or installing structures to enable semi-controlled flooding. |
| 10. Obstacles (levees, dikes, etc.) to wildlife passage. | 10. Construction of bridges or special crossing places. |
| 11. Loss of wildlands and wildlife habitat. | 11. Identification of critical habitats and planning of flood control measures to minimize effects; where habitats or species are dependent on natural flooding regime, minimize disruption of flow in that area to extent possible. |
| 12. Flooding problems created downstream. | 12. • Protection of natural overflow areas downstream.<br>• Creation of overflow basins. |

**Table 8.4. Flood Protection (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 13. Improved accessibility, development opportunities in floodplain, and sense of security after flood control measures taken, leading to influx of people with associated agricultural development, deforestation, wildlife poaching, infrastructure development, etc. | 13. • Limitation of access, if possible.<br>• Planning for anticipated influx and implementation of companion rural development activities.<br>• Introduction of non-structural control measures. |
| 14. Increased fertilizer use on agricultural fields to compensate for loss of fertility, leading to water pollution and dependence on imported supplies. | 14. • Optimal timing and rate of application.<br>• Use of nitrogen fixing cover crops.<br>• Use of organic instead of chemical fertilizers. |

## Table 8.5. Natural Forest Management

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Logging** | |
| 1. • Soils | |
| • Erosion: disturbance of the forest understory and soil, increasing susceptibility to water erosion.<br>• Slope stability: roadcuts across sloping terrain and clearing of vegetation on the slopes resulting in landslips and landslides.<br>• Nutrient loss: loss of nutrients from timber harvesting and increased leaching; exposed, disturbed soils where vegetation has been removed.<br>• Temperature: dramatic increase in temperature after removal of forest canopy, killing soil organisms or drying the soil to extent that regeneration is hindered.<br>• Structure: compaction and loss of organic matter altering soil structure, and reducing infiltration, water holding capacity, aeration and root penetration; laterization. | 1. • Avoid logging in the rainy season and establish criteria for logging on slopes and near water; and clearly mark areas that should not be harvested.<br>• Supervise logging to reduce damage and encourage rapid regeneration.<br>• Use low impact harvesting equipment and methods and minimize skid trail distances.<br>• Locate log landing in well drained, easily accessible areas downslope so a straight skid road can be followed.<br>• Restore land by grading and reseeding disturbed areas, including guidelines, locating them away from slopes and water and keeping them well maintained.<br>• No whole-tree harvest in areas of low nutrient levels, leaving all but boles on the site. |
| 2. • Vegetation | |
| • Species composition: species diversity decreased by selectively harvesting the best stems of valuable species. Soil conditions and light regimes created by various harvesting methods influencing regeneration dynamics of forest stands. | 2. • Collect information or sponsor research on plant community dynamics, regeneration biology and silviculture of forest type.<br>• Consider (and perhaps research) various regeneration and harvesting methods. |

**Table 8.5. Natural Forest Management (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Logging** | |
| 2. • Vegetation (continued) | |
| • Weeds: opening of the forest canopy resulting invasion of weeds, impeding natural regeneration and reforestation efforts.<br>• Slash: logging debris as a fire hazard and impediment to regeneration.<br>• Blow downs: increased danger due to opening up patches by logging. | • Collect information or sponsor research on plant community dynamics, regeneration biology and silviculture of forest type.<br>• Consider (and perhaps research) various regeneration and harvesting methods.<br>• Choose silvicultural system that will ensure regeneration and sustainable production and minimize damage (leave adequate number and quality of seed trees, selective harvest, small cuts to avoid large gaps).<br>• Establish preserves/parks of ecologically significant forest areas, ensuring that area is large enough to maintain biological diversity, ecological processes and cultural assets. |
| 3. • Wildlife | 3. • Maintain inventory of and collection of research results on species present in the area. |
| • Fisheries: sedimentation, nutrient loading, changes in streamflow and water temperature caused by logging causing dramatic changes to fish populations.<br>• Wildlife habitat: disruption of habitat, loss of tree species on which wildlife species depend, and disturbing migratory routes of wildlife leading to depletion of wildlife.<br>• Presence of machines and people: disturbance of wildlife through logging and transport activities.<br>• Poaching: increased poaching of wildlife due to influx of people resulting directly and indirectly from forestry activities. | • Plan harvesting intensity, methods and timing based on this information.<br>• In particular, ascertain presence of or migratory use by endangered species through contact with wildlife professionals in government, NGOs and universities. |

Table 8.5. Natural Forest Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Logging (continued)** | |
| 4. • Air<br>• Dust: logging activities and timber transportation on dirt roads generating large amounts of dust in dry season or semi-arid zones. | 4. • Reduce burning.<br>• Avoid creating large tracts of open land.<br>• Limit operations when dust and fire are a problem and plan transportation routes to avoid population centers. |
| 5. • Water<br>• Extremes of flow: soil infiltration and water holding capacity of harvested areas reduced such that water runoff is much more pronounced, aggravating flooding when rains come and low flow during dry season.<br>• Groundwater recharge: rain water recharge of aquifers reduced due to increased runoff.<br>• Ponding and stagnation: land form changes, water course obstruction and soil compaction causing localized ponding and stagnation. Increased sedimentation altering natural aquatic biology and water course features.<br>• Increased temperature: opening of the forest canopy adjacent to water body increasing water temperature, which alter aquatic biology and water chemistry.<br>• Contamination: water pollution from petroleum products, herbicides and organic waste associated with forestry operations. Turbidity due to increased sediment loading altering sunlight penetration, affecting aquatic plants and damaging fish species. | 5. • Maintain vegetation as buffer zones adjacent to every body of water.<br>• Assess impact of forestry on sediment and nutrient loading on stream flow and methods used to reduce impact.<br>• Provide adequate waste disposal facilities.<br>• Procedure for use and storage of chemicals, oil and fuel to minimize potential for pollution. |

Table 8.5. Natural Forest Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Logging (continued)** | |
| 6. • Social and Cultural<br>• Local economic and social customs: impacts on labor market and labor availability for food production, a shift to more cash-based economy, alteration of daily living patterns and political power structure changes are common.<br>• Land tenure and traditional forest uses: hunting, gathering and traditional exploitation of forest resources disrupted; limitation of access of resources by local populations.<br>• Overloading of infrastructure and social services (e.g., housing, education and health services) by in-migration of forest workers and spontaneous settlers and social problems such as an increase in crime, alcoholism, disease and violence. | 6. • Incorporate local communities in planning and execution of project.<br>• Develop local infrastructure to handle increase in population (i.e., waste disposal, school, health care and law enforcement).<br>• Protect significant cultural landmarks and traditional land and resource use patterns.<br>• Establish clear, long-term jurisdiction over the forest emphasizing local involvement in decision making.<br>• Involve local leaders in protection to avoid illegal harvesting or settlement.<br>• Monitor and control disease. |
| **Indirect: General** | |
| 7. • Increased access: roads opening forest areas causing uncontrolled population in-migration with subsequent problems. | 7. See "Rural Roads" section. |
| **Indirect: Road Construction and Transport** | |
| 8. • Direct impacts (e.g., increased soil erosion and sedimentation of surface water) and indirect impacts of road construction (see "Rural Roads" section). | 8. Align route, drainage works, etc. (See No. 7.) |

## Table 8.5. Natural Forest Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect: Road Construction and Transport (continued)** | |
| 9. • Degradation of existing public roads by heavy timber loads. | 9. • Restrict load size.<br>• Use road taxes to upgrade road. |
| **External** | |
| 10. *Cattle-ranching operations* that clear forests for pasture. | 10. See "Livestock and Rangeland Management" section. |
| 11. Conversion to commercial agriculture (rubber, oil palm, coffee, rice, etc.). | |

## Table 8.6. Plantation Development/Reforestation

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Preparation** | |
| 1. Soil erosion from clearing site. | 1. • Reestablishment of forest cover as soon as possible after clearing.<br>• Use of fast growing, intermediate tree crops or mulching of exposed soils.<br>• No clearing on steep, unstable slopes or highly erosive soils.<br>• Limitation of plantation size or stand sizes.<br>• Limitation of site preparation to dry season. |
| 2. Soil compaction and puddling by machinery. | 2. • Limitation of use of machinery.<br>• Manual site preparation. |
| 3. • Loss of organic matter and nutrients by removal of vegetation and leaching.<br>• Development of hardpans and laterization. | 3. • Rapid replanting.<br>• Cover crops.<br>• Mulching. |
| 4. Where burning is involved, air pollution from smoke. | 4. • Limitation of use of fire and size of burn where possible.<br>• Burning in wet season. |

## Table 8.6. Plantation Development/Reforestation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plantation Management and Harvesting** | |
| 5. Soil erosion from harvesting. | 5. • Replanting as soon as possible after cut.<br>• Avoidance of clear cutting; practice of "small coupe logging" (characterized by checkerboard pattern of alternating small cuts with unlogged areas).<br>• Limitation of harvesting to dry season or season of low rainfall.<br>• Planning of felling to minimize log skidding and avoidance of skidding logs parallel to slope.<br>• Stabilize skid trails as soon as possible after use.<br>• Use of animals instead of skidders for extraction. |
| 6. Loss of nutrients from the system by thinning and clear cutting and by whole-tree harvest. | 6. • Logging debris left on ground after harvesting and removal of boles only (no whole-tree harvesting).<br>• Planting of cover crops between rotations; addition of fertilizer to compensate for nutrients loss. |
| 7. Use of fertilizer, pesticides and herbicides having negative impacts on-site and on quality of local water bodies. | 7. • Limitation of potential of pest and disease infestations by choice of resistant species.<br>• Choice of chemicals with least potential negative impacts.<br>• Controlled use of chemicals. |

**Table 8.6. Plantation Development/Reforestation (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plantation Management and Harvesting (continued)** | |
| 8. Chemical and biological changes in the soil as litter becomes dominated by one or a few species and decomposition dynamics are altered. | 8. Limitation of size of stands and interspersal with stands of native vegetation. |
| 9. • Direct damage in harvesting operations by dragging and skidding logs causing compaction.<br>• Localized soil erosion and unequal distribution of debris and organic matter over the site. | 9. • Use of manual methods or animal power for clearing forest instead of mechanical means.<br>• In short rotation plantations plan use of same tracks and loading areas in harvesting operations to protect as much of site as possible. |
| 10. In semi-arid zones depletion of soil moisture and lowering of water table in plantation area. | 10. • Choice of low water demanding species.<br>• Water catchment and conservation techniques to minimize runoff and evaporation losses and maximize infiltration. |
| 11. Build up of organic matter under plantations posing a fire hazard. | 11. Periodic clearing or burning to keep volume low. |
| 12. Increased sedimentation of streams. | 12. • Buffer zones of undisturbed forest 20-40 m wide along streams.<br>• Avoidance of earthfill dams across streams as crossings.<br>• Sediment traps in streams.<br>• Avoidance of skidding trees in stream. |

Table 8.6. Plantation Development/Reforestation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plantation Management and Harvesting (continued)** | |
| 13. Increased organic matter entering surface waters in form of leaf litter and logging debris or from logs transported on river leading to decrease in water quality and perhaps eutrophication, and navigational hazards. | 13. • Buffer zones along streams.<br>• Spaced transport of logs in river over time. |
| 14. Soil erosion from logging roads. | 14. • Siting of roads on ridge tops or valley bottoms and avoidance of steep grades on hillsides.<br>• Engineering to ensure proper drainage or provision of drainage measures.<br>• Stabilization of road cuts with mulch, wood chips, etc.<br>• Minimized use of borrow pits or stabilization after use.<br>• Proper road maintenance.<br>• Use of rivers for log transport (see also "Rural Roads" section). |
| **Displacement of Other Ecosystems** | |
| 15. Loss of habitat and decreased biological diversity by replacement of natural forest by plantations with limited number of species and increased uniformity of forest structure. | 15. • Protection of natural forest area with particularly high or unique biological diversity.<br>• Limitation of plantation establishment to degraded sites or sites of low diversity. |

Table 8.6. Plantation Development/Reforestation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Displacement of Other Ecosystems (continued)** | |
| | • Increase in number of species planted and avoidance of monocultures over large area.<br>• Restriction of size of individual stands and mixing of stands of various age classes.<br>• Conservation of islands of untouched forest or natural vegetation.<br>• Separation of stands by belts of native vegetation and use of native species as plantation species. |
| 16. Increased potential for massive loss by pests or pathogens (through simplification of natural ecosystem, provision of abundant food for pest, increased pest habitat, absence of natural controls (e.g., in the case of introduced exotic tree species). | 16. • Use of native species.<br>• Choice of species and provenances with pest or disease resistance.<br>• Rotation length to minimize susceptibility (e.g., cutting before trees are overmature).<br>• Thinning and other stand improvement measures to remove dead and diseased material, and wood residues which act as centers for infection.<br>• Direct pest or disease control. |
| 17. Loss of forest products from native species. | 17. Careful evaluation of local use of forest products to accommodate continued use and determine feasibility of developing local industries based on these goods. |

Table 8.6. Plantation Development/Reforestation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Displacement of Other Ecosystems (continued)** | |
| 18. Spread of plantation species outside of plantation becoming a nuisance, competing with native species and becoming weeds in agricultural fields. | 18. Species choice to avoid ones that will grow out of control from desired site. |
| **Socioeconomic Impacts** | |
| 19. Social impacts from influx of people from outside, both wage earners and spontaneous setters, induced by road building into remote areas (direct and indirect impacts). | 19. See the following sections: "New Land Settlement"; "Indigenous Peoples"; and "Induced Development." |
| 20. Problems related to land tenure and land and resource use rights leading to unequitable sharing of costs and benefits of the project. | 20. • Genuine integration of local communities and peoples in project planning and implementation.<br>• Pre-project socioeconomic surveys and assessments and land and resource use studies.<br>• Provision of alternatives which fairly compensate local people who incur losses. |

## Table 8.7. Irrigation and Drainage

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Soil erosion (furrow, surface). | 1. • Proper design and layout of furrows or field avoiding too steep a gradient.<br>• Land leveling.<br>• Design of terraces on hillside minimizing surface erosion hazard. |
| 2. Soil erosion (with sprinkler irrigation on hilly area). | 2. Design of sprinkler system minimizing erosion hazard assuring infiltration rate exceeds application rate of the sprinklers. |
| 3. Waterlogging of soils. | 3. • Regulation of water application to avoid overwatering (including controlled turn-out to allow cutting off water supply to irrigation ditches).<br>• Installation and maintenance of adequate drainage system.<br>• Use of lined canals or pipes to prevent seepage.<br>• Use of sprinkler or drip irrigation. |
| 4. Salinization of soils. | 4. • Measures to avoid waterlogging:<br>• leaching of salts by flushing soils periodically<br>• cultivation of crops with salinity tolerance |

## Table 8.7. Irrigation and Drainage (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 5. Scouring of canals. | 5. Design of canal system to minimize risk and use of lined canals. |
| 6. Clogging of canals by sediments. | 6. • Measures to minimize erosion on fields.<br>• Design and management of canals to minimize sedimentation.<br>• Provision of access to canals for removal of weeds and sediments. |
| 7. Leaching of nutrients from soils. | 7. • Avoidance of overwatering.<br>• Replacement of nutrients by fertilizers or crop rotations. |
| 8. Algal blooms and weed proliferation. | 8. Reduction of input to and release of nutrients (nitrogen and phosphorous) from fields. |
| 9. Clogging of canals by weeds. | 9. • Design and management of canals to minimize weed growth.<br>• Provision of access to canals for treatment or removal of weeds. |
| 10. Deterioration of river water quality below irrigation project and contamination of local ground water (higher salinity, nutrients, agrochemicals) affecting fisheries and downstream users. | 10. • Improved water management; improved agricultural practices and control of inputs (particularly biocides and chemical fertilizers).<br>• Imposition of water quality criteria. |

## Table 8.7. Irrigation and Drainage (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 11. Sea water intrusion into downstream freshwater systems. | 11. • Reduction of takeoff to maintain adequate downstream flow.<br>• Recharge of coastal aquifers through injection wells. |
| 12. Reduction of downstream flows affecting flood plain use, flood plain ecology, riverine and estuarine fisheries, users of water, dilution of pollutants. | 12. • Relocation or redesign of project.<br>• Regulation of takeoff to mitigate effects.<br>• Compensatory measures where possible. |
| 13. Encroachment on swamps and other ecologically sensitive areas. | 13. Siting of projects to avoid or minimize encroachment on critical areas. |
| 14. Alteration or destruction of wildlife habitat or impediment to movement of wildlife. | 14. • Siting of project to minimize loss or avoid encroachment on most sensitive or critical areas.<br>• Establishment of compensatory parks or reserved areas.<br>• Animal rescue and relocation.<br>• Provision of corridors for movement. |
| 15. Impediment to movement of livestock and humans. | 15. Provision of passageways. |

Table 8.7. Irrigation and Drainage (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 16. Threat to historic, cultural or aesthetic features. | 16. • Siting of project to prevent loss.<br>• Salvage or protection of cultural sites. |
| 17. Alteration or loss of flood plain vegetation and disturbance of coastal ecosystems (e.g., mangroves). | 17. • Siting of project to less vulnerable area.<br>• Limitation and regulation of water take-off to minimize problems to extent possible. |
| 18. Dislocation of populations and communities. | 18. • Siting of project to minimize effect.<br>• Resettlement scheme ensuring at least equal standard of living. |
| 19. Introduction or increase in incidence of water-borne or water-related disease (schistosomiasis, malaria, onchocerciasis, etc.). | 19. • Prevention measures:<br>• use of lined canals or pipes to discourage vectors<br>• avoidance of stagnant or slowly moving water<br>• use of straight or slightly curving canals<br>• installation of gates at canal ends to allow complete flushing<br>• filling or draining of borrow pits along canals and roads<br>• disease prophylaxis<br>• disease treatment |

## Table 8.7. Irrigation and Drainage (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 20. Disease and health problems from use of wastewater in irrigation. | 20. • Wastewater treatment (e.g., settling ponds) prior to use.<br>• Establishment and enforcement standards for wastewater use. |
| 21. Conflicts over water supply and inequalities in water distribution throughout service area. | 21. Means to ensure equitable distribution among users and monitor to assure adherence. |
| 22. Overpumping of groundwater. | 22. Limitation of withdrawal so that it does not exceed "safe yield" (recharge rate). |
| **Indirect** | |
| 23. Increased pollution and health hazards from downstream industrial and municipal pollutants caused by decreased flow (decreased dilution) of river water. | 23. • Control of waste sources downstream.<br>• Reduction of water take-off. |
| **External** | |
| 24. Water quality deteriorated or made unusable by upstream land use and pollutants discharge. | 24. • Control of land use in watershed areas.<br>• Control of pollution sources.<br>• Water treatment prior to use. |

## Table 8.8. Livestock and Rangeland Management

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Degradation of vegetation resources due to overgrazing. | 1. • Limitation of animal numbers.<br>• Control of length of grazing time on particular areas.<br>• Mixing of livestock species to maximize use of vegetation resource.<br>• Reseeding and fodder production.<br>• Cut-and-carry.<br>• Strategic placement of water points and salt. |
| 2. • Increased soil erosion due to clearing of vegetation and trampling.<br>• Increased saltation of surface waters. | 2. • Restriction of livestock access to unstable areas (e.g., stoop slopes).<br>• Soil erosion control measures (e.g., reforestation, reseeding of grasses, land preparation, terracing). |
| 3. • Deterioration of soil fertility and physical characteristics through:<br>• removal of vegetation<br>• increased erosion<br>• soil compaction | 3. Same as 1 and 2. |
| 4. Increased rapid runoff due to vegetation clearing and soil compaction (decreased infiltration capacity). | 4. • Water conservation measures and water spreading.<br>• Same as 1 and 2. |

**Table 8.8. Livestock and Rangeland Management (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 5. • Degradation of vegetation and soil around water points.<br>• Overtapping of groundwater.<br>• Lowering of watertable and degradation of vegetation locally by drilling and use of boreholes. | 5. • Development of many small-capacity water sources.<br>• Strategic placement of water points.<br>• Control of use of water points (animal numbers and time of year).<br>• Closure of permanent water sources when temporary pools and streams are available.<br>• Limitation of well capacity by choice of technologies (e.g., handpumps or buckets instead of motor pumps). |
| 6. • Displacement or reduction of wildlife populations by reduction of habitat.<br>• Disruption of migratory routes.<br>• Competition for food and water resources.<br>• Introduction of diseases.<br>• Impacts of burning.<br>• Increased poaching and killing of wildlife considered as pests or predators to livestock. | 6. • Planning and implementation of range management strategies (choice of species, livestock numbers, grazing areas) that minimize negative impacts on wildlife.<br>• Establishment of compensatory wildlife refugees.<br>• Investigation of management of wildlife ranching which will help protect wildlife resources. |

Table 8.8. Livestock and Rangeland Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 7. Pollution environmental disruption and health hazards from disease and pest control measures. | 7. • Choice of chemical that is species-specific, short residence time (active period), and has low impact on other biologic resources.<br>• Protective measures for field workers.<br>• Spraying methods and timing to minimize potential of water pollution.<br>• Selection of disease-resistant livestock breed. |
| 8. Reduction of genetic variability due to selective breeding. | 8. Conservation of genetic diversity in-site (protection of wild relatives in natural habitat, maintaining variability within populations by breeding) and ex-situ (e.g., preservation of genetic material in "banks"). |
| 9. Negative effects of uncontrolled burning for brush control on soil and vegetation (deterioration of soil fertility and soil structure, altered wildlife habitat, destruction of vegetation). | 9. Implementation of well-planned and controlled burning programs. |
| 10. Conversion of moist tropical lowland forests for livestock production resulting in long-term environmental degradation and unsustainable production. | 10. Avoidance of clearing such forests for livestock production. |

## Table 8.9. Rural Roads

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: During Construction** | |
| 1. Erosion from fresh road cuts and fills and temporary sedimentation of natural drainage ways. | 1. • Limitation of earth moving to dry periods.<br>• Protection of most susceptible soil surfaces with mulch.<br>• Protection of drainage channels with berms, straw or fabric barriers.<br>• Installation of sedimentation basins, seeding or planting of erodible surfaces as soon as possible. |
| 2. Ground and water contamination by oil, grease, and fuel in equipment yards. | 2. • Collection and recycling of lubricants.<br>• Precautions to avoid accidental spills. |
| 3. Creation of stagnant water bodies in borrow pits, quarries, etc. suited to mosquito breeding and other disease vectors. | 3. Assessment of vector ecology in work areas and employment of measures (e.g., improved landscaping, filling or drainage) to avoid creating habitats. |
| 4. Environmental and social disruption by construction camps. | 4. Careful siting, construction and management of construction camps. |
| **Direct: Permanent** | |
| 5. Destruction of buildings, vegetation and soil in the right of-way, borrow pit sites, waste dumps, and equipment yards. | 5. • Alternative alignments.<br>• Harvest and utilization of public domain forest resources prior to construction. |

**Table 8.9. Rural Roads (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Permanent (continued)** | |
| | • Compensation given to private landowners.<br>• Restoration of sites to original condition to extent possible through reclamation measures. |
| 6. Interruption of subsoil and overland drainage patterns (in areas of cuts and fills). | 6. Installation of adequate drainage works. |
| 7. Landslides, slumps, slips and other mass movements in road cuts. | 7. • Route alignment to avoid inherently unstable areas.<br>• Design of drainage works to minimize changes in surface flows and adequate to local conditions, according to prior surveys.<br>• Stabilization of road cuts with structures (concrete walls, dry wall masonry, gabions, etc.). |
| 8. Erosion of lands below the roadbed receiving concentrated outflow carried by covered or open drains. | 8. • Increase in number of drain outlets.<br>• Drain outlets placed so as to avoid cascade effect.<br>• Lining of receiving surface with stones, concrete. |
| 9. Increased suspended sediment in streams affected by road cut erosion, decline in water quality and increased sedimentation downstream. | 9. • Establishment of vegetative cover on erodible surfaces as soon as possible.<br>• Establishment of retention ponds to reduce sediment load before water enters stream. |

## Table 8.9. Rural Roads (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Permanent (continued)** | |
| 10. Marred landscape (scars from road cuts, induced landslides and slumps, etc.). | 10. • Tourist site access roads planned with regard for visual aesthetics.<br>• Grade limitations to avoid cutting and filling where scenery would be spoiled.<br>• Maintenance and/or restoration of roadside vegetation. |
| 11. Health hazards and interference of plant growth adjacent to road by dust raised and blown by vehicles. | 11. Dust control by application of water or chemicals. |
| 12. Contamination of ground and surface waters by herbicides for vegetation control and chemicals (e.g., calcium chloride) for dust control. | 12. • Reduction of use.<br>• Alternative (non-chemical) methods of control. |
| 13. Accident risks associated with vehicular traffic and transport, that may result in spills of toxic materials (see "Hazardous Materials Management" section), injuries or loss of life (see "Public Health and Safety" section). | 13. • Regulation of transport of toxic materials to minimize danger.<br>• Prohibition of toxic waste transport through ecologically sensitive area. |
| 14. Creation of a new pathway for disease vectors affecting humans and animals. | 14. Establishment of plant and animal sanitation service and related checkpoints. |
| 15. Disruption/destruction of wildlife through interruption of migratory routes, disturbance of wildlife habitats, and noise related problems. | 15. Siting to minimize impacts. |

Table 8.9. Rural Roads (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 16. Unplanned or illegal timber cutting. | 16. See "Natural Forest Management" section. |
| 17. Unplanned or illegal land clearing. | 17. See "New Land Settlement" section. |
| 18. Long-term or semi-permanent destruction of soils in cleared areas not suited for agriculture. | 18. See 17 above. |
| 19. Planned development and illegal invasion of homelands of indigenous peoples by squatters and poachers causing serious social and economic disruption. | 19. See "Indigenous Peoples" section. |
| 20. Destruction or damage of terrestrial wildlife habitats, biological resources or ecosystems that should be preserved by induced development. | 20. See "Biological Diversity" and "Wildlands" sections. |
| 21. Damaging alteration of wetland ecosystems traversed by causeways. | 21. See "Wetlands" section. |
| 22. Excessive and/or destructive development of coastal areas or other use of coral for cement and landfill, destroying parts of reef uniquely endowed recreational environments made accessible by roads. | 22. See "Tourism Development" section. |

**Table 9.1. Analytical Framework for Urban Environmental Problems**

| Manifestations | Impacts | Causes | Cures |
|---|---|---|---|
| Deteriorated living environment and services | Health impacts<br>- infectious and parasitic diseases<br>- malnutrition<br>- accidents<br>- stress, drugs, violence<br>- acute and chronic toxicity<br>- genetic effects<br>- cancer<br>Lost urban productivity<br>Degradation of the natural environment<br>- resource loss<br>- amenity loss | Substandard housing<br>Lack of water and sanitation<br>Disease-carrying insects and rodents<br><br>Indoor air pollution<br>Excreta laden water/soils<br>Trash dumping<br>Noise/stress<br>Traffic congestion<br>Natural disasters | Appropriate housing and land development regulations<br>Housing finance<br>Provision of affordable infrastructure and plots<br>Provision of affordable water sanitation, solid waste services at cost<br>Targeted subsidies<br>Improved efficiency and effectiveness of infrastructure and service provision<br>Pollution control<br>Community participation |
| Ambient air pollution | Localized primarily in large cities<br><br>- health problems<br>- lost aesthetic, cultural, recreational values<br>- property damage (including historical monuments<br>At present more of metropolitan area problem than regional/global problem | Urbanization/industrialization<br><br>Fuel/energy pricing and urban energy demand<br>Vehicle ownership<br>Space heating<br>Use of highly polluting fuels:<br>- leaded gases<br>- high-sulphur lignite | Pricing of industrial and energy inputs<br>Regulations and standards<br>Emission charges<br>Monitoring and enforcement<br>Energy conservation<br>Technological interventions<br>- scrubbers, baghouse filters<br>- vehicle emissions control<br>- fuel substitution |
| Indoor air pollution | Chronic obstructive lung disease | Biofuel use for domestic cooking and heating | Pricing of commercial fuel and energy |

**Table 9.1. Analytical Framework for Urban Environmental Problems (continued)**

| *Manifestations* | *Impacts* | *Causes* | *Cures* |
|---|---|---|---|
| Indoor air pollution (continued) | | | |
| | Acute respiratory infections<br>Low birth weight and associated problems<br>Cancer | Passive smoking<br>Cottage industry exposure | Targeted fuel subsidies<br>Improved housing and ventilation<br>Public awareness |
| Solid waste pollution | Health hazards<br>Amenity impacts<br>Blocked drainage and flooding<br>Water pollution (leachates)<br>Air pollution (heavy metals/toxic organic compounds from incinerators and uncontrolled burning) | Inefficient management (collection and disposal)<br>Impacts not recognized or external to community | Improved collection<br>- expanded coverage (e.g., to low-income area via community based approaches)<br>- efficient operations (e.g., create contestable markets to encourage private sector entry)<br>- financial strengthening (budgeting, accounting, cost recovery)<br>Disposal technology and management<br>Resource recovery/recycling |
| Fecal contamination | Diarrheal diseases<br>Parasitosis<br>Malnutrition<br>High infant mortality | Lack of basic sanitation services<br>Excreta laden water/soils<br>Proliferation of garbage/ insects | Provision of affordable sanitation options at cost<br>Community-based approaches<br>Hygiene education |
| Hazardous waste pollution | Acutely affects groundwater, but often multimedia impacts<br>Damage at low concentrations<br>- Health damages (e.g., acute and chronic toxicity) | Insufficient regulations/ management<br>Pricing of inputs into into industries producing waste | Regulations, standards and changes<br>Monitoring and enforcement capacity<br>Licensing<br>Waste minization<br>- process modification |

**Table 9.1. Analytical Framework for Urban Environmental Problems (continued)**

| Manifestations | Impacts | Causes | Cures |
|---|---|---|---|
| Hazardous waste pollution (continued) | | | |
| | - Foodchain accumulation<br>"Timebombs" (hidden dumps that build up over time) | Impacts removed in space and time | - resource recovery/recycling<br>Treatment and disposal technology and management |
| Fresh water resource depletion (surface and ground water) | Sources running out<br>Increasing marginal costs<br>Land subsidence | Pricing policies<br>Cultural (perception of free good)<br>Overpumping of groundwater<br>Irrigation policies and practices (inefficiency)<br>Leakages from water | Improved pricing<br>Integrated watershed management<br>Improved technologies (e.g., wastewater reuse)<br>Regulation of groundwater extraction<br>Improved O & M |
| Fresh water resource quality degradation (surface and ground water) | Poor quality surface and ground water<br>Health impacts<br>Increasing marginal cost of:<br>- potable supply<br>- industrial supply<br>- individual treatment<br>Waterlogging and salinization<br>Saline intrusion | Municipal and industrial waste disposal practices<br>- Sewerage (water pricing, poor O & M)<br>- Industrial wastes (input pricing, poor regulations enforcement)<br>Urban runoff<br>Irrigation policies and practices<br>Overpumping of groundwater<br>Impacts not recognized or external to the community | Pricing Policies<br>Regulations, standards, charges<br>Monitoring and enforcement<br>Solid and hazardous waste management<br>Treatment technology and operations<br>Integrated watershed management<br>Regulation of groundwater extraction<br>Public education |

## Table 9.1. Analytical Framework for Urban Environmental Problems (continued)

| Manifestations | Impacts | Causes | Cures |
|---|---|---|---|
| Lake, coastal and marine water pollution (including fisheries depletion) | Mainly occurs locally:<br>- closed beaches and lost toursim revenues<br>- lost aesthetics<br>- health consequences<br>- eutrophication<br>- fish and shellfish contamination<br>Reduced employment opportunities | Municipal and industrial waste disposal practices (see above)<br>Agricultural runoff (plus related policies)<br>Detergents<br>Shipping/oil<br>Litter/plastics | Water pollution regulations (municipal and industrial)<br>Solid waste management<br>Improved technologies (e.g., outfall design)<br>Shipping facilities and regulations<br>Special areas designation (e.g., marine sanctuary)<br>Coastal zone management |
| Degradation of land and ecosystems | Loss of wetlands/wildlands (rich (genetic diversity, migratory birds, hydrological aspects)<br>Coastal zone degradation<br>Loss of recreational areas (e.g., beach fronts)<br>Deforestation (urban firewood/ charcoal demand)<br>Increased erosion | Shadow value of land much higher than prices<br>Absence of land taxation and enforcement<br>Uncontrolled urban growth<br>- absence of planning control<br>- lack of legal alternative to squatter developments<br>Water pollution<br>Solid waste disposal practices<br>Occupation of steep zones | Appropriate incentives (prices and taxes)<br>Affordable planning regulations; enforcement<br>Pollution control regulation<br>Special areas designation (e.g., nature preserves, parks, seashores)<br>NGO-type activity in support of environmental initiative |
| Occupation of high-risk land (generally squatter and low-income groups)<br>- low-lying land<br>- flood plains<br>- steep zones | Flooding<br>Landslides, mudslides<br>Erosion<br>Health risks, accidents<br>Property damage and building collapse | Land tenure systems<br>Failed land markets<br>Lack of developed lands<br>Land regulations/enforcement | Appropriate incentives (prices, taxes, tenure, access to housing finance)<br>Less regulation of land markets<br>Provision of affordable infrastructure<br>Targeted subsidies<br>Community participation programs |

**Table 9.1. Analytical Framework for Urban Environmental Problems (continued)**

| Manifestations | Impacts | Causes | Cures |
|---|---|---|---|
| Degradation of cultural property<br>- historical monuments<br>- living monuments | Loss of cultural heritage<br>Loss of tourism revenue | Local value less than international value<br>Air pollution<br>Solid waste management practices<br>Lack of enforcement | Dead monuments:<br>- pollution control<br>- preservation/enforcement<br><br>Living monuments:<br>- historical districts<br>- tax incentives<br>- public education |

## Table 9.2. Roads and Highways

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Increased sediment in streams affected by erosion at construction sites and fresh road cuts, fills and waste dumps. | 1. Protect susceptible surfaces with mulch or fabric, and plant erodible surfaces as soon as possible. |
| 2. Soil and water contamination by oil, grease, fuel and paint in equipment yards and asphalt plants. | 2. • Collect and recycle lubricants.<br>• Avoid accidental spills through good practice. |
| 3. Air pollution from asphalt plants. | 3. Install and operate air pollution control equipment. |
| 4. Local dust and noise. | 4. • Periodically water down or lightly oil temporary roads.<br>• Install and maintain mufflers on equipment. |
| 5. Air and noise pollution from vehicle operation, in populated areas traversed by the highway, notably metropolitan areas or densely settled rural areas. | 5. • Include physical barriers to noise in plans.<br>• Require adherence to engine maintenance schedules and standards (or use alternative fuels) to reduce air pollution.<br>• Enhance public transportation and traffice management capability. |
| 6. Landscape disfiguration by embankments and deep cuts, fills and quarries. | 6. • Use an architectural design to "blend" with the landscape.<br>• Replant disfigured surfaces. |

**Table 9.2. Roads and Highways (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 7. Landslides, slumps, slips and other mass movements in road cuts. | 7. • Provide drainage works as needed to reduce risk, according to prior surveys.<br>• Align route to avoid inherently unstable areas.<br>• Stabilize road cuts with structures (concrete walls, dry wall masonry, gabions, etc.). |
| 8. Erosion of lands below the road bed receiving concentrated outflow from covered or open drains. | 8. • Increase number of drain outlets.<br>• Place drain outlets so as to avoid cascade effect.<br>• Line receiving surface with stones, concrete. |
| 9. Roadside litter. | 9. • Provide for disposal facilities.<br>• Encourage anti-littering laws and regulations. |
| 10. Hazardous driving conditions where construction interferes with pre-existing roads. | 10. Provide in design for proper markers on roads, including lights. |
| 11. Alteration of overland drainage and subsoil drainage (where road cuts intercept perched water tables, springs, etc.). | 11. Installation of adequate drainage works. |
| 12. Destruction of vegetation and wildlife in the right-of-way occupied by the highway. | 12. Realignment where possible to detour exceptional areas, identified by prior surveys. |

## Table 9.2. Roads and Highways (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 13. Destruction or damage of terrestrial wildlife habitats, biological resources or ecosystems that should be preserved. | 13. Plan national transportation route alignment according to location of fragile, unique, etc., areas. |
| 14. Alteration of hydrological regimes of wetlands by causeways, with harmful effects on these ecosystems. | 14. • Realignment to avoid wetlands.<br>• Installation of culverts, bridges, etc., as needed and according to criteria from prior hydrobiological surveys.<br>• See "Wetlands" section. |
| 15. • Interruption of migratory routes for wildlife and livestock.<br>• Increased collisions with animals. | 15. • Realign to avoid imnportant migratory routes.<br>• Provide undergrade crossings. |
| 16. Poor sanitation and solid waste disposal in construction camps and work sites. | 16. Provide adequately located and maintained latrines. |
| 17. Possible transmission of communicable diseases from workers to local populations and vice versa. | 17. Periodic health examinations of workers with treatment when needed. |
| 18. Creation of temporary breeding habitats for mosquito vectors of disease, e.g., sunny, stagnant pools of water. | 18. Assess vector ecology in work areas and take steps where possible to avoid creating habitats. |
| 19. Creation of a transmission corridor for diseases, pests, weeds and other undesirable organisms. | 19. Set up plant and animal sanitation service and related checkpoints. |

Table 9.2. Roads and Highways (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 20. Poaching by construction workers. | 20. Prohibit poaching under terms of employment. |
| 21. • Dislocation and compulsory resettlement of people living on the right-of-way.<br>• Near cities and in rich farming regions, many people can be affected. | 21. • See "Involuntary Resettlement" section.<br>• Locally unprecedented mechanisms and procedures may be required to arrive at equitable and adequate compensation, and a companion effort to develop the capacity may be required. |
| 22. Obstruction of routes from homes to farms, etc., increasing travel time. | 22. Provide appropriately designed and located crossings. |
| 23. Impairment of non-motored transportation in the highway corridor due to reduced or impeded rights-of-way. | 23. Include slow traffic lanes and/or paved shoulders and safe crossings. |
| 24. Accident risks associated with vehicular traffic and transport, that may result in spills of toxic materials injuries or loss of life. | 24. • Design and implement safety measures and an emergency plan to contain damages from accidental spills.<br>• Designate special routes for hazardous materials transport.<br>• See "Industrial Hazard Management" and "Public Health and Safety" sections. |
| **Indirect** | |
| 25. Induced development: roadside commercial, industrial, residential, and "urban sprawl." | 25. • Involve land use planning agencies at all levels in project design and EA, and plan for controlled development. |

**Table 9.2. Roads and Highways (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 26. Increased motorized transportation (with possible increased dependency on imported fuels). | 26. Include project components to encourage use of non-motorized transportation. |
| 27. Impairment of non-motorized transportation economy due to changes in land use and/or increased availability of motorized alternatives. | 27. Include project components to stimulate local production and use of non-motorized modes of transportation. |
| 28. Unplanned or illegal timber cutting. | 28. See "Rural Roads" section. |
| 29. Unplanned or illegal land clearing. | 29. See "Rural Roads" section. |
| 30. Illegal invasion by squatters and poachers of homelands of indigenous peoples. | 30. See "Indigenous Peoples" and "Induced Development" sections in Chapter 3. |

## Table 9.3. Inland Navigation

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Dredging Process and Disposal** | |
| 1. Project location (e.g., enhancement or development of a waterway) may affect sensitive habitats and/or valuable fisheries resources. | 1. Perform screening analysis of site environs and ecology, and select an area that is not adjacent to sensitive habitat and would not displace valuable fisheries resources or otherwise significantly degrade environmental quality. |
| 2. Removal and disturbance of flora and fauna at the dredging site. | 2. • Plan for minimizing impacts on local flora and fauna.<br>• Screen for the presence of rare, threatened, or endangered species which are indigenous to the project location, and modify design to avoid or protect. |
| 3. Interference of stationary dredging equipment with other maritime traffic. | 3. Prepare a program in advance to coordinate and reduce interference to other waterway users. |
| 4. Possible disturbance or damage to stationary installations such as underwater cables, pipelines, and outfalls. | 4. • Identify and document locations of stationary installations.<br>• Modify dredging process/disposal plans to accommodate presence of such structures. |
| 5. Objectionable noise to nearby residents, especially at night. | 5. Reduce noise level by decreasing operating level during quiescent periods in the local community. |
| 6. Increased short-term turbidity at dredging site. | 6. Reduce turbidity by efficient use of less intrusive dredging equipment, silt curtains, dredging during low flow periods. |
| 7. Alterations of bottom surface which may be unfavorable to the success of indigenous benthic flora and fauna. | 7. Plan for minimizing impact on important or sensitive benthic fauna and flora through ecological investigation during project planning. |

Table 9.3. Inland Navigation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Dredging Process and Disposal (continued)** | |
| 8. Partitioning of natural and/or anthropogenic contaminants from sediments to the water column. | 8. • Perform physical and chemical analysis of sediments prior to disturbance.<br>• Locate potential "hot spots" and prepare plan to minimize sediment resuspension in these areas. |
| 9. Modified bathymetry causing changes in tidal currents, river circulation, species diversity, and salinity. | 9. Perform project area investigation, sampling, and modelling characterization and design project accordingly to minimize impacts. |
| 10. Generation of turbidity plumes. | 10. Use technologies such as temporary dams and/or barriers to lessen the transport of suspended material away from the project area. |
| 11. Loss of shoreline integrity. | 11. Evaluate shoreline geology and hydrology prior to project design to ensure deepening will not cause modifications such as slumping and increased erosion. |
| 12. Upland disposal of dredged material could modify terrestrial habitat. | 12. • Evaluate disposal options and select one with least impingement on important habitat.<br>• Require reclamation plans for terrestrial sites. |
| 13. Short-term air quality degradation resulting from dredging-related operations. | 13. Monitor local air quality and reduce operations if unacceptable quality arises. |
| 14. Projects may result in stress on local cultures. | 14. • Evaluate local sociocultural environment prior to project implementation.<br>• Develop specific mitigation measures with community involvement. |

Table 9.3. Inland Navigation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Dredging Process and Disposal (continued)** | |
| 15. Covering of potential archaeological sites with dredge spoil. | 15. Evaluate disposal area for presence of important artifacts, and modify design to salvage or protect artifacts. |
| 16. Spills associated with increased maritime commerce. | 16. Develop spill prevention and clean-up plans. Train a team to handle spills. |
| **Indirect: Dredging Processes/Disposal** | |
| 17. Uptake and accumulation of resuspended and partitioned sediment contaminants by biota. | 17. Physical and chemical analyses permits proper planning prior to project implementation, thus minimizing sediment resuspension through proper selection of dredging equipment and implement long-term biota tissue monitoring program. |
| 18. Occupational health effects on workers from sediment handling operations. | 18. • Train employees to be aware of potential occupational hazards and establish a program on safety and health which includes all of the following:<br>• site characterization and analysis<br>• site control<br>• training<br>• medical surveillance<br>• engineering controls, work practices and personal protective equipment<br>• monitoring and informational programs<br>• handling raw and process materials<br>• decontamination procedures<br>• emergency response<br>• illumination<br>• sanitation at permanent and temporary facilities |

## Table 9.3. Inland Navigation (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect: Dredging Processes/Disposal (continued)** | |
| 19. Impacts of possible land disposal on groundwater, surface runoff and/or land use. | 19. • If land disposal is the selected option, contaminated wastes should be contained in a structure that minimizes leachate generation and release to local aquifers.<br>• Uncontaminated sediments have some practical uses; however, wetlands reclamation is no longer considered an environmentally sound option. |
| 20. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting materials to/from the construction sites. | 20. • Proper site selection can mitigate many of these problems, but special transportation sector studies should be prepared during project feasibility to select best routes to reduce new shorezone facilities/industries.<br>• Develop emergency contingency plans to minimize risk of accidents during transport.<br>• Initiate discussions on transport regulations, where none exist. |

## Table 9.4. Port and Harbor Facilities

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Project location (e.g., enhancement or development of a waterway) may affect sensitive habitats and/or valuable fisheries resources or otherwise significantly degrade environmental quality. | 1. Perform screening analysis of site environs and ecology and select an area that is not adjacent to sensitive habitat and would not displace valuable fisheries resources. |
| 2. Repositioning of "null zone" in port vicinity. | 2. Perform analyses to establish "controlling channel depth" which represents an equilibrium between flow-associated transport energy and sediment supply. |
| 3. Removal and disturbance of flora and fauna at the dredging site. | 3. Plan for minimizing impacts on local flora and fauna, and screen for the presence of rare, threatened or endangered species which are indigenous to the project location. |
| 4. Interference of stationary dredging equipment with other maritime traffic. | 4. Prepare a program in advance to coordinate and reduce interference to other waterway users. |
| 5. Possible disturbance or damage to stationary installations such as underwater cables, pipelines, and outfalls. | 5. • Identify and document locations of stationary installations.<br>• Modify dredging process/disposal plans to accommodate presence of such structures. |
| 6. Objectionable noise to nearby residents, especially at night. | 6. Reduce noise level by decreasing operating level during quiescent periods in the local community. |
| 7. Increased short-term turbidity at dredging site causing decreased light penetration and associated photosynthetic activity. | 7. Reduce turbidity by efficient use of less intrusive dredging equipment, silt curtains, timing to coincide with low flow. |

Table 9.4. Port and Harbor Facilities (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 8. Alterations of bottom surface, which may be unfavorable to the success of indigenous benthic flora and fauna. | 8. Plan for minimizing impact on important or sensitive benthic fauna and flora through ecological investigation during project planning. |
| 9. Partitioning of natural and/or anthropogenic contaminants from sediments to the water column. | 9. • Perform physical and chemical analysis of sediments prior to disturbance.<br>• Locate potential "hot spots" and prepare plan to minimize sediment resuspension in these areas. |
| 10. Modified bathymetry causing changes in tidal bore, river circulation, species diversity, and salinity. | 10. Perform project area investigation, sampling, and characterization so project planning can yield a design which minimizes impacts. |
| 11. Generation of turbidity plumes. | 11. Use technologies such as temporary dams and/or barriers to lessen the transport of suspended material away from the project area. |
| 12. Loss of shoreline integrity. | 12. Evaluate shoreline geology and hydrology prior to project design to ensure deepening will not cause modifications such as slumping and increased erosion. |
| 13. Upland disposal of dredged material would modify terrestrial habitat. | 13. • Evaluate disposal options and select one with least impingement on important habitat.<br>• Require reclamation plans for terrestrial sites. |
| 14. Short-term air quality degradation resulting from dredging-related operations. | 14. Monitor local air quality and reduce operations if unacceptable quality arises. |

Table 9.4. Port and Harbor Facilities (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 15. Projects may result in stress on local cultures. | 15. • Evaluate local sociocultural environment prior to project implementation.<br>• Develop specific mitigation measures with community involvement. |
| 16. Covering of potential archaeological sites with dredge spoil. | 16. • Evaluate disposal area for presence of important artifacts.<br>• Modify design or salvage or protect artifacts. |
| 17. Spills associated with increased maritime commerce. | 17. • Develop spill prevention and clean-up plans.<br>• Train a team to handle spills. |
| 18. Covering of valuable benthic species (e.g., mussels, clams) by sediment. | 18. • Monitor turbidity and maintain concentration below 2 grams/liter.<br>• Limit dredging activity during critical spawn-and-set periods for shellfish. |
| 19. Increasing saltwater intrusion to groundwater and surface water. | 19. • Major modification to channel depth and cross section should consider the effect on saltwater encroachment.<br>• Analysis of effects on tidal bore and river flow will be helpful. |

**Table 9.4. Port and Harbor Facilities (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect: Dredging Processes/Disposal** | |
| 20. Uptake and accumulation of resuspended and partitioned sediment contaminants by biota. | 20. • Physical and chemical analyses permits proper planning prior to project implementation, thus minimizing sediment resuspension through proper selection of dredging equipment.<br>• Implement long-term biota tissue monitoring program. |
| 21. • Occupational health effects on workers from sediment handling operations.<br>• Accidents occur at higher than normal frequency because of lower level of skill or labor. | 21. • Train employees to be aware of potential occupational hazards and establish a facility program on safety and health which includes all of the following:<br>• site characterization and analysis<br>• site control<br>• training<br>• medical surveillance<br>• engineering controls, work practices and personal protective equipment<br>• monitoring and informational programs<br>• handling raw and process materials<br>• decontamination procedures<br>• emergency response<br>• illumination<br>• sanitation at permanent and temporary facilities |
| 22. Impacts of possible land disposal on groundwater, surface runoff and/or land use. | 22. • If land disposal is the selected option, contaminated wastes should be contained in an engineered structure which minimizes leachate generation and release to local aquifers. |

Table 9.4. Port and Harbor Facilities (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect: Dredging Processes/Disposal (continued)** | |
| | • Uncontaminated sediments have some practical uses; however, wetlands reclamation is no longer considered an environmentally sound option. |
| 23. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting materials to/from port and harbor facilities. | 23. • Proper site selection can mitigate many of these problems, but special transportation sector studies should be prepared during project feasibility to select best routes to reduce new shorezone facilities/industries.<br>• Develop emergency contingency plans to minimize risk of accidents during transport.<br>• Initiate discussions on transport regulations where none exist. |

## Table 9.5. Large-Scale Housing Projects

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Displacement of existing land uses. | 1. • Ensure that due consideration is given to the proper trade-offs between land values for housing and those of other uses, such as prime farmland, forests, or other land uses or natural habitats of value to society as a whole.<br>• Investigate existing planning and design standards to ensure that they are suited to local conditions and not unnecessarily wasteful of land.<br>• Assist in drafting new regulations that are more appropriate. |
| 2. Destruction of environmentally critical areas. | 2. Ensure that regionally critical environmental sites such as major forested areas, major water bodies and wetlands, habitats containing rare and endangered species, etc., are identified and not threatened by project location. |
| 3. Danger to residents from hazardous natural conditions. | 3. • Ensure that project site is not located in the following areas:<br>• major floodplain<br>• coastal zone inundation areas<br>• areas of unstable soil or subsurface conditions<br>• areas of highly saline soils<br>• areas subject to landslides<br>• seismically or volcanically active areas<br>• excessively steep or wet areas<br>• areas where significant risk from disease vectors exist, or any other areas of significant natural hazard<br>• Design accordingly if site cannot be moved. |

## Table 9.5. Large-Scale Housing Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 4. Danger to residents from hazardous man-made conditions. | 4. • Identify areas that have significant man-made hazards such as filled land, areas subject to subsidence from mining activity, groundwater, oil or other extractive processes.<br>• Identify areas where solid or liquid, or toxic wastes may be or have been dumped.<br>• Investigate site conditions with proper geotechnical or chemical testing procedures.<br>• Ensure that adequate funding and technical expertise are available to deal with the special conditions.<br>• Investigate alternate sites. |
| 5. Hazard to residents from air, water, or noise pollution from other adjacent or nearby land uses. | 5. • Ensure that the site is located away from such pollution sources.<br>• Do not locate down-wind of significant point sources of air pollution such as smoke stacks, for example.<br>• Identify noise sheds around airports, major roads, etc.<br>• Provide buffers of other compatible uses of adequate width between residential areas and sources of pollution.<br>• Take measures to abate pollution at the source, if feasible, such as noise barriers along expressways.<br>• Investigate alternate sites. |

## Table 9.5. Large-Scale Housing Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Hazard to residents from air pollution due to site location being in an area subject to frequent temperature inversions. | 6. • Seek alternate site location if pollution is from existing sources that are difficult to abate.<br>• Otherwise, design project with low densities and non-polluting technologies for heating, cooking, etc. |
| 7. Dislocation of existing resident populations. | 7. Ensure that any involuntary resettlement is done in accordance with proper standards or consider alternate sites. |
| 8. Destruction of historic or cultural resources. | 8. • Consider alternate sites or make provision for historic culturally significant areas to be set aside in specially zoned areas.<br>• Adapt project design to include existing historic or cultural resources. |
| 9. Overloading of existing infrastructure and services. | 9. • Coordinate with other planning goals and objectives for region.<br>• Upgrade existing infrastructure and services, if feasible.<br>• Consider alternate sites. |
| 10. Excessive depletion of resources such as lumber or fuel, or overtaxing of traditional industries, such as brickmaking. | 10. • Review capacity of local resources and industries to provide for large-scale construction and upgrade, if feasible.<br>• Select materials and design criteria according to local conditions and availability of resources. |

Table 9.5. Large-Scale Housing Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Design for maximum efficiency in materials and energy use.<br>• Encourage the study of indigenous customs and techniques for building and incorporate in project design. |
| **Local and Site Scale Impacts** | |
| 11. Damage to sites and their immediate surroundings resulting from the disruption of the basic natural framework of the environment, in particular the soils, vegetation, and drainage network. (See below for more detailed comments.) | 11. • Identify the basic natural systems of a site and its immediate surroundings and protect with set-asides for open space, easements, buffer areas, etc.<br>• Adapt layouts to fit natural patterns rather than imposing rigid geometries. |
| 12. Degradation of habitats caused by fragmentation. | 12. Maintain and/or design open space networks to follow natural site features, such as stream corridors, and connect them throughout the site and local and regional open space systems. |
| 13. More extreme flood/drought cycles, increased erosion and siltation and degradation of stream biota and riparian vegetation, etc., caused by increased runoff from developed sites. | 13. • Preserve existing stable drainage patterns on site.<br>• Preserve existing vegetation, particularly intact natural habitats.<br>• Institute a stormwater management plan, which should consider such strategies as:<br>  • minimizing impervious area<br>  • increasing infiltration to soil by use of recharge areas<br>  • the use of natural vegetated swales instead of pipes, or<br>  • by using detention or retention facilities with graduated outlet control structures |

Table 9.5. Large-Scale Housing Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Local and Site Scale Impacts (continued)** | |
| | • Use "soft" engineering techniques for soil and bank stabilization, such as vegetative stabilization (soil bio-engineering) in preference to built structures. |
| 14. Depletion and/or pollution of local groundwater resources. | 14. • Ensure that projected use of groundwater is within capacity of natural system to replenish itself.<br>• Avoid "mining" groundwater particularly in drier climates.<br>• Avoid using open channel, sprinklers, or other wasteful irrigation techniques for landscaping in drier climates.<br>• Use indigenous vegetation that requires less water, drip irrigation or shaded plantings.<br>• Ensure that soils are suitable for septic tank or other on-site treatment.<br>• Design centralized systems to avoid leakage, etc.<br>• Design stormwater management systems as suggested above, in particular, use vegetation to retain, recharge and purify stormwater. |
| 15. Degradation of soil cover from erosion, removal, or loss of soil structure due to compaction. | 15. • Have both temporary (during construction) and permanent erosion control plans. |

Table 9.5. Large-Scale Housing Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Local and Site Scale Impacts (continued)** | |
| | • Temporary control plans should include:<br>  • silt fencing<br>  • temporary silt trap basins<br>  • short term seeding or mulching of exposed soil areas, (particularly on slopes)<br>  • limitations on access for heavy machinery and the storage of materials to avoid soil compaction<br>• Permanent erosion control plans should focus on the establishment of stable native vegetation communities.<br>• Ensure that topsoil in construction areas is stripped and stored for future use and not illegally removed from site. |
| 16. Loss or degradation of vegetation from unnecessary removal or mechanical damage. | 16. • Identify important stands of vegetation, large contiguous stands of forest or other natural habitat, vegetation on steep slopes, vegetated stream corridors or swales.<br>• Incorporate these areas into design layout or open space system.<br>• Protect such areas during construction by temporary fencing and limitations on access for heavy machinery and materials storage. |

**Table 9.5. Large-Scale Housing Projects (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Local and Site Scale Impacts (continued)** | |
| 17. Degradation of habitat from inappropriate management or introduction of invasive exotic species. | 17. • Protect natural habitat from destructive management or maintenance practices, such as the removal of understory vegetation from woodlands, or excessive clearance of vegetation from stream banks.<br>• Do not use invasive exotic species for landscaping or reforestation. |

## Table 9.6. Solid Waste Collection and Disposal Systems

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Uncollected refuse clogs open drains and sewers. | 1. Provide complete refuse collection service to the urban environment. |
| 2. Aesthetic degradation and property value loss from litter and clandestine dumping. | 2. Same as above. |
| 3. Smoke from open burning of uncollected refuse. | 3. Same as above. |
| 4. Populations of disease vectors (e.g., flies, rats, cockroaches) increase where refuse is either uncollected or open dumped. | 4. Same as above. |
| 5. Poorly located communal containers create wasted time and effort for residents. | 5. Examine movement patterns of residents and survey them for the distance they would be willing to walk. |
| 6. Lack of resident cooperation with collection systems which do not fit social and cultural behavior of residents. | 6. • Survey residents for social and cultural behavior:<br>• who performs the chore of waste discharge<br>• at what hours are they at home<br>• how much time could they spent on this chore<br>• how much self-reliance will they accept<br>• what can they afford |
| 7. Dust during loading of refuse from stationary communal containers. | 7. Minimize extra handling and maximize containment to the extent affordable. |
| 8. Refuse scattered from stationary communal containers, plastic bags, baskets, etc., and by animals. | 8. Educate residents to discharge refuse just before the scheduled time of collection service. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 9. Worker accidents (e.g., back injuries) when refuse bins are overweight. | 9. • Appropriate size refuse containers (e.g., 80 to 100 liter capacity).<br>• Provide covers for containers so that rain does not add weight to the refuse. |
| 10. Dust and litter along roadways used by refuse collection vehicles. | 10. Provide enclosed refuse collection vehicles or cloth tarps to cover open vehicles. |
| 11. Worker hazard when medical wastes are not specially handled. | 11. • Separate collection of medical wastes using dedicated vehicles.<br>• Provide a separate disposal area at the refuse landfill. |
| 12. Worker hazard when potentially hazardous wastes are not specially handled. | 12. • Survey industries to assess nature and quantity of hazardous wastes.<br>• Provide separate collection and disposal in specially designed systems.<br>• Test for waste compatibility before disposal. |
| 13. Dust from unloading and loading operations at transfer stations. | 13. Provide enclosure to the loading and unloading areas, as well as ventilation and air filtration. |
| 14. Loss of income to pickers and loss of low-cost feedstock to industry when recovery of secondary materials is hindered. | 14. • Design collection, transfer and/or disposal systems to accommodate continuation of recycling. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Increase source separation and recovery of secondary materials before waste discharge for collection. |
| | • Provide job training and employment assistance to pickers losing occupation. |
| 15. Dust from unloading and spreading/grading operations at land disposal sites. | 15. • Provide buffer zone around land disposal site. |
| | • Pave access roads. |
| | • Design location of working face to minimize truck traffic. |
| | • Water spray the working areas to suppress dust. |
| 16. Smoke from open burning or refuse at land disposal sites. | 16. Spread and compact incoming refuse, cover daily with soil, install gas control systems. |
| 17. Odors from land disposal sites. | 17. Same as above. |
| 18. Odors from composting systems. | 18. Maintain aerobic conditions during composting. |
| 19. Contamination of ground and/or surface water by leachate from land disposal systems. | 19. • Locate land disposal systems where soils underlying landfill are relatively impermeable and have attenuative properties. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Provide an adequate depth between the bottom of the landfill and the top of the groundwater.<br>• Provide adequate horizontal distance to the nearest surface water. |
| 20. Restriction to beneficial uses of receiving waters contaminated by leachate. | 20. Do not locate land disposal upgradient of any ground or surface water whose usage could be affected by receipt of contamination, unless the distance between the land disposal and the receiving water is adequate to dilute, disperse or attenuate contamination. |
| 21. Loss of deep-rooted vegetation (e.g., trees) from landfill gas. | 21. Provide gas control systems in landfills. |
| 22. Explosion or toxic response from accumulated landfill gas in buildings. | 22. • Same as above.<br>• Also restrict development of buildings in the vicinity of landfills.<br>• Install gas monitoring wells around the site. |
| 23. Emission of potentially toxic volatile organics from land disposal sites. | 23. Restrict potentially hazardous wastes from being disposed in landfill for general refuse. |
| 24. Contamination of air quality from incineration or resource recovery facilities. | 24. Provide state-of-the-art air pollution control. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 25. Contamination of soil and potential biological uptake of toxic chemicals (e.g., heavy metals) from application of compost. | 25. • Based on crops planned to receive land application of compost and chemical concentrations they can tolerate.<br>• Determine which constituent is land-limiting.<br>• Then, based on concentrations of this constituent in compost, determine the total concentration which can be applied before phytotoxic levels are reached.<br>• From this, determine amount of compost which can be applied. |
| **Indirect** | |
| 26. Decline in civic pride and public morale when refuse visibly degrades the urban environment. | 26. • Provide public education to obtain public cooperation with environmental regulations about littering and clandestine dumping.<br>• Provide adequate collection and disposal service. |
| 27. Loss of tourism when refuse visibly degrades urban environment. | 27. • Same as above.<br>• Also, provide regular street cleaning of roadways and urban environments commonly traveled by tourists. |
| 28. Waste of municipal revenues when collection equipment is inappropriate and collection service in inefficient. | 28. • Pilot test collection systems before implementation.<br>• Regularly evaluate costs of collection in various neighborhoods by various techniques.<br>• Undertake measures to lower costs and improve service. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| | • Regularly design optimum routes for collection.<br>• Implement transfer systems whenever direct haul is uneconomic (e.g., when travel times are over half an hour or more than 15 km).<br>• Increase inspection and supervision to obtain improved productivity and effectiveness by collection workers.<br>• Decrease vehicle downtime by adequate planning of the spare parts inventory needs. |
| 29. Land use conflicts when solid waste facilities are not well located. | 29. • Plan locations of facilities to fit existing and planned land use.<br>• Provide buffer zones to minimize aesthetic impact of facilities.<br>• Try to limit truck traffic to use of major roadways which do not have residential development. |
| 30. Public opposition to proposed solid waste facilities. | 30. • Provide adequate operation of existing facilities.<br>• Provide a demonstration of how the proposed facility will be operated.<br>• Perform public relations early in the facility planning process, including visual aids showing similar facilities in other places. |

Table 9.6. Solid Waste Collection and Disposal Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 31. Deterrent to industrial development by environmentally conscious industries when competent disposal facilities do not exist for hazardous wastes. | 31. • Provide special facilities for receipt of potentially hazardous wastes.<br>• Provide equitable environmental regulation and enforcement at the national level so that all industries are operating under the same environmental standards. |
| 32. Loss in public's faith in the political system when inappropriate solid waste facilities (e.g., incinerators) are constructed and not used. | 32. • Set up institutional arrangements, such as an interministerial task force whose mandate is to review technical and economic viability of large projects and prioritize them for financial assistance (as in Indonesia).<br>• Set up institutional mechanisms whereby all large projects have an environmental and economic impact assessment presented for review at the national level prior to receiving approval for implementation (as in Thailand). |
| 33. Increase in country trade imbalance and energy consumption when there is a decrease in recycling of secondary materials from wastes into industrial feedstock. | 33. • Provide incentives to private sector entrepreneurial initiatives in recovering secondary materials or recycling.<br>• Improve government procurement specifications so that producing products from recycled materials in encouraged.<br>• Provide public education which encourages recycling.<br>• Facilitate source segregation of recyclables and separate collection.<br>• Design transfer systems and/or disposal systems to accommodate recycling from mixed refuse. |

## Table 9.7. Tourism Development

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. • Beach mining of sand for construction. | 1. • Control of construction contractor. |
| • Destruction of reef for aggregate materials used in construction. | • Submission of plans in accordance with local ordinances on beach sand mining. |
| 2. Destruction of wetlands, forests, other unique/sensitive habitats or cultural, historical and archaeologically important sites. | 2. • Areas considered for development should have zoning plans to account for natural geographic and socioeconomic condition. |
| | • Base development phase on an inventory of resources. |
| 3. Erosion resulting from uncontrolled clearing, infrastructure construction such as roads and marinas. | 3. Develop erosion and sediment control plans. |
| 4. Loss of "free" environmental services from natural systems and degradation of air, water, land resources. | 4. • Carrying capacity should be defined so that target tourist population can be sustained without overburdening existing infrastructure and resources. |
| | • Include improvements in project design. |
| 5. • Water pollution from inappropriate sewage or solid waste disposal. | 5. • Allowance made for use of existing municipal or regional collection and disposal system or construction of on-site sewage treatment plant. |
| • marine effluent disposal<br>• residential sewage disposal<br>• marinas<br>• infiltration to groundwater | • Liquid waste should not be discharged onto beaches, coral reefs, or other sensitive areas. |
| | • Verify local capacity to monitor and enforce pollution regulations. |

**Table 9.7. Tourism Development (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Solid and liquid waste disposal creates nuisance conditions adjacent to amenities. | 6. • Appropriate waste disposal options required to manage potential problem.<br>• Landfill versus incineration alternatives, as well as waste minimization will be considered. |
| 7. • Access problems created:<br>• traffic congestion<br>• noise<br>• minor and localized air pollution<br>• people density greater than services available | 7. Access problems minimized by integrated planning to reduce traffic and pedestrian congestion, noise. |
| 8. Sea turtle nesting affected (special case). | 8. • Beach monitoring for turtle protection coupled with beach zoning and development guideline to preserve the natural beach environment from the primary dune seaward.<br>• Restricting night activities on nesting beaches during egg-laying and incubation periods. |
| 9. Displacement of human population. | 9. • Plan and implement program of compensation and resettlement.<br>• See Chapter 3 for discussion of involuntary resettlement concerns. |

Table 9.7. Tourism Development (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 1. Conflicts with other resource use such as fisheries, agriculture. | 1. • Conceive tourism development in framework of national, regional, local socioeconomic development plans to integrate new objectives into development strategies.<br>• Identify zones most suitable for tourism. |
| 2. • Stress to capacity to manage the "tourist or related environment."<br>• legislation and polling constraints<br>• agency support lacking<br>• staffing and financial resources to mitigate impacts absent/reduced<br>• inadequate training in environmental management | 2. • Comprehensive legislative action frequently required to address direct and indirect impacts and their monitoring and evaluation.<br>• Staffing and equipment support must be budgeted, including whatever training necessary to mitigate impacts and monitor the "environmental protection plan" or other mitigation plan. |
| 3. Multiplier effect on other industries causes increased stress on natural resources or services (craft market, vendor, taxi driver, suppliers, farmers/fishermen). | 3. • Provide adequate infrastructure and services support to meet physical, social and economic needs of the region.<br>• Recognize that "overbuilding" may be a persistent problem. |
| 4. Congestion, overcrowding. | 4. Design (urban areas and transport networks, etc.) according to carrying capacity of natural setting. |
| 5. Natural hazards peculiar to developed site such as coastal storms, flooding, landslides, earthquakes, hurricanes, volcanos, may stress infrastructure and reduce long-term benefits. | 5. Design facilities to: (a) meet best possible specifications for natural hazard amelioration; (b) take advantage of natural resources such as wetlands ability to buffer storms or absorb treated wastewater (see "Natural Hazards" section). |

## Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems

| 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.<br>• 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.<br>• 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.<br>• Select appropriate technology.<br>• Design for reliability, ease of maintenance.<br>• 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. |

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

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • 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: | 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. |
| • soil and crops by toxic substances and pathogens<br>• groundwater by toxic substances and nitrogen | • 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. |

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

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 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.<br>• Establish system performance standards by modeling or other means which will result in meeting criteria. |
| 8. Odors and noise from treatment process or sludge disposal operations. | 8. • Site treatment works only near compatible land uses.<br>• Select appropriate technology.<br>• Include odor control and low-noise equipment in design.<br>• 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 start-up plan.<br>• Implement effective industrial waste pretreatment program (see text for guidelines).<br>• Ensure preapplication treatment and operating guidelines for land application and other reuse or disposal systems are adequate to safeguard health of humans and livestock.<br>• Inspect for compliance with operating guidelines. |

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

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 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.<br>• Implement effective industrial waste pretreatment program (see text for guidelines).<br>• Provide appropriate safety equipment and monitoring instruments.<br>• 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.<br>• 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.<br>• Clean sewers as necessary.<br>• Provide monitoring system with alarms for pump station failure.<br>• Provide alternate power supply at critical pump stations.<br>• Educate public to prevent disposal of solid waste in sewers. |

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

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 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). |
| **Indirect** | |
| 19. Unplanned development induced or facilitated by infrastructure. | 19. • Coordinate installation of sewerage with land use planning.<br>• Strengthen land use control regulations and institutions.<br>• 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.<br>• Implement industrial waste pretreatment program. |

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

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 21. Loss of fisheries productivity. | 21. • Evaluate importance of receiving water in local and regional fisheries.<br>• Implement mitigating measures 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.<br>• Implement mitigating measures for direct impacts 3, 4, 5, 7, 8 and 14. |

## Table 10.1. Industrial Hazard Management

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Fires, explosions, emission of toxic gases, vapors, dust, emission of toxic liquids, radiation and various combination of these effects. | 1. • Provision of bunkers or blast walls.<br>• Firewalls/fireproofing of structures.<br>• Provision of escape routes for employees.<br>• Provision of safety and emergency training for employees.<br>• Implementation of emergency procedure on- and off-site.<br>• Provision of public alert systems and education of public.<br>• Planning and training for evacuation.<br>• Provision of safety buffer zones around the plant boundary. |
| 2. Explosives: explosion | 2. • Storage and handling should be according to the manufacturers recommendation.<br>• Special precautions should be taken against theft and fires and during destruction.<br>• The following general rules should be applied:<br>  • Lighting in the storage area should be natural or by permissible lights.<br>  • Lamps should be vapor proof and switch should be outside the building.<br>  • Only tools of wood or other non-metallic material should be used.<br>  • Cases of explosive should not be piled in stacks more than 6 feet high. |

**Table 10.1. Industrial Hazard Management (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Cases of explosives should be stored topside up, so that cartridges are lying flat. |
| | • They should be turned at regular intervals, as this will help to prevent their deterioration. |
| 3. Flammable Materials: fire hazard | 3. • Store in places that are cool enough to prevent accidental ignition in the event that vapors of the flammable materials mix with the air. |
| | • Provide adequate ventilation in storage space, so that leakage of such vapors from containers will be diluted enough to prevent a spark from igniting them. |
| | • Locate storage area well away from areas of fire hazard (for example, where torch-cutting of metals is to be performed). |
| | • Keep apart from powerful oxidizing agents materials that are susceptible to spontaneous heating (explosive or materials that react with air or moisture to evolve heat). |
| | • Provide fire-fighting equipment. |
| | • Prevent smoking or use of bare filament heaters. |
| | • Storage area must be electrically grounded and equipped with automatic smoke or fire detection equipment. |
| 4. Oxidizing Agents: fire hazard | 4. • Store away from liquids of low flash point (flammable). |
| | • Keep area cool and ventilated. |

**Table 10.1. Industrial Hazard Management (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Keep fuel away.<br>• The area should be fireproof.<br>• Note: Normal firefighting equipment is of little use since the blanketing or smothering effect of fire extinguishers is less effective because the oxidizers supply their own oxygen. |
| 5. Water Sensitive Materials: evolve heat, flammable gases or explosive gases in contact with water, steam or water solution. | 5. • Store in dry and cool areas.<br>• Because many of these materials are also flammable, it is essential that no automatic sprinkler system be used in the storage area.<br>• Such an area should have no water coming to it at all.<br>• Heating may be electrical or with hot, dry air.<br>• Storage building must be waterproof, located on high ground and separated from other storage.<br>• Particular attention should be paid to the following:<br>  • pocketing of light gases under the roof<br>  • introduction of sources of ignition<br>  • periodic inspection<br>  • automatic detection systems<br>  • alarms in case of dangerous concentrations of flammable gases |

## Table 10.1. Industrial Hazard Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Acid and Acid Fume-Sensitive Materials: evolve heat, hydrogen and flammable and/or explosive gases. | 6. • Do not store acids in proximity to such materials (e.g., storing acids on structural alloys sheds).<br>• If metal is used in construction, it should be painted or otherwise rendered immune to attack by acid.<br>• Area must be kept cool, ventilated and periodically inspected.<br>• Source of ignition must be kept away. |
| 7. Pressurized Storage of Flammable Fluids: when subjected to fire can cause "Boiling Liquid Expanding Vapor Explosion" (BLEVE). | 7. • Tanks should be stored upright and chained or otherwise securely attached to some substantial support to minimize the chance of falling over and breaking or straining the valve or other part of the tank.<br>• Tank storage area should be kept cool, out of direct rays of sun, and away from hot pipes.<br>• Provide means (sprinkler) of keeping the tanks cool in case of external or internal fire.<br>• Take care to keep from damaging tanks in handling.<br>• Valves must be operated carefully and kept in good condition.<br>• Do not hammer valve cocks.<br>• Discourage tampering with tanks in any way. |

**Table 10.1. Industrial Hazard Management (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 8. Toxic Materials: cause serious danger (death or serious injury to people or environment). | 8. • Reduction of inventories in storage and in process.<br>• Modify process or storage conditions (e.g., store and process toxic gases in a large volume of nontoxic carrier material).<br>• Store hazardous gas as a refrigerated liquid rather than under pressure.<br>• Improve shutdown and secondary containment which will reduce the amount escaping from containment or from site.<br>• Automatic shutdown will reduce the amount of material escaping from containment:<br>  • water curtains will restrict gas release.<br>  • dikes (or bunds) will restrict liquid release. |
| 9. Corrosive Materials: destroy containers, and react to evolve toxic gases in contact with substances such as cyanides and arsenides. | 9. • Keep storage or process area cool and ventilated to prevent accumulation of fumes.<br>• Keep containers closed and labeled.<br>• Paint all exposed metal in the vicinity of such storage and check it periodically for weakening by corrosion.<br>• Keep isolated from materials that would produce highly toxic fumes if contacted.<br>• Provide instructions for and supply of specific neutralizing agent to be used in case of spill, leak or major accident. |

Table 10.1. Industrial Hazard Management (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 10. • Occupational health effects on workers due to fugitive dust, materials handling, noise, or other process operations.<br>• Accidents occur at higher than normal frequency because of level of skill or labor. | 10. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control health hazards<br>• provide safety training |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage or lack of ultimate disposal facilities. | 11. • Plan for adequate on-site disposal areas assuming screening for hazardous characteristics of the leachate is known.<br>• Provide, in design phase, for adequate ultimate disposal facilities. |
| 12. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials to/from facility. | 12. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transporter regulation and development of emergency contingency plans to minimize risk of accidents. |

## Table 10.2. Electric Power Transmission Systems

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Vegetation damage, habitat loss, and invasion by exotic species along the ROW and access roads and around substation sites. | 1. • Utilize appropriate clearing techniques, (e.g., hand clearing versus mechanized clearing).<br>• Maintain native ground cover beneath lines.<br>• Replant disturbed sites.<br>• Manage ROWs to maximize wildlife benefits. |
| 2. Habitat fragmentation or disturbance. | 2. • Select ROW to avoid important natural areas such as wildlands and sensitive habitats.<br>• Maintain habitat (i.e., native vegetation) beneath lines.<br>• Make provisions to avoid interfering with natural fire regimes. |
| 3. Increased access to wildlands. | 3. • Select ROW to avoid sensitive wildlands.<br>• Develop protection and management plans for these areas.<br>• Use discontinuous maintenance roads. |
| 4. Runoff and sedimentation from grading for access roads, tower pads, and substation facilities, and alteration of hydrological patterns due to maintenance roads. | 4. • Select ROW to avoid impacts to water bodies, floodplains, and wetlands.<br>• Install sediment traps or screens to control runoff and sedimentation.<br>• Minimize use of fill dirt.<br>• Use ample culverts.<br>• Design drainage ditches to avoid affecting nearby lands. |

Table 10.2. Electric Power Transmission Systems (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 5. Loss of land use and population relocation due to placement of towers and substations. | 5. • Select ROW to avoid important social, agricultural, and cultural resources.<br>• Utilize alternative tower designs to reduce ROW width requirements and minimize land use impacts.<br>• Adjust the length of the span to avoid site-specific tower pad impacts.<br>• Manage resettlement in accordance with Bank procedures. |
| 6. Chemical contamination from chemical maintenance techniques. | 6. • Utilize mechanical clearing techniques, grazing and/or selective chemical applications.<br>• Select herbicides with minimal undesired effects.<br>• Do not apply herbicides with broadcast aerial spraying.<br>• Maintain naturally low-growing vegetation along ROW. |
| 7. Avian hazards from transmission lines and towers. | 7. • Select ROW to avoid important bird habitats and flight routes.<br>• Install towers and lines to minimize risk for avian hazards.<br>• Install deflectors on lines in areas with potential for bird collisions. |
| 8. Aircraft hazards from transmission lines and towers. | 8. • Select ROW to avoid airport flight paths.<br>• Install markers to minimize risk of low-flying aircraft. |
| 9. Induced effects from electromagnetic fields. | 9. • Select ROW to avoid areas of human activity. |

**Table 10.2. Electric Power Transmission Systems (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 10. Impaired cultural or aesthetic resources because of visual impacts. | 10. • Select ROW to avoid sensitive areas, including tourist sites and vistas.<br>• Construct visual buffers.<br>• Select appropriate support structure design, materials, and finishes.<br>• Use lower voltage, DC system, or underground cable to reduce or eliminate visual impacts of lines, structures, and ROWs. |
| **Indirect** | |
| 1. Induced secondary development during construction in the surrounding area. | 1. • Provide comprehensive plans for handling induced development.<br>• Construct facilities to reduce demand.<br>• Provide technical assistance in land use planning and control to local governments. |
| 2. Increased access to wildlands. | 2. • Route ROW away from wildlands.<br>• Provide access control. |

## Table 10.3. Oil and Gas Pipelines

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Resuspension of toxic sediments from construction of offshore pipelines. | 1. • Select alternate location for laying pipeline.<br>• Use alternative pipeline construction techniques to minimize resuspension of sediments (e.g., laying pipeline versus burying pipeline).<br>• Lay pipeline at a period of minimal circulation. |
| 2. Interference with fishing activities from offshore and nearshore pipelines. | 2. • Select pipeline route away from known fishing areas.<br>• Mark and map location of offshore pipelines.<br>• Bury pipeline that must be located in critical fishing areas. |
| 3. Habitat and organism loss along offshore and upland pipeline ROWs and pumping and compressor station sites, and increased access to wildlands. | 3. • Select ROW to avoid important natural resource areas.<br>• Utilize appropriate clearing techniques (e.g., hand clearing versus mechanized clearing) along upland ROWs to maintain native vegetation near pipeline.<br>• Replant disturbed sites.<br>• Use alternative construction techniques (see No. 1). |
| 4. Erosion, runoff, and sedimentation from construction of pipeline, grading for access roads and substation facilities. | 4. • Select ROW to avoid impacts to water bodies and hilly areas.<br>• Install sediment traps or screens to control runoff and sedimentation.<br>• Use alternative pipeline laying techniques that minimizes impacts.<br>• Stabilize soils mechanically or chemically to reduce erosion potential. |
| 5. Alteration of hydrological patterns. | 5. • Select ROW to avoid wetlands and flood plains.<br>• Minimize use of fill.<br>• Design drainage to avoid affecting nearby lands. |

Table 10.3. Oil and Gas Pipelines (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Evasion of exotic species and habitat fragmentation. | 6. • Select corridor and ROW to avoid important wildlands and sensitive habitats.<br>• Maintain native ground cover (vegetation) above pipeline.<br>• Make provisions to avoid interfering with natural fire regimes. |
| 7. Loss of land use due to placement of upland pipeline and substations. | 7. • Select ROW to avoid important social (including agricultural) and cultural land uses.<br>• Design construction to reduce ROW requirements.<br>• Minimize offsite land use impacts during construction.<br>• For buried pipelines, restore disturbed land along ROW. |
| 8. Creation of barriers for human and wildlife movement. | 8. • Select ROW to avoid travel routes and wildlife corridors.<br>• Elevate or bury pipeline to allow for movement. |
| 9. Increased traffic due to construction. | 9. • Phase construction activities to control traffic.<br>• Construct alternative traffic routes. |
| 10. Chemical contamination from wastes and accidental oil spills. | 10. • Develop waste and spill prevention and cleanup plans.<br>• Utilize spill containment techniques.<br>• Clean up and restore affected areas. |
| 11. Hazards from gas pipeline leakage or rupture. | 11. • Clearly mark locations of buried pipelines in high-use areas.<br>• Develop emergency evacuation plans and procedures.<br>• Monitor for leaks.<br>• Install alarms to notify the public of accidents. |

**Table 10.3. Oil and Gas Pipelines (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 1. Induced secondary development during construction in the surrounding area. | 1. • Develop comprehensive plan for location of secondary development.<br>• Construct facilities and provide financial support to existing infrastructure. |
| 2. Increased access to wildlands. | 2. • Develop protection and management plans for these areas.<br>• Construction barriers (e.g., fences) to prohibit access to sensitive wildlands. |

## Table 10.4. Checklist--Offshore Oil and Gas Development

1. Production

   - Field: Size, depth, area, structure, oil/gas/water ratios, oil type, gas type(s), pressures.
   - Operations: Site preparation, well spacing, start-up period (production rate, field life, sanitary wastes), pollution control, monitoring, oil spill and hydrogen sulfide contingency plans.
   - Air Emissions: Emission quantity and, where applicable, composition: venting, flaring, equipment emissions, evaporation from oil spills and leakage.
   - Waste Discharge: Projected quantity and composition; treatment/disposal method (production water, sanitary wastes, drilling muds and cuttings, oil spill and leakage).
   - Landuse: Area of field, port facilities, pipelines.
   - Equipment: Type and number of drilling and production platforms and ancillary units, transport of supplies and workers.
   - Supplies: Drilling muds, pipe, chemicals, water, fuel.
   - Staffing: Number and skills, source, housing plans.

2. Environmental Resources

   - Geology: Stratigraphy, structure, fracture patterns, aquifers (depth, thickness and quality, esp. if near shore), bottom character, geologic hazards, seismic history.
   - Oceanography: Water depths, temperature, mixing, tides and currents, bottom sediments, organic material, particulates, nutrients, salinity, contaminants.
   - Biological: Coastal habitats (coastal barriers, wetlands, bays, lagoons, estuaries, marshes, mangrove swamps, seagrasses); offshore habitats (shelf, banks, slope, deep sea, reefs); substrate, biota, communities, resident and casual populations, rare or significant species, significant habitat.
   - Climate: Precipitation patterns (amount, frequency, type), air quality, wind and storm patterns (direction, speed, frequency), temperature, climatic zone.

3. Socio-Economic Factors

   - Nearby communities: Location, access, population (number, demographic and social characteristics); economy (employment rate, income distribution, tax base); services (types, capacity, adequacy) and housing; concern is the ability to (a) provide workforce, (b) service new development and (c) absorb and adjust to growth (worker/family in-migration).
   - Land Use: Intensive and casual, full time and seasonal, actual and projected, specially designated areas (marine sanctuaries, coral reefs, recreational beaches or seashores, parks, refuges, reservations, wilderness), man-made features.
   - Cultural: Historic sites, archaeologic sites, native religious or harvest sites, ship wrecks.

4. Regulatory Framework

   - Applicable environmental laws, regulations, policies, standards, and requirements; monitoring and enforcement: air, water, waste, noise, reclamation, land use controls and approvals, cultural and historic resource protection.
   - Designation and protection of special areas and resources: parks, refuges, wilderness, sensitive ecological communities, threatened species of flora and fauna, native communities (including religious sites and harvesting/hunting or subsistence areas).
   - Authority/willingness to require special mitigation: community assistance, staged or phased development, isolate development workforce, pre- and post-development studies and monitoring (with corrective action as needed), worker training, mass transit of workforce.

## Table 10.5. Oil and Gas Development--Offshore

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Disturbance of cultural resources, benthic communities, coral reefs, coastal barriers, wetlands, pipelines and cables (e.g., anchor dragging, bottom sampling, pipeline trenching, drill ship positioning, platform siting, and so forth). | 1. • Require appropriate resource surveys of the offshore and coastal areas that may be affected by the project prior to any disturbance. Typically this will include:<br>• an inventory of cultural and historic resources<br>• an inventory of the flora and fauna of the region<br>• identification of significant topographic features<br>• an inventory of existing offshore pipelines and cables<br>• Mitigation measures based on identified resource conflicts may include:<br>• avoidance<br>• timing of operations<br>• recovering and archiving cultural and historic resources |
| 2. Degradation of coastal and offshore waters by discharges during routine operations (e.g., drilling muds, sanitary waters, production waters, and spills). | 2. • Require separation of cuttings from drilling mud and washing before discharge.<br>• Disposal of drilling muds onshore.<br>• Treatment of formation waters, sanitary and domestic wastes, and cleaning waters/solvents to meet water quality standards before discharge.<br>• Gutters and drip pans, especially at transfer points, to control platform spills. |

## Table 10.5. Oil and Gas Development--Offshore (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Water quality standards should be established for all waste water discharges. |
| | • Drill cuttings checked for residual oil before discharge. |
| | • Waters in vicinity of platform or drill ship monitored for oil sheen. |
| 3. Degradation of air quality from routine operational emissions (e.g., combustion, venting, spills). | 3. • Require appropriate pollution control devices installed and operative on all diesel generators and pumps. |
| | • Require hydrocarbon vapor control at all oil or gas transfer points, and prompt cleanup of any oil spills. |
| | • Minimize venting during production. |
| 4. Mortality and/or reduced reproduction of benthic organisms, coral communities, and other marine life through smothering (e.g., disturbed bottom sediments, drill muds, cuttings). | 4. • Prohibit or restrict bottom-disturbing activities in vicinity of significant coral reefs and benthic communities. |
| | • Discharged drill cuttings should be shunted to avoid these features. |
| | • Spent drilling muds should be barge to shore or discharged well away from any significant live bottom communities. |
| 5. Mortality and/or reduced reproduction of marine flora and fauna, waterfowl, sea birds and waterfowl through oil coating resulting from oil spills. | 5. • Minimize routine oil spillage through adherence to water quality, discharge standards, and good housekeeping practices on drill ships, platforms, shuttle boats, barges and tankers, and at transfer points. |

Table 10.5. Oil and Gas Development–Offshore (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Prompt detection and effective response to any operational or catastrophic spills.<br>• Provision for treatment facilities for any oiled birds or aquatic mammals. |
| 6. Disturbance of marine mammals by seismic surveys, drilling and ship noises. | 6. Prohibit use of explosives during presence of sensitive marine mammals. |
| 7. Degradation of beach areas, coastal facilities, and boats by oil spills and littering (e.g., coating, tar balls, trash and debris from offshore facilities and transport). | 7. • Solid waste disposal requirements, including sanitary and domestic wastes.<br>• Require labeling of all loose materials and equipment on vessels and platforms (especially barrels, boxes, etc.). |
| 8. Obstruction of boat traffic by offshore facilities. | 8. Do not site platforms in established shipping lanes. |
| 9. Loss or reduction of fishing areas and recreation sites. | 9. Do not site platforms in significant fishing or water-oriented recreation areas. |
| 10. Degradation of sea-ward vista (by siting of drilling ships and platforms). | 10. • Paint structures to blend with background (water and sky).<br>• Camouflage structures (however, reducing the visibility of drill ships or platforms may increase navigation hazards).<br>• Use subsurface or bottom production units where feasible. |

## Table 10.5. Oil and Gas Development--Offshore (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 11. Congestion and increased boating accidents in the coastal (from increased ship traffic). | 11. • Establish and publicize sea-lanes for shuttle traffic.<br>• When possible, avoid areas of heavy recreational or fishing boat use. |
| 12. Disturbance to humans and wildlife by increased noise levels in coastal area from aircraft overflights, ship traffic, and facility operations. | 12. Minimize overflights of populated areas. |
| 13. Loss of beach areas to pipeline landfalls and support facilities (e.g., land use, impact of spill cleanup activities, use of dispersants, traffic, disturbance from cleaning activities, and soil contamination). | 13. Avoid heavily-used recreational beaches. |
| 14. Injury/loss of life from accidents in transportation and facility operations. | 14. • Periodic training and continual safety reminders to all operating staff.<br>• Require periodic drills in emergency procedures.<br>• Ensure that all visitors are briefed on potential hazards and necessary safety precautions.<br>• Ensure that appropriate safety and rescue equipment is available and employees trained in its use.<br>• Install safety valves and alarms in subsurgace well-completion systems, with monitoring at production platforms and onshore location. |

Table 10.5. Oil and Gas Development–Offshore (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 15. Contamination of groundwater aquifers (e.g., wells). | 15. • Require proper drilling practices, casing, and sealing off all aquifers during drilling.<br>• Ensure that all aquifers are properly sealed off prior to well completion or abandonment. |
| 16. Increased demands on community facilities and services in the coastal area. | 16. • Require pre-development, socio-economic studies of potentially affected communities to identify possible impacts on services, infrastructure, dislocations, and conflicts.<br>• These impacts can be addressed by:<br>  • community assistance grants<br>  • loans<br>  • pre-payment of taxes<br>  • phasing the oil and gas development<br>  • constructing needed community facilities<br>• Cooperative and open working relations should be established early with local communities and maintained throughout the life of the project.<br>• Project workers should be encouraged to participate in community affairs. |

**Table 10.5. Oil and Gas Development--Offshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 17. Conflicts with native cultures, traditions, and life-styles. | 17. • Brief all employees to ensure awareness of and sensitivity to the local cultures, traditions, and lifestyles.<br>• Ensure that native leaders are aware of the projected activities, are assisted in identifying impacts that may be of particular concern to them, and have a voice in appropriate mitigation measures.<br>• Mitigation may include isolating the development work force from the native community. |

## Table 10.6. Checklist--Onshore Oil and Gas Development

### 1. Production

- *Production Zone(s):* Reserves, depth, area, structure, oil/gas/water ratios, oil type, gas type(s), pressures.
- Operations: Site preparation, well spacing, start-up period (production rate, product transportation, field life, waste sanitary wastes), pollution control, monitoring, spill response and reclamation plans.
- Air Emissions: Emission quantity and, where applicable, composition: dust, venting, flaring, waste pit burning, combustion, equipment emissions, oil spills and leakage.
- Waste Water Discharge: Projected quantity and composition; treatment/disposal method (production water, sanitary wastes).
- *Services:* Utilities (type, source, load), roads, airfields, rail, fire protection, security.
- Landuse: Area of field, transportation and utility routes, pipelines, buildings and structures (at field and stations along pipeline).
- Equipment: Type and number for site preparation, drilling, production, transportation, waste water separations and disposal, waste haulage pumping, reclamation, transport of supplies and workers.
- Supplies: Drilling muds, pipe, chemicals, water, fuel.
- Staffing: Construction, production, reclamation phases, number and skills, source, housing plans.

### 2. Environmental Resources

- *Geology: Stratigraphy, structure, fracture patterns, seismic history.*
- Groundwater: Depth to and thickness of aquifers, quality and quantity, hydraulics, recharge, uses.
- Surface Water: Quality, quantity, seasonal variations, uses.
- Soil: Soil profile (depth, type, characteristics).
- Vegetation: Types, density, rare or significant species or communities, wetlands.
- *Wildlife: Resident and casual, populations, rare or significant species, significant habitat.*
- Topography: Drainage patterns, elevations and slopes, prominent features.
- Climate: Precipitation patterns (amount, frequency, type), air quality, wind patterns (direction, speed, frequency), temperature, climatic zone.

### 3. Socio-Economic Factors

- Nearby communities: Location, access, population (number, demographic and social characteristics); economy (employment rate, income distribution, tax base); services (types, capacity, adequacy) and housing; concern is the ability to (a) provide workforce, (b) service new development and (c) absorb and adjust to growth (worker/family in-migration).
- Land Use: Intensive and casual, full time and seasonal, actual and projected, specially designated areas (parks, refuges, reservations, wilderness), man-made features (structures, roads, utilities).
- Cultural: Historic sites, archaeologic sites, native religious or harvest sites.

### 4. Regulatory Framework

- Applicable environmental laws, regulations, policies, standards, and requirements; monitoring and enforcement: air, water, waste, noise, reclamation, land use controls and approvals, cultural and historic resource protection.
- Designation and protection of special areas and resources: parks, refuges, wilderness, sensitive ecological communities, threatened species of flora and fauna, native communities (including religious sites and harvesting/hunting or subsistence areas).
- Authority/willingness to require special mitigation: community assistance, staged or phased development, isolate development workforce, pre- and post-development studies and monitoring (with corrective action as needed), worker training, mass transit of workforce.

**Table 10.7. Oil and Gas Development--Onshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Treatment of sanitary/domestic wastes and cleaning waters/solvents to meet water quality standards before discharge. |
| | • Prompt cleanup of any spills (oil, drilling mud, formation water). |
| | • Water quality standards should be established for all waste water discharges. |
| 3. Degradation of air quality from routine operational emissions. | 3. • Require appropriate pollution control devices on diesel generators and pumps, and hydrocarbon vapor control at all oil or gas transfer points. |
| | • Require prompt cleanup of any oil spills. |
| | • Minimize venting during production. |
| 4. Mortality and reduced reproduction of wildlife from habitat disturbance or loss, road kills, and hunting. | 4. • Prohibit or restrict disturbance of significant habitat and wetlands. |
| | • Mark wildlife road crossings. |
| | • Prohibit firearms possession in the area. |
| 5. Modification of vegetation and introduction of non-native species. | 5. Require prompt reclamation of disturbed areas and revegetation with native species. |

## Table 10.7. Oil and Gas Development--Onshore

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Disturbance of cultural resources, historic sites, vegetation, wetlands, surface drainages, and wildlife. | 1. • Require appropriate resource surveys of the areas that may be affected by the project prior to any disturbance. Typically this will include:<br>• an inventory of cultural and historic resources<br>• an inventory of the flora and fauna of the region<br>• identification of significant topographic features<br>• an inventory of existing pipelines and cables<br>• Mitigation measures based on identified resource conflicts may include:<br>• avoidance<br>• timing of operations<br>• recovering and archiving cultural and historic resources<br>• compensating for losses by protecting or enhancing comparable resources in region |
| 2. Degradation of surface waters by soil erosion from disturbed areas, discharge of drilling slurries and produced waters, wastes equipment servicing, and sanitary and domestic wastes. | 2. • Require control of stormwater runoff and prompt revegetation on disturbed areas.<br>• Burial of drilling muds and cuttings.<br>• Re-injection of produced formation waters.<br>• Good housekeeping practices at drill and production sites to minimize leaks and spills. |

**Table 10.7. Oil and Gas Development--Onshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Degradation/loss of vegetation (and soil productivity) from discharge or spills of produced waters, oil, and drilling muds. | 6. • Require blow-out preventers and control and prompt cleanup of oil and formation water spillage.<br>• Keep soil disturbance and vegetation clearing to minimum required for operation and safety. |
| 7. Land-use conflicts. | 7. • Consult with local land users in siting access, air fields, utility lines, and, to extent possible, production facilities.<br>• Allow other land uses to continue on the site where compatible with the operations. |
| 8. Degradation of remote areas through improved access and increased use. | 8. • Access remote areas by air during early exploration stage.<br>• Restrict use of access roads.<br>• Remove and reclaim any access roads at end of production.<br>• Minimize need for community development by rotating work crews and precluding permanent residence. |
| 9. Road damage, accidents, and traffic delays from increased truck traffic on local roads. | 9. • Observe road load limits.<br>• Design roads for adequate capacity and visibility.<br>• Ensure that roads are properly signed, vehicles are well-maintained, and drivers are trained and safety-conscious.<br>• Require that commuting workers car-pool or provide buses. |

**Table 10.7. Oil and Gas Development--Onshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 10. • Visual intrusions from wells, tanks, and production facilities.<br>• Cleared linear rights-of-way for pipelines, utilities, and roads, and processing facilities. | 10. • Paint structures to blend with background (vegetation and sky).<br>• Avoid contrasting colors.<br>• Utilize utility corridors.<br>• Minimize clearing and blend vegetation where feasible. |
| 11. Disturbance of humans and wildlife by noise from seismic surveys, drilling, pumping, and processing facilities. | 11. • Avoid seismic shots, low overflights, and other sudden loud noises in critical wildlife areas, especially during mating or nesting season.<br>• Require proper mufflers on diesel equipment. |
| 12. Loss of birds and animals in sludge ponds. | 12. • Minimize surface area and number of sludge pits, and require that they be promptly drained, closed, or covered (with netting) when not in use. |
| 13. Injury/loss of life from accidents. | 13. • Periodic training and continual safety reminders to all operating staff.<br>• Require periodic drills in emergency procedures.<br>• Ensure that all visitors are briefed on potential hazards and necessary safety precautions.<br>• Ensure that appropriate safety and rescue equipment is available and employees trained in its use.<br>• Install subsurface safety valves on gas producing wells. |

**Table 10.7. Oil and Gas Development--Onshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 14. Contamination of groundwater aquifers. | 14. • Require proper drilling practices, casing and sealing off all aquifers during drilling.<br>• Ensure that all aquifers are properly sealed off prior to well completion or abandonment.<br>• Line all mud storage and waste fluid pits. |
| 15. Increased demands on services and facilities in local communities, social and cultural conflicts, concern with community stability (boom and bust scenario). | 15. • Require pre-development, socio-economic study of potentially affected communities to identify possible impacts on services, infrastructure, dislocations, and conflicts.<br>• These impacts can be addressed by:<br>  • community assistance grants<br>  • loans<br>  • pre-payment of taxes<br>  • phasing the oil and gas development<br>  • constructing needed community facilities<br>• Cooperative and open working relations should be established early with local communities and maintained throughout the life of the project.<br>• Project workers should be encouraged to participate in community affairs. |

**Table 10.7. Oil and Gas Development--Onshore (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 16. Conflicts with native cultures, traditions, and life-styles. | 16. • Brief all employees to ensure awareness of and sensitivity to the local cultures, traditions, and lifestyles.<br>• Ensure that native leaders are aware of the projected activities, are assisted in identifying impacts that may be of particular concern to them, and have a voice in appropriate mitigation measures.<br>• Mitigation may include isolating the development work force from the native community. |
| 17. Subsidence of land surface. | 17. Re-injection of produced formation water and injection of additional water to replace volume of oil removed. |
| 18. Use of local surface water or groundwater. | 18. • Obtain water from unutilized aquifers.<br>• Non-potable water can be used for drilling, sprinkling roads, and irrigating. |

## Table 10.8. Hydroelectric Projects

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. • Negative environmental effects of construction:<br>• air and water pollution from construction and waste disposal<br>• soil erosion<br>• destruction of vegetation<br>• sanitary and health problems from construction camps | 1. • Measures to minimize impacts:<br>• air and water pollution control<br>• careful location of camps, buildings, borrow pits, quarries, spoil and disposal sites<br>• precautions to minimize erosion<br>• land reclamation |
| 2. Dislocation of people living in inundation zone. | 2. • Relocation of people to suitable area.<br>• Provision of compensation in kind for resources lost.<br>• Provision of adequate health services, infrastructure, and employment opportunities. |
| 3. Loss of land (agricultural, forest, range, wetlands) by inundation to form reservoir. | 3. • Siting of dam to decrease losses.<br>• Decrease of dam and reservoir size.<br>• Protection of equal areas in region to offset losses.<br>• Creation of useable land in previously unsuitable areas to offset losses. |
| 4. Loss of historic, cultural or aesthetic features by inundation. | 4. • Siting of dam or decrease of reservoir size to avoid loss.<br>• Salvage or protection of cultural properties. |

**Table 10.8. Hydroelectric Projects (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 5. Loss of wildlands and wildlife habitat. | 5. • Siting of dam or decrease of reservoir size to avoid/minimize loss.<br>• Establishment of compensatory parks or reserved areas.<br>• Animal rescue and relocation. |
| 6. Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation systems, navigation and fisheries and increasing water loss through transpiration. | 6. • Clearance of woody vegetation from inundation zone prior to flooding (nutrient removal).<br>• Weed control measures.<br>• Harvest of weeds for compost, fodder or biogas.<br>• Regulation of water discharge and manipulation of water levels to discourage weed growth. |
| 7. Deterioration of water quality in reservoir. | 7. • Clearance of woody vegetation from inundation zone prior to flooding.<br>• Control of land uses, wastewater discharges, and agricultural chemical use in watershed.<br>• Limit retention time of water in reservoir.<br>• Provision for multi-level releases to avoid discharge of anoxic water. |

## Table 10.8. Hydroelectric Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 8. Sedimentation of reservoir and loss of storage capacity. | 8. • Control of land use in watershed (especially prevention of conversion of forests to agriculture).<br>• Reforestation and/or soil conservation activities in watersheds (limited affect).<br>• Hydraulic removal of sediments (flushing, sluicing, release of density currents).<br>• Operation of reservoir to minimize sedimentation (entails loss of power benefits). |
| 9. Formation of sediment deposits at reservoir entrance creating backwater effect and flooding and waterlogging upstream. | 9. Sediment flushing, sluicing. |
| 10. Scouring of riverbed below dam. | 10. Design of trap efficiency and sediment release (e.g., sediment flushing, sluicing) to increase salt content of released water. |
| 11. Decrease in floodplain (recession) agriculture. | 11. Regulation of dam releases to partially replicate natural flooding regime. |
| 12. Salinization of floodplain lands. | 12. Regulation of flow to minimize effect. |
| 13. Salt water intrusion in estuary and upstream. | 13. Maintenance of at least minimum flow to prevent intrusion. |

## Table 10.8. Hydroelectric Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 14. Disruption of riverine fisheries due to changes in flow, blocking of fish migration, and changes in water quality and limnology. | 14. • Maintenance of at least minimum flow for fisheries.<br>• Provision of fish ladders and other means of passage.<br>• Protection of spawning grounds.<br>• Aquaculture and development of reservoir fisheries in compensation. |
| 15. Snagging of fishing nets in submerged vegetation in reservoir. | 15. Selective clearance of vegetation before flooding. |
| 16. Increase of water-related diseases. | 16. • Design and operation of dam to decrease habitat for vector.<br>• Vector control.<br>• Disease prophylaxis and treatment. |
| 17. Conflicting demands for water use. | 17. • Planning and management of dam in context of regional development plans.<br>• Equitable allocations of water between large and small holders and between geographic regions of valley. |
| 18. Social disruption and decrease in standard of living of resettled people. | 18. • Maintenance of standard of living by ensuring access to resources at least equalling those lost.<br>• Provision of health and social services. |

## Table 10.8. Hydroelectric Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 19. Environmental degradation from increased pressure on land. | 19. • Choice of resettlement site to avoid surpassing carrying capacity of the land.<br>• Increase of productivity or improve management of land (agricultural, range, forestry improvements) to accommodate higher population. |
| 20. Disruption/destruction of tribal/indigenous groups. | 20. Avoid dislocation of unacculturated people and where not possible, relocate in area allowing them to retain lifestyle and customs. |
| 21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos, tsetse). | 21. Vector control. |
| **Indirect** | |
| 22. Uncontrolled migration of people into the area made possible by access roads and transmission lines. | 22. Limitation of access, provision of rural development, and health services to try to minimize impact. |
| 23. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth). | 23. Basin-wide integrated planning to avoid overuse, misuse, and conflicting uses of water and land resources. |
| **External** | |
| 24. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality. | 24. Land use planning efforts which include watershed areas above dam. |

**Table 10.9. Thermoelectric Projects**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Air emission effects to human health, agriculture, and native wildlife and vegetation. | 1. • Locate facility away from sensitive air quality receptors.<br>• Design higher stacks to reduce ground level concentrations.<br>• Use cleaner fuels (e.g., low sulfur coal).<br>• Install air pollution control equipment. |
| 2. Increased noise and vibration. | 2. • Use lower rated equipment.<br>• Control the timing of noise and vibration to least disruptive periods.<br>• Install noise barriers. |
| 3. Change in surface water and groundwater quality. | 3. • Treat discharges chemically or mechanically on-site.<br>• Prevent groundwater contamination through use of liners.<br>• Use deep well injection below potable zones.<br>• Construct liners for ponds and solid waste disposal areas.<br>• Dilute effluent at point of discharge. |
| 4. Toxic effects of chemical discharges and spills. | 4. • Develop spill prevention plans.<br>• Develop traps and containment systems and chemically treat discharges on-site. |
| 5. Thermal shock to aquatic organisms. | 5. • Use alternative heat dissipation design (e.g., closed cycle cooling).<br>• Dilute thermal condition by discharging water into larger receiving water body.<br>• Install mechanical diffusers.<br>• Cool water on-site in holding pond prior to discharge.<br>• Explore opportunities to use waste heat. |

**Table 10.9. Thermoelectric Projects (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 6. Entrainment and impingement of aquatic organisms. | 6. • Select water intake in area that avoids significant impact.<br>• Install screens to eliminate entrainment and impingement. |
| 7. Change in surface water and groundwater quantity. | 7. • Develop water recycling plan. |
| 8. Change in surface water flow and discharge. | 8. • Construct drainage ways and holding ponds on-site. |
| 9. Vegetation removal and habitat loss. | 9. • Select alternative site or site layout to avoid loss of ecological resources.<br>• Restore or create similar vegetation or habitats. |
| 10. Dredging and filling of wetlands. | 10. • Select alternative site or site layout to avoid loss of wetlands.<br>• Restore or create similar wetlands. |
| 11. Avian hazards from stacks, towers, and transmission lines. | 11. • Site stacks and tower away from flyways.<br>• Install deflectors, lights, and other visible features. |
| 12. Human population displacement. | 12. • Select alternative site or site layout to avoid displacement.<br>• Involve affected parties in the resettlement planning and program.<br>• Construct socially and culturally acceptable settlements/infrastructure development (see "Involuntary Resettlement" section). |
| 13. Disruption of traffic. | 13. • Develop traffic plan that includes phasing road use by workers.<br>• Upgrade roads and intersections. |

**Table 10.9. Thermoelectric Projects (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 14. Modification of historically or archaeologically significant structures or lands (e.g., churches, temples, mosques, cemeteries). | 14. • Select alternative site or site layout.<br>• Develop and implement "chance find" procedures to recover, relocate or restore structures (see "Cultural Property" section for detailed discussion).<br>• Fence or construct other barriers to protect structures or lands. |
| 15. Visual impact on historical, archaeological, and cultural resources and on landscapes. | 15. • Select alternative site or site layout.<br>• Construct visual buffers (e.g., plant trees). |
| 16. Worker exposure to dust from ash and coal. | 16. • Provide dust collector equipment.<br>• Maintain dust levels $\leq 10$ mg/m$^3$.<br>• Monitor for free silica content.<br>• Provide dust masks when levels are exceeded. |
| 17. Worker exposure to toxic gases leaking from broilers. | 17. • Maintain boilers properly.<br>• Monitor concentrations with levels not to exceed:<br>$SO_2$ 5 ppm<br>CO 50 ppm<br>$NO_2$ 5 ppm |
| 18. Worker exposure to excessive noise. | 18. • Maintain noise levels below 90 dBA, or provide ear protection. |

Table 10.9. Thermoelectric Projects (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 1. Induced secondary development including increased demands on infrastructure. | 1. • Provide infrastructure plan and financial support for increased demands.<br>• Construct facilities to reduce demands. |
| 2. Changes in demographic patterns and disruption of social and cultural values and patterns. | 2. • Develop plan to educate workers on sensitive values and patterns.<br>• Provide behavioral and/or psychological readjustment programs and services. |

## Table 10.10. Cement

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plant in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Integrate site selection process with natural resource agencies to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and not preclude beneficial use of the water body.<br>• Plants with liquid discharges should only be located on a watercourse having adequate waste-absorbing capacity. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate in an area not subject to air inversions or trapping of pollutants, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • Site selection should evaluate the location according to the following guidelines:<br>• plot size sufficient to landfill or dispose on-site<br>• proximity to suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal |
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles. | 5. • Laboratory analysis of liquid effluent should include TDS, TSS, salts, alkalinity, potassium, sulfates, and in-situ pH temperature monitoring. |

**Table 10.10. Cement (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| • Plant: Total Suspended Solids (TSS), Total Dissolved Solids (TDS), temperature, pH<br><br>• Materials storage piles runoff: TSS, pH | <u>All Plants</u><br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• No discharge of slurry tank wash or spills.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br><br><u>Non-Leaching Plants</u><br>• TSS <5 g/ton product<br>• TDS no greater than levels of water incoming to plant<br><br><u>Leaching Plants</u><br>• TSS <150 g/ton product<br>• TDS <1.5 kg/ton product<br><br><u>Material Storage Piles</u><br>• Minimize rainfall allowed to percolate through piles and runoff in uncontrolled fashion.<br><br>• Line storage areas.<br><br><u>Equipment Washing, Road Washing, Other Washing</u><br>• <150 g/ton product during equipment cleaning operations or during periods of rainfall.<br>• Plant housekeeping procedures must reflect desired level of mitigation. |

Table 10.10. Cement (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 6. Particulate emissions to the atmosphere from all plant operations, crushing, material handling, kilns, clinker coolers. | 6. • Control particulates by fabric filter collectors.<br>• Control kiln particulate emissions by electrostatic precipitator dust collectors, with moisture conditioning required for dry process operations.<br>• Control particulates on dry basis as follows:<br>  • from kiln, 150 g/ton feed<br>  • from clinker cooler, 50 g/ton feed<br>  • ground level outside plant fence, 80 $\mu g/m^3$<br>  • stack discharge, 100 $\mu g/m^3$ |
| 7. Particulate emission from ground sources (fugitive dust particulates), roads, piles. | 7. • Control measures include:<br>  • road treatment<br>  • water spray on piles<br>  • use of industrial vacuum cleaner<br>  • limit speed to 20 km/hr |
| 8. Kiln gaseous emission of $SO_x$ to the atmosphere from fuel burning. | 8. • Control by natural scrubbing action of alkaline materials and enhanced by utilization of preheater kilns, and use of exhaust gases to dry raw materials in grinding.<br>• An analysis of raw materials during feasibility stage of project can determine levels of sulfur to properly design emission control equipment.<br><br><u>Inside plant fence</u><br>• Annual arithmetic mean: 100 $\mu g/m^3$<br>• Maximum 24 hour peak: 1000 $\mu g/m^3$ |

Table 10.10. Cement (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| | Outside plant fence<br>• Annual arithmetic mean: 100 $\mu g/m^3$<br>• Maximum 24 hour peak: 500 $\mu g/m^3$ |
| 9. Kiln gaseous emissions of $NO_x$ to the atmosphere from fuel burning. | 9. • Reduce $NO_x$ by use of coal fuel and preheater/precalciner kilns.<br>• Use of vegetative material or chemical wastes from other local industries should be carefully reviewed since these fuels may increase $NO_x$ releases to the atmosphere. |
| 10. Air pollution during start-up of the kiln (and the electrostatic precipitator is not available). | 10. Where possible, conduct start-up when wind direction is not directed to ecologically sensitive or populated areas. |
| 11. Air pollution as a result of electrostatic malfunction. | 11. • Design precipitator with parallel chambers to enable the use of one part of the precipitator when the other is under repair.<br>• Enforce kiln shut-down when precipitator is completely out-of-order. |
| 12. • Burning hazardous wastes or waste oils as supplemental fuels could emit toxic air pollutants as products of incomplete combustion and metals such as lead to the atmosphere.<br>• Handling and storage of hazardous wastes pose risks to community and environment. | 12. • Although studies have shown that most organic materials are destroyed at an efficiency of 99.99 percent and metals are adsorbed to cement dust that is collected by the air pollution control system.<br>• Care must be exercised to ensure that (a) hazardous waste and waste oils are analyzed before approval for burning, and (b) kiln operating efficiency is maintained. |

Table 10.10. Cement (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| | • Add the waste at the "hot" end of the kiln. |
| | • Develop hazardous waste handling procedures and contingency plans (see "Hazardous Materials Management" section). |
| 13. Surface runoff of constituents leached from kiln dust, raw materials, clinker, coal and other substances frequently stored in piles on the facility grounds can pollute surface waters or percolate to ground waters. | 13. • Rainwater percolation and runoff from solid materials, fuel and waste piles can be controlled by covering and/or containment to prevent percolation and runoff to ground and surface waters. |
| | • Diked areas should be of sufficient size to contain an average 24 hour rainfall. |
| **Indirect** | |
| 14. • Occupational health effects on workers due to fugitive dust, materials handling or other process operations. | 14. • Facility should implement a Safety and Health Program designed to: |
| • Accidents occur at higher than normal frequency because of level of skill or labor. | • identify, evaluate, monitor, and control safety and health hazards at a specific level of detail<br>• address the hazards to worker health and safety<br>• propose procedures for employee protection<br>• provide safety training |
| 15. Regional solid waste problem exacerbated by inadequate on-site storage. | 15. • Plan for adequate on-site disposal areas or use of kiln dust or other by-products as local fill material, assuming screening for hazardous characteristics of the leachate is known. |
| | • Use kiln dust for soil liming, neutralizing acid or stabilizing hazardous waste. |

**Table 10.10. Cement (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 16. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials, fuel or cement to/from facility. | 16. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transporter regulation and development of emergency contingency plans to minimize risk of accidents during transport of waste fuels. |
| 17. Mining of limestone locally to provision cement facility can create conflicts with other industries, such as housing and construction, that rely on some similar resources and can aggravate erosion/sedimentation of water courses by uncontrolled or unrestricted operations. | 17. • Plan for limestone resource usage to fit availability and impose restrictions on manner of quarrying.<br>• Coordination with responsible agency-in-charge to examine site reclamation options once facility is de-commissioned.<br>• Provide plan for limestone mine restoration. |

**Table 10.11. Chemical and Petrochemical**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plants in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Involve natural resource agencies in site selection process to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and do not preclude beneficial use of the water body.<br>• Plants with liquid discharges should be located only on a watercourse having adequate capacity to assimilate wastes in treated effluent. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate plants in an area not subject to air inversions or trapping of pollutants, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • Site selection should evaluate the location according to the following guidelines:<br>• plot size sufficient for landfill or disposal on-site<br>• proximity to suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal |

## Table 10.11. Chemical and Petrochemical (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles.<br>• Depending on the process, runs at too high TOS, BOD, COD, and pH. | 5. • Laboratory analysis of liquid effluent should include applicable chemicals (depending on the process), TOS, BOD, COD, pH and in-situ temperature monitoring.<br><br>All Plants<br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to specified limitations in Bank or other guidelines for specific process.<br><br>Processing, Storage and Dispatch Area<br>• Minimize rainfall allowed to percolate through piles and runoff in uncontrolled fashion.<br><br>• Line open storage areas to collect all stormwater. |
| 6. Particulate emissions to the atmosphere from all plant operations. | 6. Control particulates by scrubbers, fabric filter collectors or electrostatic precipitators. |
| 7. Gaseous emission of $SO_x$, $NO_x$, and CO and other applicable chemicals to the atmosphere from chemical processes. | 7. Control by scrubbing with water or alkaline solutions, incineration, or absorption by other catalytic processes. |
| 8. Accidental release of potentially hazardous solvents, acidic and alkaline materials. | 8. • Maintain storage and disposal areas to prevent accidental release.<br>• Provide spill mitigation equipment.<br>• Provide area diking or double wall tanks. |

Table 10.11. Chemical and Petrochemical (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 9. Accidental radiation/biological hazard release (pharmaceuticals). | 9. Maintain certified storage and disposal facilities to minimize potential for release. |
| 10. Noise. | 10. • Reduce noise impact by enclosing and insulating noise emitting processes or equipment in buildings or by use of other noise abatement procedures. |
| 11. Surface runoff of chemicals, raw materials, intermediates, end products, and solid wastes frequently stored in piles on the facility site can pollute surface waters or percolate to groundwaters. | 11. • Rainwater percolation and runoff from solid materials, fuel and waste piles can be controlled by covering and/or containment to prevent percolation and runoff to ground and surface waters.<br>• Diked areas should be of sufficient size to contain an average 24 hour rainfall.<br>• Collect and monitor stormwater before discharge. |
| **Indirect** | |
| 12. • Occupational health effects on workers due to fugitive dust, materials handling, noise, or other process operations.<br>• Accidents occur at higher than normal frequency because of level of skill or labor. | 12. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control health hazards<br>• provide safety training |
| 13. Regional solid waste problem exacerbated by inadequate on-site storage or lack of ultimate disposal facilities. | 13. • Plan for adequate on-site disposal areas assuming screening for hazardous characteristics of the leachate is known.<br>• Provide, in design phase, for adequate ultimate disposal facilities. |

**Table 10.11. Chemical and Petrochemical (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 14. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials to/from facility. | 14. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transporter regulation and development of emergency contingency plans to minimize risk of accidents. |

## Table 10.12. Fertilizer

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plant in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Integrate site selection process with natural resource agencies to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and not preclude beneficial use of the water body.<br>• Plants with liquid discharges should only be located on a watercourse having adequate waste-absorbing capacity. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate at a high elevation in an area not subject to air inversions, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • Site selection should evaluate the location according to the following guidelines:<br>• plot size sufficient to landfill or dispose on-site<br>• proximity to suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal<br>• availability of options for gypsum disposal or reuse |

Table 10.12. Fertilizer (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles.<br>• Phosphate plants: phosphate, fluoride, $BOD_5$, Total Dissolved Solids (TDS), pH<br>• Nitrogen plants: ammonia, urea, ammonium nitrate, COD, pH<br>• Materials storage piles runoff: TSS, pH, metals | 5. • Laboratory analysis of liquid effluent should include fluoride, $BOD_5$, TSS, and in-situ pH temperature monitoring.<br><br>All Plants<br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to EPA limitations (40 CFR 418) for specific process.<br><br>Material Storage Piles/Solid Waste Disposal Areas<br>• Minimize rainfall allowed to percolate through piles and runoff in uncontrolled fashion.<br><br>• Line storage areas. |
| 6. Particulate emissions to the atmosphere from all plant operations. | 6. Control particulates by fabric filter collectors or electrostatic precipitators. |
| 7. Gaseous emission of $SO_x$ and $NO_x$, ammonia, acid mist and fluorine compounds to the atmosphere. | 7. • Control by scrubbing.<br>• Analyze raw materials during feasibility stage of project.<br>• Proper design of sulfuric acid plants and nitric acid plants with $NO_x$ abatement equipment. |

Table 10.12. Fertilizer (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 8. Accidental release of potentially hazardous solvents, acidic, and alkaline materials. | 8. • Maintain storage and disposal areas to prevent accidental release.<br>• Provide spill mitigation equipment.<br>• Provide dikes around storage tanks. |
| 9. Surface runoff of constituents, raw materials, and solid wastes frequently stored in piles on the facility grounds can pollute surface waters or percolate to ground waters. | 9. • Plan proper storage in design phase.<br>• Cover and/or line storage areas (especially gypsum piles) to prevent percolation and runoff to ground and surface waters.<br>• Diked areas should be of sufficient size to contain an average 24 hour rainfall. |
| 10. Occupational health effects on workers due to fugitive dust, materials handling or other process operations, and accidents occur at higher than normal frequency because of level of skill or labor. | 10. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control safety and health hazards at a specific level of detail<br>• address the hazards to worker health and safety<br>• propose procedures for employee protection<br>• provide safety training |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage or lack of ultimate disposal facilities. | 11. Plan for adequate on-site disposal, assuming screening for hazardous characteristics of the leachate is known. |

**Table 10.12. Fertilizer (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 12. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials to/from facility. | 12. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transporter regulation and development of emergency contingency plans to minimize risk of accidents. |
| 13. Increasing nitrate pollution of ground water from use of nitrogen fertilizers. | 13. Directions for use should be provided to minimize nitrate pollution potential. |
| 14. Eutrophication of natural water systems. | 14. Directions for use should be provided to minimize nitrate and phosphate pollution potential. |

## Table 10.13. Food Processing

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs or use of prime agricultural lands. | 1. • Locate plant to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Integrate site selection process with natural resource agencies to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and not preclude beneficial use of the water body using the following guidelines:<br>• on a watercourse having maximum water dilution and absorbing capacity<br>• in an area where wastewater can be reused with minimal treatment for agricultural or industrial purposes<br>• within a municipality that is able to accept the plant wastes in their sewage treatment system |
| 3. Siting can cause serious odor pollution problems for local area. | 3. Locate plant in an area not subject to air inversions or to trapping pollution, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • For facilities producing large volume of waste, site selection should evaluate the location according to the following guidelines:<br>• plot size sufficient to landfill or on-site disposal<br>• proximity to a suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal |

**Table 10.13. Food Processing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles.<br>• Plant: Oil and Grease, TDS, TSS, BOD, COD | 5. • Laboratory analysis of liquid effluent should include oil and grease, TDS, TSS, BOD, COD and in-situ temperature monitoring.<br><br>All Plants<br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to EPA specified limitations (40 CFR 405-409; 432) for specific process.<br>• Land application of waste effluents where appropriate. |
| 6. Particulate emissions to the atmosphere from all plant operations. | 6. Control particulates by fabric filter collectors or electrostatic precipitators. |
| 7. Gaseous and odorous emissions to the atmosphere from processing operations. | 7. • Control by natural scrubbing action of alkaline materials.<br>• Analysis of raw materials during feasibility stage of project can determine levels of sulfur to properly design emission control equipment. |
| 8. Accidental release of potentially hazardous solvents, acidic alkaline materials. | 8. • Maintain storage and disposal areas to prevent accidental release.<br>• Provide spill control equipment. |

Table 10.13. Food Processing (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 9. • Occupational health effects on workers due to materials handling, noise or other process operations.<br>• Accidents occur at higher than normal frequency because of level of knowledge and skill. | 9. • Facility should implement a Safety and Health Program designed to identify, evaluate, monitor, and control safety and health hazards at a specific level of detail, and to address the hazards to worker health and safety and procedures for employee protection, including any or all of the following:<br>• site characterization and analysis<br>• site control<br>• training<br>• medical surveillance<br>• engineering controls, work practices and personal protective equipment<br>• monitoring<br>• informational programs<br>• handling raw and process materials<br>• decontamination procedures<br>• emergency response<br>• illumination<br>• sanitation at permanent and temporary facilities<br>• regular safety meetings |
| 10. Regional solid waste problem exacerbated by inadequate on-site storage. | 10. Plan for adequate on-site disposal areas assuming that the characteristics of the leachate is known. |

**Table 10.13. Food Processing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 11. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials to/from facility. | 11. • Site selection can mitigate some of these problems, such as pedestrian hazards.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transport regulation and development of emergency contingency plans to minimize risk of accidents. |
| 12. Potential for disease transmission from inadequate waste disposal. | 12. • Develop specifications for:<br>• food preparation and or processing<br>• waste disposal processes<br>• monitor fecal coliform or other bacteria |

## Table 10.14. Iron and Steel Manufacturing

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plant in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Involve natural resource agencies in site selection process to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and do not preclude beneficial use of water bodies.<br>• Plants with liquid discharges should only be located on a water-course having adequate capacity to assimilate waste in treated effluent. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate plant at elevation above local topography, in an area not subject to air inversions, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • Site selection should evaluate the location according to the following guidelines:<br>• proximity to suitable disposal site<br>• plot size sufficient for landfill or disposal on-site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal<br>• reuse or recycle materials to reduce waste volumes |

**Table 10.14. Iron and Steel Manufacturing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles.<br>• Plant: Total Suspended Solids (TSS), oil and grease, ammonia nitrogen, cyanide, phenols, benzene, naphthalene, benzo-a-pyrene, pH, lead, zinc<br>• Materials storage piles runoff: TSS, pH, metals | 5. • Laboratory analysis of liquid effluent should include: TSS, oil and grease, ammonia nitrogen, cyanide, phenols, benzene, naphthalene, benzo-a-pyrene, pH, lead, zinc, and in-situ temperature monitoring.<br>All Plants<br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to specified limitations in Bank or other guidelines (e.g., EPA 40 CFR 420) for specific process.<br>Material Storage Piles/Solid Waste Disposal Areas<br>• Minimize stormwater allowed to percolate through materials and runoff in uncontrolled fashion.<br>• Line open storage areas. |
| 6. Particulate emissions to the atmosphere from all plant operations. | 6. Control particulates by fabric filter collectors or electrostatic precipitators. |
| 7. Gaseous emission of $SO_x$ and CO to the atmosphere from coke production and fuel burning. | 7. • Control by scrubbing with alkaline resolutions.<br>• Analysis of raw materials during feasibility stage of project planning can determine existing levels of sulfur to properly design emission control equipment.<br>• Strip, recycle and reuse carbon monoxide. |

## Table 10.14. Iron and Steel Manufacturing (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 8. Accidental release of potentially hazardous solvents, acidic and alkaline materials. | 8. • Maintain storage and disposal areas to prevent accidental release.<br>• Provide spill mitigation equipment, double wall tanks and/or diking of storage tanks. |
| 9. Surface runoff of constituents, raw materials, coal, coal breeze and other substances frequently stored in piles on the facility grounds can pollute surface waters or percolate to ground waters. | 9. • Rainwater percolation and runoff from solid materials, fuel and waste piles can be controlled by covering and/or containment to prevent percolation and runoff to ground and surface waters.<br>• Diked areas should be of sufficient size to contain an average 24 hour rainfall. |
| **Indirect** | |
| 10. • Occupational health effects on workers due to fugitive dust, materials handling, noise or other process operations.<br>• Accidents occur at higher than normal frequency because of level of skill or labor. | 10. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control safety and health hazards<br>• provide safety training |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage or lack of ultimate disposal facilities. | 11. Plan for adequate on-site disposal areas, assuming screening for hazardous characteristics of the leachate is known. |

**Table 10.14. Iron and Steel Manufacturing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 12. Transit patterns disrupted, noise congestions created, and pedestrian hazards aggravated by heavy trucks transporting raw materials and fuel to/from facility. | 12. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transport regulation and development of emergency contingency plans to minimize risk of accidents. |

## Table 10.15. Nonferrous Metals

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plant in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Involve natural resource agencies in site selection process to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives which minimize environmental effects and do not preclude beneficial use of water bodies.<br>• Plants with liquid discharges should only be located on a watercourse having adequate capacity to assimilate waste in treated effluent. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate plant at elevation above local topography in an area not subject to air inversions, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • Site selection should evaluate the location according to the following guidelines:<br>• proximity to suitable disposal site<br>• plot size sufficient for landfill or disposal on-site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal<br>• reuse or recycle materials to reduce waste volumes |

## Table 10.15. Nonferrous Metals (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles.<br>• Plant: metals, oil and grease, ammonia nitrogen<br>• Materials storage piles runoff: TSS, pH, metals | 5. • Laboratory analysis of liquid effluent should include: metals, TSS, oil and grease, ammonia nitrogen, pH, and in-situ temperature monitoring.<br><br>All Plants<br>• No cooling water discharge. If recycling not feasible, discharge cooling water provided receiving water temperature does not rise >3°C.<br>• Maintain pH level of effluent discharge between 6.0 and 9.0.<br>• Control effluent to specified limitations in Bank or other guidelines (e.g., EPA 40 CFR 421) for specific process.<br><br>Material Storage Piles/Solid Waste Disposal Areas<br>• Minimize stormwater allowed to percolate through materials and runoff in uncontrolled fashion.<br><br>• Line open storage areas. |
| 6. Particulate emissions to the atmosphere from all plant operations. | 6. Control particulates by fabric filter collectors or electrostatic precipitators. |
| 7. Gaseous emission to the atmosphere from metals processing and fuel burning. | 7. • Control by scrubbing with alkaline solutions.<br><br>• Analysis of raw materials during feasibility stage of project planning can determine existing levels of sulfur to properly design emission control equipment. |

Table 10.15. Nonferrous Metals (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 8. Accidental release of potentially hazardous solvents, acidic and alkaline materials. | 8. • Maintain storage and disposal areas to prevent accidental release.<br>• Provide spill mitigation equipment, double wall tanks and/or diking of storage tanks. |
| 9. Surface runoff of constituents, raw materials, and other substances frequently stored in piles on the facility grounds can pollute surface waters or percolate to ground waters. | 9. • Rainwater percolation and runoff from solid materials, fuel and waste piles can be controlled by covering and/or containment to prevent percolation and runoff to ground and surface waters.<br>• Diked areas should be of sufficient size to contain an average 24 hour rainfall. |
| **Indirect** | |
| 10. • Occupational health effects on workers due to fugitive dust, materials handling, noise or other process operations.<br>• Accidents occur at higher than normal frequency because of level of skill or labor. | 10. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control safety and health hazards<br>• provide safety training |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage or lack of ultimate disposal facilities. | 11. Plan for adequate on-site disposal areas, assuming screening for hazardous characteristics of the leachate is known. |
| 12. Transit patterns disrupted, noise congestions created, and pedestrian hazards aggravated by heavy trucks transporting raw materials and fuel to/from facility. | 12. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transport regulation and development of emergency contingency plans to minimize risk of accidents. |

**Table 10.15. Nonferrous Metals (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 13. Mining of ore and coal locally for metals manufacturing can create conflicts with other industries (coal for utilities), and aggravate erosion/sedimentation of water courses by uncontrolled or unrestricted operations. | 13. • Plan for coal resource usage to fit availability and impose restrictions on manner of mining.<br>• Coordination with responsible agency-in-charge to examine site reclamation options once facility decommissioned. |
| 14. Metals processing may require significant amounts of electricity which may result in conflicts with other industrial users. | 14. • Operate metals processing operations at hours when other power consuming industries are not operating.<br>• Increase electrical power generation capabilities. |

## Table 10.16. Petroleum Refining

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of refinery on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate refinery in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Integrate site selection process with natural resource agencies to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and not preclude beneficial use of the water body using the following guidelines:<br>• on a watercourse having adequate waste assimilative capacity<br>• in an area where wastewater can be reused with minimal treatment for agricultural or industrial purposes<br>• within a municipality that is able to accept the plant wastes in their sewage treatment system |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate refinery in an area not subject to air inversions or trapping of air pollution, and where prevailing winds are towards relatively unpopulated areas. |
| 4. Siting can aggravate solid waste problems in an area. | 4. • For facilities producing large volume of waste, site selection should evaluate the location according to the following guidelines:<br>• plot size sufficient to landfill or dispose on-site<br>• proximity to suitable disposal site<br>• convenient for public/private contractors to collect and haul solid wastes for final disposal |

## Table 10.16. Petroleum Refining (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation** | |
| 5. • Water pollution from discharge of liquid effluents and process cooling water or runoff from waste piles may contain:<br><br>BOD, COD, TOC, oil and grease, ammonia, phenolic compounds, sulfides, and chromium. | 5. • Control by wastewater reuse, at-source pretreatment and end-of-pipe control technology.<br><br>(a) Major at-source pretreatment measures include:<br>• stripping of sour waters<br>• neutralization and oxidation of spent caustics<br><br>(b) End-of-pipe control technology relies on a combination of flow equalization, physical-chemical methods (such as dissolved air flotation and sludge thickeners), and biological methods (such as activated sludge, aerated lagoons or trickling filters). |
| 6. • Air pollution from refinery operations:<br><br>(a) Storage vessels -- hydrocarbons (HC)<br><br>(b) Refinery process gas -- hydrogen sulfide ($H_2S$)<br><br>(c) Catalyst regenerators -- particulates, carbon monoxide (CO)<br><br>(d) Accumulator vents -- HC<br><br>(e) Pumps and compressors -- HC | 6. • Source control measures to reduce air contaminants and odors:<br><br>(a) vapor recovery systems, floating-roof tanks, pressure tanks, vapor balance, painting tanks white<br><br>(b) ethanolamine absorption, sulfur recovery<br><br>(c) cyclones-precipitator in-situ CO combustion, CO boiler, cyclones-water scrubber, multiple cyclones, electrostatic precipitator, bag filter<br><br>(d) vapor recovery and vapor incineration<br><br>(e) mechanical seals, vapor recovery, sealing glands by oil pressure, maintenance |

## Table 10.16. Petroleum Refining (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| (f) Vacuum jets -- HC | (f) vapor incineration |
| (g) Equipment valves -- HC | (g) inspection and maintenance |
| (h) Pressure relief valves -- HC | (h) vapor recovery, vapor incineration, rupture discs, inspection and maintenance |
| (i) Effluent waste disposal -- HC | (i) enclosure of separators, covering of sewer boxes, use of liquid seal, liquid seals on drains |
| (j) Bulk-loading facilities -- HC | (j) vapor collection with recovery or incineration, submerged or bottom loading |
| (k) Acid treating -- HC, sulfides, mercaptans | (k) continuous-type agitators with mechanical mixing, replacement with catalytic hydrogenation units, incineration of all vented gases, cessation of sludge burning |
| (l) Acid sludge storage and shipping -- HC | (l) same as (k) |
| (m) Spent-caustic handling -- sulfides, mercaptans | (m) Steam scrubbing, neutralization incineration, return system |
| (n) Sweetening processes -- HC | (n) steam stripping of spent doctor solution to hydrocarbon recovery before air regeneration, replacement of treating unit with other less objectionable units |
| (o) Sour-water treating -- ammonia ($NH_3$) | (o) use of sour-water oxidizers and gas incineration, conversion to ammonium sulfate |

## Table 10.16. Petroleum Refining (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| (p) Mercaptan disposal | (p) conversion to disulfides, adding to catalytic cracking charge stock; incineration, use of material in organic synthesis |
| (q) Asphalt blowing -- HC | (q) incineration, water scrubbing (non-recirculating type) |
| (r) Shutdowns, turnarounds -- HC | (r) depressurizing and purging to vapor recovery |
| (s) Boilers and heaters -- $SO_x$, $NO_x$, particulates | (s) fuel hydro-desulfurization, flue gas desulfurization |
| (t) Sulfur recovery unit (Claus) -- $SO_2$ | (t) provide tail gas treatment; spare unit put into operation during main unit downtime |
| (u) Solvents (hydrocarbons, amines) | (u) provide closed circuit recovery units |
| 7. Noise Emissions | 7. • Enclose noise emitting equipment/processes in structures to reduce potential for fugitive emissions.<br>• Employ other noise abatement procedures. |
| 8. Accidental release (spills) of raw materials, products, potentially hazardous solvents, chemicals, acidic and alkaline materials. | 8. • Inspect and maintain storage and disposal areas to prevent accidental release.<br>• Provide alarms, automatic shut-off valves, containment (bunding, enclosing) of accidental spills, spill mitigation equipment and emergency response plans. |

Table 10.16. Petroleum Refining (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 9. Surface runoff of constituents, raw materials, processing facilities and transfer areas can pollute surface waters or percolate to ground waters. | 9. • Rainwater percolation and runoff follow appropriate regulators for product or raw material transport can be controlled by covering and/or containment to prevent percolation and runoff to ground and surface waters.<br>• Diked areas should be lined and of sufficient size to contain an average 24 hour rainfall. |
| **Indirect** | |
| 10. • Occupational health effects on workers due to fugitive dust, materials handling, noise or other process operations.<br>• Accidents occur at higher than normal frequency because of level of skill or labor. | 10. • Facility develops a Safety and Health Program designed to identify, evaluate, monitor, and control safety and health hazards at a specific level of detail, and to address the hazards to worker health and safety and procedures for employee protection, including any or all of the following:<br>• site characterization and analysis<br>• site control<br>• training<br>• medical surveillance and tracking of clinical records<br>• engineering controls, work practices and personal protective equipment<br>• monitoring<br>• informational programs<br>• handling raw and process materials<br>• decontamination procedures<br>• emergency response<br>• illumination<br>• sanitation at permanent and temporary facilities |

**Table 10.16. Petroleum Refining (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 11. Regional solid waste problem exacerbated by inadequate on-site storage. | 11. Plan for adequate on-site disposal areas assuming screening for hazardous characteristics of the leachate is known. |
| 12. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials to/from facility. | 12. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility to select best routes to reduce impacts.<br>• Transporter regulation and development of emergency contingency plans to minimize risk of accidents. |
| 13. Potential for increased land/surface water degradation by pipeline transport of products or new materials. | 13. • Siting of pipeline should be such as to minimize environmental hazards.<br>• Develop program for periodic pipeline surveillance. |

## Table 10.17. Pulp, Paper, and Timber Processing

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Site Selection** | |
| 1. Siting of plant on/near sensitive habitats such as mangroves, estuaries, wetlands, coral reefs. | 1. • Locate plant in industrially zoned area, if possible, to minimize or concentrate the stress on local environmental services and to facilitate the monitoring of discharges.<br>• Integrate site selection process with natural resource agencies to review alternatives. |
| 2. Siting along water courses causing their eventual degradation. | 2. • Site selection process should examine alternatives that minimize environmental effects and not preclude beneficial use of the water body.<br>• Plants with liquid discharges should only be located on a watercourse having adequate waste-absorbing capacity. |
| 3. Siting can cause serious air pollution problems for local area. | 3. Locate in an area not subject to air inversions or trapping of pollution, and where prevailing winds are towards relatively unpopulated areas. |
| **Direct: Plant Operation** | |
| 4. • Inadequate or non-existent forest management resulting in soil erosion, diminishing biotopes.<br>• Unchecked pesticide application causing toxicologic effects on beneficial organisms and undesirable changes in forest ecosystems. | 4. • In project design phase, develop a forest management plan based on an environmental impact study.<br>• Do not select wood supply from primary forest reserves (for further discussion, see sections on "Natural Forest Management" and "Tropical Forests"). |

**Table 10.17. Pulp, Paper, and Timber Processing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| 5. • Release of gaseous wastes.<br>• Sulfur dioxide<br>• Total reduced sulfur compounds (TRS)<br>• Particulates<br>• Toxic organic compounds (e.g., chlorine, hydrogen sulfide) | 5. • <u>Sulfur Dioxide</u><br>• Control by proper operations such as liquor recovery furnace.<br>• Select appropriate auxiliary fuels.<br>• Fuel desulfurization, flue gas scrubbing, and process modification.<br><br><u>TRS</u><br>• Collection by headers, scrubbed with alkali solution, then burned.<br><br><u>Particulate</u><br>• Removal by evaporator-scrubbers, cyclones or electrostatic precipitators.<br><br><u>Air toxins</u><br>• Prevent/control releases through process design. |
| 6. • Release of liquid wastes to water bodies.<br>• Conventional pollutants causing the following impacts:<br>• changes in pH and toxicity<br>• dissolved and suspended solids<br>• eutrophication<br>• foam and scum<br>• slime growth<br>• thermal effects<br>• changes in taste, color and odor<br>• fish-flesh tainting | 6. • In-plant operating and housekeeping measures:<br>• Pulp washing, chemical and fiber recovery, treatment and reuse of selected waste streams, collection of spills, and prevention of and collection tanks for accidental discharges.<br>• Monitoring of sewers, drainage channels, and discharges to warn of spills.<br>• Load leveling of treatment facilities by use of storage basins and other measures.<br>• Recycling of barking water. |

Table 10.17. Pulp, Paper, and Timber Processing (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct: Plant Operation (continued)** | |
| • Toxins such as trichlorophenol, pentachlorophenol and zinc. | • External effluent treatment:<br>  • Primary--sedimentation basins, gravity clarifiers, and dissolved air flotation.<br>  • Secondary--oxidation ponds, trickling filter, aerated lagoon, activated sludge, irrigation, sedimentation basin (to remove biological solids) and secondary clarifier.<br>  • Toxins control by substitution of less/non-toxic chemicals. |
| 7. • Disposal of solid wastes on the land.<br>  • Subsurface leaching with subsequent contamination of ground and surface water.<br>  • Destruction of ecologically sensitive areas such as marshes and other wetlands.<br>  • Proliferation of rodents, scavengers and insects harmful to human health.<br>  • Fires, health hazards, and unsightly conditions. | 7. Source reduction, source segregation, by-product utilization, appropriate planning and management of disposal sites such as lining of disposal sites with collection system for run-off water and leachate (see "Solid Waste Collection and Disposal Systems" section). |
| 8. Sludge incineration. | 8. • Dewatering by vacuum filtration and chemical conditioning to prepare sludges for burning.<br>• Incinerators:<br>  • waste only<br>  • burning in the bark boiler<br>  • burning in power boiler |

**Table 10.17. Pulp, Paper, and Timber Processing (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect** | |
| 9. • Occupational health effects on workers due to:<br>• Special pulp mill operations such as preparing logs (chipping and grinding).<br>• Handling and storing of pulpwood and paper chips, and raw materials other than pulpwood.<br>• Chemical processes used in making pulp, bleaching, and stock preparation.<br>• Handling of spent liquors and machine room operations involves dust, fumes and gases, as well as special equipment such as shredders, clippers, cutters, heavy mobile equipment, etc. | 9. • Facility should implement a Safety and Health Program designed to:<br>• identify, evaluate, monitor, and control hazards to employees<br>• design safe operating procedures<br>• provide training in safety practices and the handling of emergencies |
| 10. Transit patterns disrupted, noise and congestion created, and pedestrian hazards aggravated by heavy trucks transporting raw materials, fuel and final products to/from the facility. | 10. • Site selection can mitigate some of these problems.<br>• Special transportation sector studies should be prepared during project feasibility stage to select best routes to reduce impacts.<br>• Follow transportation regulations and develop emergency contingency plans to minimize risk of accidents. |

## Table 10.18. Mining and Mineral Processes

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct** | |
| 1. Modification/loss of soil profile, vegetation, and surface drainages during exploration, mining, and construction. | 1. • Require appropriate resource surveys, before disturbance, of areas that may be affected by the project to identify:<br>• cultural and historic resources<br>• flora and fauna<br>• soils<br>• surface and groundwater quality and quantity<br>• land uses<br>• significant topographic features<br>• Mitigation measures based on identified resource conflicts may include:<br>• avoidance<br>• timing of operations<br>• recovering and archiving cultural and historic resources<br>• segregation and stockpiling for use in reclamation (soils) |
| 2. • Damage/destruction of cultural resources and historic sites.<br>• Survey monuments during exploration, mining and construction. | 2. See No. 1. |
| 3. • Degradation of surface waters by soil erosion from disturbed areas, waste piles, and stockpiles.<br>• Decreased capacity of local reservoirs/ponds from siltation. | 3. • Require control of stormwater runoff and prompt revegetation on disturbed areas.<br>• Avoid disturbance of streams, drainages, ponds and wetlands. |

Table 10.18. Mining and Mineral Processes (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| | • Where disturbance cannot be avoided, require use of sediment control structures/practices. |
| | • Water quality standards should include suspended solids. |
| 4. Contamination of surface waters and shallow groundwater wastes, (aquifers) by waste water from mine drainage, equipment servicing, and sanitary and domestic wastes. | 4. • Require treatment of:<br>• mine drainage<br>• sanitary/domestic and stormwater runoff to meet water quality standards before discharge |
| | • Prompt cleanup of any spills (oils, lubricants and cleaning solvents). |
| | • Water quality standards should be established for all waste water discharges. |
| 5. Disruption/contamination of local aquifers by exploration drill holes and mining excavations. | 5. • Avoid or minimize penetration of aquifers below the strata being mined. |
| | • Drill holes outside or below the mine area should be properly cased or sealed. |
| 6. Reduction in local water supplies. | 6. Require replacement from alternate sources. |

Table 10.18. Mining and Mineral Processes (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 7. Reduced reproduction and populations of wildlife from habitat modification and loss. | 7. • Prohibit or restrict disturbance of significant habitat wetlands.<br>• Require prompt reclamation to forage and habitat favorable to local wildlife. |
| 8. Wildlife mortality from road traffic and surface disturbances. | 8. • Mark wildlife road crossings.<br>• Emphasize driver awareness.<br>• Install road underpasses. |
| 9. Degradation/loss of vegetation (and soil productivity) from discharge of contaminated waters (see No. 4). | 9. See No. 4. |
| 10. Modification of vegetation and introduction of non-native species. | 10. Require prompt reclamation of disturbed areas and revegetation with native species. |
| 11. Contamination of surface areas with mineralized/toxic rock material. | 11. Require identification and segregation of toxic rock materials. |
| 12. Degradation of air quality and visibility from airborne particulates (blasting, road traffic, wind erosion). | 12. • Require the following:<br>• proper blasting practices to minimize airborne particulates<br>• watering haulage roads<br>• prompt revegetation or application of sealants and dust suppressants to disturbed areas (including waste and topsoil piles) |

**Table 10.18. Mining and Mineral Processes (continued)**

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 13. Degradation of air quality from routine operational (diesel) emissions. | 13. • Appropriate pollution control devices should be installed and operative on all diesel/gasoline powered equipment.<br>• Hydrocarbon vapor control at all fuel transfer points.<br>• Prompt cleanup of any oil spills. |
| 14. Air quality degradation from processing emissions. | 14. Require use of adequate technology to ensure emissions are kept at acceptable levels. |
| 15. Land-use conflicts. | 15. • Consult with local land users in siting access roads, air fields, utility lines, and to extent possible, mining and processing facilities.<br>• Allow other land uses to continue on the site where compatible with the operations. |
| 16. Road damage, accidents, and traffic delays from increased truck traffic on local roads. | 16. • Observe road load limits.<br>• Design roads for adequate capacity and visibility.<br>• Ensure that roads are properly signed, vehicles are well-maintained, and drivers are trained and safety-conscious.<br>• Provide buses or require that commuting workers car-pool or provide buses. |

Table 10.18. Mining and Mineral Processes (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 17. • Visual intrusions from drill rigs, surface mine excavations and equipment, mine facilities and headframes (underground mines).<br>• Cleared linear rights-of-way for pipelines, utilities, roads and processing facilities (see also No. 12). | 17. • Paint structures to blend with background (vegetation and sky).<br>• Avoid contrasting colors.<br>• Utilize utility corridors, minimize clearing, and blend vegetation where feasible. |
| 18. Disturbance of humans and wildlife by noise from equipment operation, blasting, and processing facilities. | 18. • Utilize earth mound vegetative screening.<br>• Follow proper blasting procedures, use minimum charges, and avoid blasting at night or early morning. |
| 19. Damage to structures and disturbance of local residents by blasting vibrations. | 19. Use blasting procedures to minimize vibrations to nearby residences and structures, and install monitoring instruments at sensitive locations. |
| 20. Injury/loss of life from accidents. | 20. • Periodic training and continual safety reminders to all operating staff.<br>• Require periodic drills in emergency procedures.<br>• Ensure that all visitors are briefed on potential hazards and necessary safety precautions.<br>• Ensure that appropriate safety and rescue equipment is available and employees trained in its use. |

Table 10.18. Mining and Mineral Processes (continued)

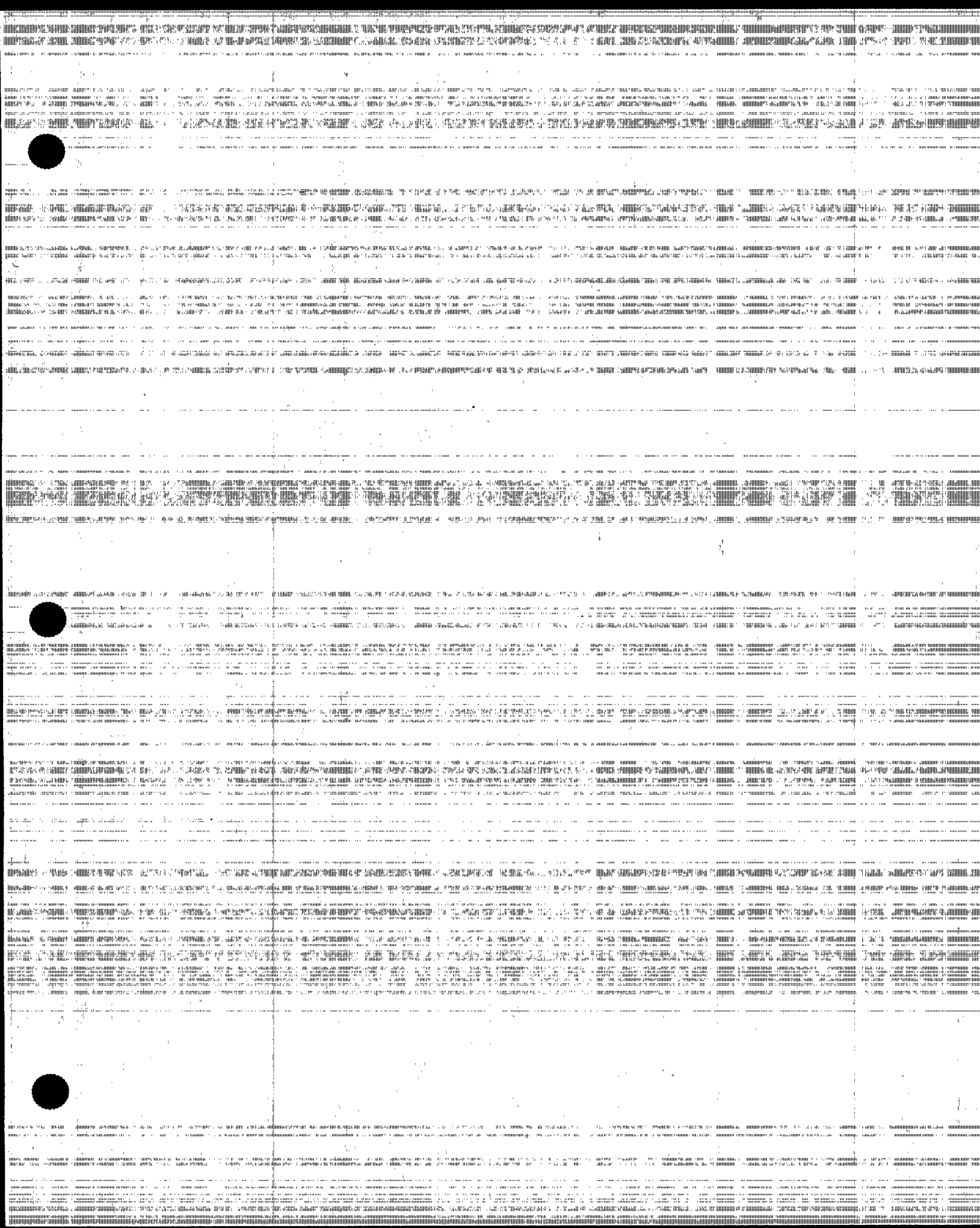
| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 21. Increased demands on services and facilities in local communities, social and cultural conflicts, concern with community stability (boom and bust scenario). | 21. • Require pre-development, socioeconomic study of potentially affected communities to identify possible impacts on services, infrastructure, dislocations, and conflicts.<br>• These impacts can be addressed by:<br>  • community assistance grants<br>  • loans<br>  • prepayment of taxes<br>  • phasing mineral development<br>  • constructing needed community facilities<br>• Cooperative and open working relations should be established early with local communities and maintained throughout the life of the project.<br>• Project workers should be encouraged to participate in community affairs. |
| 22. Conflicts with native cultures, traditions, and life-styles. | 22. • Brief all employees to ensure awareness of and sensitivity to the local cultures, traditions, and lifestyles.<br>• Ensure that native leaders are aware of the projected activities, are assisted in identifying impacts that may be of particular concern to them, and have a voice in appropriate mitigation measures.<br>• Mitigation may include isolating the work force from the native community. |

Table 10.18. Mining and Mineral Processes (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Direct (continued)** | |
| 23. Subsidence of land surface (underground mining). | 23. • Require adequate support be provided in the underground workings through pillars, cribbing or backfill.<br>• Monitor controlled subsidence and identify possible subsidence areas for land-use restrictions. |
| 24. Loss of birds and animals in tailings and leach ponds. | 24. • Minimize surface area of tailings and leach ponds, and require that they be promptly drained or closed when not in use.<br>• Net covering, fencing, or scaring may be required at active ponds. |
| 25. Modification/disruption of surface waters (dredging). | 25. • Require use of sediment control structures/practices.<br>• Water quality standards should include suspended solids. |
| **Indirect** | |
| 1. Degradation of remote areas through improved access and increased use. | 1. • Access remote areas by air rather than roads during early exploration stage.<br>• Restrict use of access roads, and remove and reclaim any access roads at end of production.<br>• Minimize need for community development by rotating work crews and precluding permanent residences. |

Table 10.18. Mining and Mineral Processes (continued)

| Potential Negative Impacts | Mitigating Measures |
|---|---|
| **Indirect (continued)** | |
| 2. Vandalization of cultural resources and historic sites. | 2. • Do not publicize cultural resource sites in remote or unprotected locations.<br>• Restrict unnecessary access and patrol sites. |
| 3. Wildlife loss through poaching. | 3. Prohibit carrying of firearms in area, restrict unnecessary access, and patrol areas. |
| 4. Secondary population growth and related effects. | 4. See No. 20. |



# SECTION 4

# COUNTRY SPECIFIC LAWS/BACKGROUND

# 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 Regulations.** (Source: 46 Federal Register 18026 - 18038, March 23, 1981)

- **EPA's Section 309 Review: The Clean Air Act and NEPA.** U.S. Environmental Protection Agency. March 1995

- **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 Stature, Executive Order, or Other Administrative Directives.** (Source: Council on Environmental Quality. 1992. Environmental Quality. 22nd Annual Report)

## OTHER 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. 1(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), 1506. 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.

United States Environmental Protection Agency
Office of Enforcement and Compliance Assurance

March 1995

# EPA's Section 309 Review: The Clean Air Act and NEPA

Office of Federal Activities (2251)

Quick Reference Brochure

## ENVIRONMENTAL REVIEW AND THE CLEAN AIR ACT

The Clean Air Act, a law to prevent pollution of a single environmental medium, contains an unusual provision. That provision is Section 309, which authorizes the Environmental Protection Agency (EPA) to review certain proposed actions of other federal agencies in accordance with the National Environmental Policy Act (NEPA) and to make those reviews public. If the proposing agency (the "lead" agency) does not make sufficient revisions and the project remains environmentally unsatisfactory, EPA may refer the matter to the President's Council on Environmental Quality for mediation. (See **Highlight A.**)

### HIGHLIGHT A: Section 309 of the Clean Air Act

(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 Act 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 102(2)(C) of Public Law 91-190 [*] 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 standpoint 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.

[*] NEPA (42 *USC* 4332(2)(C) et seq.)

Section 309 originated in 1970, the year in which landmark national legislation created new agencies and new requirements for restoring and protecting the environment. Besides NEPA and its creation of CEQ, the National Oceanic and Atmospheric Administration (NOAA) and EPA were established, and, at the end of 1970, the Clean Air Act was passed. At that time, many issues of environmental consequence were brewing (see **Highlight B**), one of which—the proposed supersonic transport aircraft (SST)—became a crucial test of NEPA. (See **The National Environmental Policy Act** section, below.)

The lead agency for the SST project, the Department of Transportation (DOT), chose not to disclose EPA's comments on the NEPA-required environmental impact statement (EIS) before having

issued its final decision, construing NEPA to contain no explicit public disclosure requirements. Although later CEQ regulations under the Act would clarify this ambiguity, the Congress had a vehicle at hand in which to make its point: the draft Clean Air Act. Senator Edmund Muskie, sponsor of Section 309, said to the Senate when submitting the conference report, that as soon as EPA has completed its review of a proposed action, it must make its written comments public, and "not when the environmental impact agency decides the public should be informed." (116 *Cong. Rec.* S-20602, Dec. 18, 1970)

**HIGHLIGHT B: When NEPA Was New: 1970-1971 Issues**

- Trans-Alaska oil pipeline and the North Slope-Valdez route
- Supersonic transport aircraft
- Cross-Florida Barge Canal
- Clearcutting "areas of scenic beauty" in national forests
- Tennessee-Tombigbee Waterway
- Dredging and filling in wetlands
- Calvert Cliffs (MD) nuclear power plant

To correct another ambiguity of NEPA, Section 309 places the requirement to review EISs upon EPA because NEPA "does not assure that Federal environmental agencies will effectively participate in the decision-making process. It is essential that mission-oriented Federal agencies have access to environmental expertise in order to give adequate consideration to environmental factors." (*Sen. Rept.* No. 91-1196, 91st Cong., 2d Sess. 43, 1970) Consequently, EPA has reviewed most of the approximately 20,000 draft and final EISs produced since the passage of NEPA.

Section 309 confers upon EPA broad review responsibilities for proposed federal actions. (See Highlight C.) The EPA Administrator delegates this responsibility to the Office of Federal Activities (OFA), which has developed a set of criteria for rating draft EISs. The rating system provides a basis upon which EPA makes recommendations to the lead agency for improving the draft. If improvements are not made in the final EIS, EPA may refer the final EIS to CEQ. (See sections on **The National Environmental Policy Act** and **Referrals**, below.)

**HIGHLIGHT C: Materials Which EPA Reviews Under Section 309 Authority**

- Proposed legislation
- Proposed regulation
- Environmental assessment (EA)
- Environmental impact statement (EIS), draft and final
- Any proposal that the lead agency maintains does not require an EIS but that EPA believes constitutes a major federal action significantly affecting the environment so as to require an EIS.

Annually, OFA's Federal Agency Liaison Division and its regional counterparts review about 450 EISs and some 2000 other actions (see **Figures 1** and **2**). Among the variety of proposed actions that may be reviewed, besides that for which an agency provides an impact statement, are: legislation proposed by a federal agency; a proposed agency regulation; the renewal of an action originally approved before the enactment of NEPA; a proposal for which an agency has determined that no impact statement is needed, whether or not the agency has published a Finding of No Significant Impact (FONSI); and, an action that is actually a segment of either a program or a reasonably expected succession of actions that could result in a cumulative negative impact on human health or welfare or the environment.

**Figure 1: EPA's Criteria for Sec. 309 Review of Impact Statements**

Rating Environmental Impacts:

LO--Lack of Objections

EC--Environmental Concerns--Impacts identified that should be avoided. Mitigation measures may be required.

EO--Environmental Objections--Significant impacts identified. Corrective measures may require substantial changes to the proposed action or consideration of another alternative, including any that was either previously unaddressed or eliminated from the study, or the no-action alternative). Reasons can include:

- o violation of a federal environmental standard;
- o violation of the federal agency's own environmental standard;
- o violation of an EPA policy declaration;
- o potential for significant environmental degradation; or,
- o precedent-setting for future actions that collectively could result in significant environmental impacts.

EU--Environmentally Unsatisfactory--Impacts identified are so severe that the action must not proceed as proposed. If these deficiencies are not corrected in the final EIS, EPA may refer the EIS to CEQ Reasons, in addition to impacts identified, can include:

- o substantial violation of a federal environmental standard;
- o severity, duration, or geographical extent of impacts that warrants special attention; or,
- o national importance, due to threat to national environmental resources or policies.

Rating Adequacy of the Impact Statement:

1 (Adequate)--No further information is required for review.

2 (Insufficient Information)--Either more information is needed for review, or other alternatives should be evaluated. The identified additional information or analysis should be included in the final EIS.

3 (Inadequate)--Seriously lacking in information or analysis to address potentially significant environmental impacts. The draft EIS does not meet NEPA and/or Section 309 requirements. If not revised or supplemented and provided again as a draft EIS for public comment, EPA may refer the EIS to CEQ.

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(See Selected Publications, below: EPA's ***Policy and Procedures for the Review of Federal Actions Impacting the Environment.***)

In addition to conducting environmental reviews, OFA develops guidance materials and provides training courses on NEPA and Section 309 requirements for EPA regional staff, and promotes coordination between EPA offices and other federal agencies. Also, OFA distributes annual certificates of merit to federal agencies in recognition of outstanding performance for environmental protection.

## THE NATIONAL ENVIRONMENTAL POLICY ACT AND CEQ

The National Environmental Policy Act (NEPA, 42 *USC* 4321 et seq.) was enacted on January 1, 1970 in recognition of the widening influence on the human and natural environment that individual federal agency actions can exert. With its stated purpose (see **Highlight D**) and with heightened

public awareness of environmental quality questions, NEPA makes its goals and policies "supplemental to those set forth in existing authorities of Federal agencies" (NEPA, Section 105). In this way, the agencies' authorizing statutes were amended to include NEPA requirements.

Title I of NEPA requires the federal government to use all practicable means to preserve and maintain conditions under which human beings can coexist with the natural world in productive harmony. Section 102 directs federal agencies to lend appropriate support to initiatives and programs meant to anticipate and prevent degradation of world environmental quality. Further, this section requires federal agencies to incorporate environmental considerations in their decision-making, using a systematic, interdisciplinary approach.

**HIGHLIGHT D: The Purposes of NEPA**

The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

(PL 91-190, 42 *USC* 4321 et seq.)

Title II of NEPA establishes the Council on Environmental Quality (CEQ, or the Council). Two months after enactment of NEPA, the President issued Executive Order 11514 authorizing CEQ to guide the Sec. 102 process. Under this order, the Council immediately published guidelines, followed in 1978 by regulations (40 *CFR* Parts 1500-1508) requiring all Federal agencies to issue NEPA regulations consistent with CEQ's. Advisory to the President, CEQ conducts studies, prepares the annual Environmental Quality Report to Congress, and reviews EISs. Moreover, CEQ mediates interagency disputes concerning environmental analyses of matters of national importance. (See **Referrals** section, below.)

As evidence of compliance with the NEPA Section 102 provisions for a proposed major action that could significantly affect the environment, CEQ requires the lead agency to prepare a detailed written statement addressing NEPA concerns, i.e., an EIS (40 *CFR* Part 1501). The lead agency may first prepare an environmental assessment (EA), which is a concise public document (40 *CFR* Part 1501.3) that determines whether an EIS or a FONSI (40 *CFR* Part 1501.4(e)) should be prepared. An EA is not necessary, however, if the agency has decided at the outset to prepare an EIS.

For review, the lead agency provides the EIS to those federal agencies having statutory jurisdiction or special expertise, as well as to appropriate other federal, state, and local agencies; Indian tribes, when the proposed action might impact tribal lands; and, the interested or affected public (40 *CFR* Part 1503.1). Once the EIS is final, the lead agency must file it formally, simultaneously making it available to the public, together with the reviewers' comments and the lead agency's responses to those comments (40 *CFR* Part 1506.9). The CEQ regulations designate EPA the official recipient of all final EISs, which responsibility the EPA Administrator delegates to OFA.

## REFERRALS TO THE COUNCIL ON ENVIRONMENTAL QUALITY

The "predecision referrals" provision (40 *CFR* Part 1504) enables any federal agency under NEPA to refer another agency's final EIS to CEQ during the 30-day waiting period before a lead agency can proceed with the action. On the other hand, Section 309 authorizes EPA to refer to CEQ a broader range of federal activities, not only actions for which EISs are prepared. The CEQ regulations (40 *CFR* 1504.1(b)) implement Section 309 of the Clean Air Act, acknowledging that EPA has been assigned more extensive review and referral authority than the other agencies (see **Highlight C**).

Within 25 days after the lead agency has made the final EIS available to the public, the referring agency must provide early notification to that agency about its intention, and make its referral in writing to CEQ. The lead agency, once it has received written notification from CEQ, is to respond in writing within 25 days. During that same period, other agencies and the public may submit written comments to CEQ. Then CEQ may publish Findings and Recommendations; mediate between the disputing agencies; hold public meetings or hearings; refer irreconcilable disputes to the Executive Office of the President for action; or, conclude either that the issue is not of national importance or that insufficient information has been submitted upon which to base a decision.

In the time since the referral process was formally established in 1973, agencies have referred a total of 24 proposed federal actions to CEQ. Of these, EPA was responsible for 15, of which one was referred jointly with the Department of the Interior (DOI). (See **Figure 2** for EPA regional environmental review offices.) So far, in no case has CEQ made a formal referral to the Office of the President. Most often, CEQ has issued Findings and Recommendations. In a few cases the lead agency has withdrawn the proposal, and in three cases CEQ determined that the issue was not a matter of national importance.

In 1989, CEQ upheld EPA's Section 309 referral authority. At issue was a DOI Bureau of Reclamation proposal to renew longterm water contracts for irrigation operations of the Friant Unit in the Central Valley Project of California. The reason for referral was that no EIS had been prepared on the contract renewals, which individually and in the aggregate were likely to result in unsatisfactory environmental effects. In response, DOI questioned EPA's right to challenge the agency's decision that no EIS was needed. In rejecting that argument, CEQ established a precedent, that is, affirmed that EPA may identify a major federal action significantly affecting the environment, even though the lead agency disagrees.

**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:<br>Cal. Food & Agric. Code §33487 (new construction or repairs of dairy farms)<br>Cal. Gov. Code §7075 (establishment of enterprise zones)<br>Cal. Gov. Code §7087.5 (initial study and notice of preparation under Employment and Economic Incentive Act)<br>Cal. Gov. Code §51119 (timberland production zones; exemption)<br>Cal. Gov. Code §65950.1 (extension of time for EIR for planning and zoning of development projects)<br>Cal. Health & Safety Code §33333.3 (preparation and adoption of community redevelopment plans)<br>Cal. Health & Safety Code §56040 (implementation and administration for large scale urban development)<br>Cal. Pub. Res. Code §6873.2 (oil and gas leases on tide and submerged lands and beds of navigable rivers and lakes)<br>Cal. Pub. Res. Code §25540.4 (power facility and site certification)<br>Cal. Pub. Res. Code §30718 (implementation of port development under California Coastal Act)<br>Cal. Str. & H. Code §199.9 (mass transit guideway system)<br>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). |